TRANSIT COOPERATIVE RESEARCH PROGRAM

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TCRP Synthesis 9

Waste Control Practices at Bus Maintenance Facilities

A Synthesis of Transit Practice

Transportation Research Board
National Research Council

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Synthesis of Transit Practice 9

Waste Control Practices at Bus Maintenance Facilities

DOUGLAS D. LOWELL
Acurex Environmental
Mountain View, California

Transportation Research Board
National Research Council

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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213--Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Federal Transit Administration (FTA). A report by the American Public Transit Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academy of Sciences, acting through the Transportation Research Board (TRB), and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at anytime. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

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The TCRP provides a forum where transit agencies can cooperatively address common operational problems. TCRP results support and complement other ongoing transit research and training programs.

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PREFACE

A vast storehouse of information exists on many subjects of concern to the transit industry. This information has resulted from research and from the successful application of solutions to problems by individuals or organizations. There is a continuing need to provide a systematic means for compiling this information and making it available to the entire transit community in a usable format. The Transit Cooperative Research Program includes a synthesis series designed to search for and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in subject areas of concern to the transit industry.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on measures found to be successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation Research Board

This synthesis will be of interest to transit agency general managers, as well as to personnel in operations, maintenance, and environmental departments. It will also be of interest to environmental agency officials, equipment suppliers, consultants, and others concerned with bus maintenance and fueling operations, planning, and design. This synthesis explores waste management practices employed in bus maintenance and fueling operations and it identifies some successful practices that are being employed to reduce or eliminate waste.

Administrators, practitioners, and researchers are continually faced with issues or problems on which there is much information, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered or not readily available in the literature, and, as a consequence, in seeking solutions, full information on what has been learned about an issue or problem is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to the available methods of solving or alleviating the issue or problem. In an effort to correct this situation, the Transit Cooperative Research Program (TCRP) Synthesis Project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common transit issues and problems and synthesizing available information. The synthesis reports from this endeavor constitute a TCRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to a specific or closely related issue or problem.

This report of the Transportation Research Board strives to familiarize transit agency staff with federal and state environmental regulations involving wastes generated by bus maintenance activities. Complying with these regulations and local guidelines that may also apply can be confusing and costly, but failing to comply may lead to administrative, civil, or criminal penalities, including fines and imprisonment. An equally powerful force pushing agency managers to move in the direction of waste minimization is the opportunity to generate significant cost savings.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, available information was assembled from numerous sources, including a large number of public transportation agencies. A topic panel of experts in the subject area was established to guide the researchers in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now on hand.

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WASTE CONTROL PRACTICES AT BUS MAINTENANCE FACILITIES

SUMMARY

Transit agencies must comply with federal and state environmental regulations involving management of wastes generated by bus maintenance activities. These regulations, the most notable of which is the Federal Resource and Recovery Act (RCRA), generally dictate methods for identifying, tracking, storing, transporting, and disposing of hazardous and toxic wastes. A thorough understanding of each applicable regulation is necessary for successful waste management. Complying with these regulations can be both confusing and costly. Failing to comply with environmental regulations may lead to administrative, civil, or criminal penalties, including fines and imprisonment.

Along with all other regulated industries, transit agencies have had to develop extensive recordkeeping and careful waste-handling systems to comply with these regulations. In the course of complying, many transit agencies have looked beyond the letter of the regulations, seeking not only to behave as responsible stewards of their local environments, but also to implement innovative waste control or waste reduction methods. Although waste control is everyone's responsibility, success in this area is keyed to a dependable and well-trained facility maintenance work force, whose diligence results in the benefits that accrue from waste minimization. The importance of maintaining clean and attractive bus parking areas and the use of oil/water separators to capture oil and drips found in common stormwater discharges cannot be overlooked. Further, many transit agencies have identified and capitalized on opportunities for cost savings as a result of employing waste control practices.

This synthesis describes the waste control practices employed by 21 transit agencies in bus maintenance and fueling operations. Specifically, this project examines waste control practices for painting and paint removal, washing and cleaning, parts cleaning, fueling and fuel storage, changing of oil and antifreeze, and replacement of Freon, batteries, tires, and filters. Recycling of glass, metal, and vinyl are outside the scope of this report.

Much of the waste resulting from painting and paint removal operations is classified as hazardous. To reduce waste volume and emissions of volatile organic compounds, some agencies have switched from conventional spray guns to modern, high-transfer-efficiency equipment. Other techniques in use include alternative coatings, such as synthetic enamels, water-borne paints, and high-solids paints. Rigid inventory control and improved housekeeping practices were also cited as important paint waste reduction methods.

Conventional paint removal methods, such as chemical stripping are still in use, but several transit agencies prefer a media blasting technique. Of the agencies practicing

media blasting (traditionally performed with sand), a growing number are switching from sand to plastic beads. Media blasting can generate a large reduction in the volume of paint-removal waste as well as a cost savings relative to chemical stripping.

Wastes generated by bus and engine washing and cleaning operations include hazardous and nonhazardous wastewater and sludge. Wastewater is either discharged to sewers, or recycled on-site. Recycling wastewater is an effective way to reduce the quantity generated, and may be necessary for some transit agencies to meet state and local water discharge regulations. Sludge from bus washing operations generally is disposed of in a landfill.

Waste solvents and metal-containing solid wastes are the primary wastes generated from parts cleaning operations. Used solvents that have lost their effectiveness and require replacement can be recycled off-site or on-site. Leasing solvent sinks, a practice employed by many transit agencies, allows them to conduct parts cleaning on-site while leaving the waste handling responsibilities to contractors specializing in hazardous waste management. Industrial furnaces designed to pyrolize dirt and grease, leaving a dry residue that can be brushed off, eliminates the hazardous waste stream associated with solvent-based parts cleaning. This technique, which requires high capital investment and high energy costs, is being demonstrated at two of the agencies surveyed.

To minimize fuel spills and leaks, spill containment systems and secondary containment for stored fuels can be used. Containment methods used for fuels include doublewalled piping, aboveground piping systems, electronic leak detection within piping systems and around tanks, and vacuum extraction from fuel tanks to lessen fuel pressure contributing to leaks.

Options for effectively managing used oil, other lubricants, and antifreeze include various methods of on- and off-site recycling. Refrigerants are recycled with special equipment to prevent the release of chlorofluorocarbons into the atmosphere. Both airconditioning technicians and equipment now require certification under Environmental Protection Agency regulations that became effective in November of 1994.

On a weight basis, used batteries are one of the largest categories of hazardous waste generated by transit agencies. Transit agencies surveyed currently either sell used batteries to a recycler or return them to the vendor. The batteries are then rebuilt for resale or sent to a processor for material salvage.

Re-treading is the most common form of tire recycling. Currently, about one-fifth of the vehicle tires made in the United States are re-treaded. Tires that are in poor condition are used for asphalt paving, brake lining, bumpers, boiler fuel, and new tires.

Most transit agencies place used air filters in drums and dispose of them in landfills. A few employ innovative air-filter waste management techniques, including rebuilding conventional filters or employing reusable filters. Used oil filters are drained and crushed, then sold for scrap, recycled, or disposed in a landfill.

Many agencies participating in this project noted that a key to waste reduction from an operational standpoint is simply to maintain clean, well-organized work stations that result from improved housekeeping. While rules and regulations are forcing transit agencies and other pollution generators to re-examine their procedures, materials, facilities, and overall operations to cut back on the volume and harmful effects of their waste streams, an equally powerful force pushing agency managers to move in the direction of waste minimization is the opportunity to generate significant cost savings. The combined effects of these efforts provide the public with a double benefit: a cleaner environment with less waste to dispose of, plus a more cost-effective public transit alternative.

CHAPTER ONE

INTRODUCTION

Transit agencies must comply with federal and state environmental regulations involving wastes generated by bus maintenance activities. These regulations generally dictate methods for tracking, storing, transporting, and disposing of hazardous and toxic wastes. Complying with these regulations can be both difficult and costly. A thorough understanding of each applicable regulation is necessary for successful waste management. Failing to comply with environmental regulations may lead to administrative, civil, or criminal penalties, including fines and imprisonment.

Along with all other regulated industries, transit agencies have had to develop extensive recordkeeping and careful waste-handling systems to comply with these regulations. In the course of complying, many transit agencies have looked beyond the letter of the regulations, seeking not only to behave as responsible stewards of their local environments, but also to implement innovative waste control or waste reduction methods that reduce the volume of waste generated from their facilities. Furthermore, many transit agencies have identified and capitalized on opportunities for cost savings as a result of employing waste control practices.

PROJECT SCOPE

This synthesis examines the waste control practices employed by transit agencies in bus maintenance operations. Specifically, the project examines waste control practices for the following activities involved in bus maintenance:

- Painting and paint removal
- Washing and cleaning
- Parts cleaning
- Fueling and fuel storage
- Changing oil and antifreeze
- Freon replacement
- Battery replacement
- Tire replacement
- Filter replacements

This synthesis first describes the federal regulatory environment pertaining to these bus maintenance activities, and highlights several examples to demonstrate how state regulations can extend beyond the federal statutes Next, current waste control practices of 21 U.S. transit systems are discussed, and more detailed case studies of the waste management practices at two transit agencies are presented. The topics of air emissions from vehicle refueling and engine emissions from transit buses are outside the focus of this synthesis, as is discussion of recycling of glass, metal, or vinyl.

To assist the reader, a glossary of technical terms and acronyms is provided immediately following the main text of this synthesis report.

BACKGROUND: LEGISLATIVE AND REGULATORY REQUIREMENTS

Because their bus maintenance activities generate toxic and hazardous wastes, transit agencies nationwide must comply with federal, state, and local environmental regulations related to the use, storage, and disposal of waste materials. Managers of bus maintenance facilities must develop a thorough knowledge of the regulations applicable to waste management in a given locale to ensure the proper handling of the toxic and hazardous wastes generated at their facilities. States and local governments have the authority to pass regulations that are more stringent than federal regulations Transit agencies must understand the state and local regulations and how they differ from federal regulations. Some examples of local regulations are discussed in this chapter.

Transit agencies should also be familiar with Occupational Safety And Health Administration (OSHA) regulations, which address proper employee protection for handling toxic and hazardous wastes While important, this subject is extensive and outside the scope of this synthesis.

To provide transit agencies with descriptions of the major environmental requirements that may affect acquisition and maintenance of vehicles and facilities, the Federal Transit Administration published a *Sourcebook on Transit-Related Environmental Regulations*, (Report DOT-T-95-09) in December of 1994. Section 5 of the *Sourcebook* addresses hazardous waste management at transit facilities. The *Sourcebook* is a guide to the complex regulatory documents that govern waste management. These documents include the *U.S. Code*, which codifies all federal legislation, the *Code of Federal Regulations* (CFR), which codifies all federal regulations that implement federal statutes, and the *Federal Register*, in which the regulations as well as other important notices are first published. The *Sourcebook* is an excellent complement to this report. Readers should look to the *Sourcebook* for the specific citations that refer to the sections of those regulations in which they are interested.

Federal Regulations

Applicable federal regulations pertaining to toxic chemicals usage and hazardous waste generation at transit bus maintenance facilities are summarized in Table 1. The federal Resource Conservation and Recovery Act (RCRA) of 1976 is the most significant waste management regulation. Passed by Congress to ensure the proper management of all hazardous wastes, RCRA introduced the concept of "cradle to grave" waste management. Under this concept, the waste generator must control and document the management of a hazardous waste from the time it is generated until its ultimate disposal, and actually even after its disposal. RCRA dictates that, to dispose of hazardous wastes at a permitted landfill

TABLE 1
FEDERAL REGULATIONS AND REQUIREMENTS FOR WASTE MANAGEMENT

Federal Regulations	Requirements
Resource Conservation and Recovery Act (RCRA) 40 CFR Ch. 1, 260-266 (cradle-to-grave responsibility)	Generator ID number Proper waste determination-listed or characteristic Proper storage Weekly inspection Accumulation and storage limits Labeling as hazardous waste Contingency plan Training Uniform hazardous waste manifest Record retention Biennial report
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (spills, liability-Superfund)	Spill response and reporting Establish financial responsibility (insurance, taxes)
Hazardous and Solid Waste Amendments (HSWA) (hazardous and solid waste)	Construction standards Leak detection Reporting Records Closure Financial responsibility (land disposal)
Superfund Amendments and Reauthorization Act (SARA) (Superfund)	Community right to know Amendment to CERCLA
Clean Water Act (CWA) (water emissions, regional water quality)	National Pollution Discharge Elimination System (NPDES) Stormwater permits
U.S Department of Transportation (DOT) (labeling, packaging, manifesting)	Labeling requirements Performance oriented packaging Shipping papers/manifests

disposal facility, the waste generator (the transit agency, in this case) must provide appropriate and adequate storage for the waste on-site until shipment is made to the disposal site. The generator is responsible for choosing a reputable transporter and disposal site. The generator must also fully document the contents of the waste in a hazardous waste manifest that remains with the waste material from generation through ultimate disposal. Finally, the waste generator must provide adequate training to employees who handle the waste.

Congress amended RCRA with the Hazardous and Soil Waste Amendments of 1984 (HSWA), imposing far-reaching new requirements on hazardous waste management. HSWA indicates a clear federal redirection away from landfill disposal and toward waste reduction, recycling, and new treatment technologies for flammable, reactive, corrosive, and toxic wastes.

Complementing the preventive focus of the RCRA legislation, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, which was later amended under the Superfund Amendments and Reauthorization Act (SARA) of 1986, provides a national policy and procedures to identify and clean up sites contaminated by releases of hazardous substances, and to finance these remediation activities. The Superfund program, created to implement CERCLA and SARA, is administered by the EPA, but specific elements of these laws allow states with approved CERCLA programs to take the leading role in certain waste removal and cleanup situations. The laws also provide for extensive public participation in the process. The Superfund program provides funding for response and cleanup at federally recognized sites, with separate funding for cleanup at additional statelisted sites. The Superfund program has the following purposes:

- Identify sites that may be contaminated with hazardous substances
- Set priorities for waste removal and cleanup
- Rank contaminated sites according to a quantitative hazard ranking system (HRS)
- Identify parties potentially responsible for contamination of the site
- Clean up the site
- Provide funding
- Report source reduction and recycling efforts.

Among the parties potentially responsible for contaminating a given site, all can be held liable for waste removal and ultimate cleanup, including the original hazardous waste generator, the waste transporter, the disposal site or facility operator, and the landowner. "Potentially responsible parties" is a legal term used frequently in hazardous waste regulations to identify all persons or organizations who have any connection with a hazardous waste; the phrasing used in this section, while worded slightly differently to fit the sentence, is intended to convey the same meaning as the legal phrase. Together, these contributing parties are potentially jointly liable for the entire cost of a cleanup. The technical term that describes the liability of all potentially responsible parties is "jointly and severally" liable. This term means that the group shares the liability, and in the worst case, each separate party is potentially liable for the entire cost of remediation.

In addition to the national legislation, industry associations such as the National Fire Protection Association (NFPA) provide industry-wide codes for such things as underground storage tanks for petroleum products.

State and Local Requirements

Under RCRA, individual states may apply to EPA for approval to conduct their own hazardous waste management programs. Many states do not impose additional regulations to the waste management regulations mandated by the federal government However, many states now have waste management regulations that are in some aspect more restrictive than federal regulations. The majority of these changes from the federal regulations impact only reporting requirements. Several states have begun regulating wastes beyond those defined as hazardous under RCRA, while also implementing land disposal restrictions and mandating recycling programs for spent solvents.

Because a discussion of the regulations of each state is not possible within a concise synthesis report, the following subsection focuses on the California regulations as an example of the additional regulations imposed by a particular state with environmentally aggressive policies.

The centerpiece of California's hazardous waste program is regulated under the California Hazardous Waste Control Act This law gives California enforcement responsibility under RCRA for hazardous waste within the state. While this law implements the same basic requirements as found in RCRA, there are significant differences These differences are:

- California uses different analytical techniques to define a hazardous waste;
- California includes as hazardous waste asbestos, PCB-containing wastes, and mislabeled or damaged containers of wastes;
- California classifies waste generators as exempt or not exempt, with exemption levels different from those found in RCRA;
- California imposes additional recycling requirements stricter than those found in RCRA;
- California requires the permitting of transportation facilities

The state has enacted special rules regarding several materials related to bus maintenance activities. These materials, which require special handling, disposal, and/or recycling, include the following:

- Automobile batteries
- Latex paint
- Motor oil and oil products (includes brake and transmission fluids)
- Spent oil filters
- Wastewater from bus washing

The Carpenter-Presley-Tanner Hazardous Substance Account Act, commonly known as *California Superfund,* requires that waste handlers report immediately upon discovery, a release or threat of release of hazardous material into the environment. The local administrative agency must be notified immediately, and the state must be notified within 30 days. In addition, *California Superfund* requires an inventory of hazardous chemicals be prepared every 2 years. California also requires facilities to report all waste minimization efforts that have been employed, mandating those that are technically and economically feasible. If significant quantities of hazardous materials are located at the facility, a risk management plan may be requested to determine the potential risk of release of hazardous materials from the facility.

Many other states are still developing and refining their programs, and the pace of program development varies from one state to another. For this reason, experts caution waste generators (which include bus maintenance facilities operated by transit agencies) to familiarize themselves with not only the federal requirements but also any variations or additions dictated by state regulations. Examples of these include the following:

- Alabama has more stringent technical standards for the design of storage areas where hazardous wastes are intended for storage for no more than 90 days,
- North Carolina has more extensive recordkeeping requirements for generators of hazardous wastes, and
- Texas has three classifications of nonhazardous wastes, each with its own set of management requirements.

Local Regulations

County health departments and local fire departments may impose restrictions on the storage of hazardous chemicals and wastes. Building codes and electrical codes also may pertain. In addition, local fire departments, as well as local sewer and regional water quality control boards, may require a risk management prevention program or spill control measures, including an evacuation and spill control plan. In general, local governments primarily enforce federal or statewide hazardous waste regulations.

CHAPTER TWO

WASTE MANAGEMENT PRACTICES

Twenty-one transit agencies nationwide were surveyed on their waste management practices for each of the nine transit operations described in the preceding chapter. Each agency completed a questionnaire that requested it to define its facility, characterize its waste streams, and describe its current waste management practices. Samples of the initial and follow-up questionnaires are provided in Appendix A. Responses are tabulated in Appendix B. Table 2 shows the state-by-state distribution of the 21 responding agencies. On-site investigations were also performed at two selected transit agencies. To complement the information gathered directly from transit agencies through the site visits and the survey, and to gather additional information relevant to waste management practices at transit facilities, a literature search was performed This chapter incorporates and discusses the results of both the survey and the literature search for the nine transit operations.

TABLE 2
SURVEY RESPONDENTS

Agency Number	Transit Agency	Approximate Bus Fleet Size
1	Alameda-Contra Costa Transit (Oakland, California)	750
2.	Bi-State Development Agency (St Louis, Missouri)	640
3.	Central Oklahoma Transportation (Oklahoma City, Oklahoma)	83
4	Command Bus Company, Inc (Brooklyn, New York)	140
5.	Green Bus Services (Jamaica, New York)	180
6.	Metropolitan Transit Authority (Houston, Texas)	1,260
7.	Los Angeles County MTA (Los Angeles, California)	2,300
8	Metro Dade Transit Agency (Miami, Florida)	700
9	New Jersey Transit (Newark, New Jersey)	1,900
10	New York City Transit Authority (Brooklyn, New York)	3,960
11.	Orange County Transportation Authority (Garden Grove, California)	500
12	Phoenix Transit Systems (Phoenix, Arizona)	330
13	Pierce County Public Transit (Tacoma, Washington)	165
14.	Regional Transportation District (Denver, Colorado)	820
15.	Sun Tran Public Transit (Tucson, Arizona)	200
16	Jamaica Buses, Inc (Jamaica, New York)	100
17	Greater Bridgeport Transit District (Bridgeport, Connecticut)	52
18	Manistee County Transportation, Inc (Manistee, Michigan)	23
19	Great Falls Transit District (Great Falls, Montana)	18
20	Tri-County Metropolitan (Portland, Oregon)	600
21	Capital Metropolitan Transportation Authority (Austin, Texas)	230

PAINTING AND PAINT REMOVAL

Painting and paint removal operations include bus painting, paint removal, and touchup operations. The types and quantities of waste generated by these operations depend on the painting and paint removal methods and materials used. Wastes generated from painting at surveyed transit facilities include leftover paints and paint wastes. Wastes from paint removal operations include used thinners from chemical stripping and inorganic wastes from media blasting. With the exception of the inorganic wastes, these wastes are classified as hazardous and are subjected to the RCRA rules and regulations governing hazardous wastes described in the preceding chapter.

The survey responses reveal that some agencies (7 of the 21 who responded) have switched from conventional spray guns to modern, high-transfer-efficiency equipment. The remaining transit agencies either still use conventional spray equipment, do not conduct painting operations, or did not address this part of the questionnaire.

Chemical stripping, a conventional paint removal method, is carried out at three transit facilities. Twelve transit agencies use a media blasting technique (traditionally performed with sand) for paint removal A few facilities have switched from sand to plastic beads, the state-of-the-art material for removing paint through media blasting. The waste management practices followed by the responding agencies for painting and paint removal operations are discussed separately below.

Painting

Three practices are commonly employed to reduce wastes from painting operations:

- Minimizing overspray using high-transfer-efficiency equipment,

- Using alternative coatings, and
- Maintaining rigid inventory control and good housekeeping.

Paint wastes can be reduced by minimizing paint overspray with high-transfer-efficiency painting equipment, as less paint misses the targeted surface than with conventional spray equipment. Examples of this equipment include high-volume, low-pressure (HVLP) spray guns; high-volume, stepped-down, low-pressure (HVSDLP) guns; low-pressure, low-volume (LPLV) guns; and thin-film atomization (TFA) The conventional compressed-air-driven spray gun costs approximately $200, whereas an HVLP spray gun costs approximately $400. Although the initial cost is higher for the HVLP, the paint usage costs are reduced substantially. The typical transfer efficiency of conventional systems ranges from 20 to 40 percent, but is greater than 65 percent for high-transfer-efficiency painting equipment *(1).* Of the 21 transit agencies surveyed, 7 use HVLP spray guns.

Alternative coatings, such as synthetic enamels, water-borne paints, and high-solids paints, can also be used to reduce volatile organic compound (VOC) emissions and hazardous waste Waterborne paints do not contain hazardous organic solvents. However, the formulation for a complete water-base system (primer, basecoat, and topcoat) is still in the development stage. High-solids paints are becoming increasingly available within the painting industry; these have the advantage of reducing VOC emissions by up to 75 percent. Synthetic enamels can be used to replace acrylic lacquers. Acrylic lacquers are typically thinned with solvent by 125 to 150 percent. With synthetic enamels, the addition of only 15- to 33 percent thinner is required. Because enamel dries to a gloss and is not sanded, only two or three coats are needed to achieve adequate coverage *(1).*

To reduce wastes generated from painting operations, rigid inventory control and better housekeeping practices can provide a very effective means of waste reduction at the source. These savings generate little or no cost to the transit agency, and occasionally result in a net savings. Rigid inventory control involves controlling the amount of paint and solvents issued for use Better housekeeping practices include establishing strategic paint and solvent drum locations and employing efficient material transfer methods to minimize leaks and spills. These procedures can reduce all waste generated from painting and paint removal operations.

Paint Removal

Chemical stripping using methylene chloride-based strippers is a common conventional practice for paint removal. Methylene chloride is toxic and very volatile Less toxic stripping agents have become available. Substitutes include dibasic esters (DBE), semiaqueous terpene-based products, and C9- to C12-based hydrocarbon strippers. Manufacturers of these substitute stripping agents claim that they are nonchlorinated and biodegradable, exhibit low volatility, and are not listed as hazardous substances (2). Regardless of the stripping agent used, chemical stripping as a paint removal technique generates a large volume of wastes.

Media blasting is often used in preference to chemical stripping to minimize air emissions as well as costs. The media used are sand or plastic beads. Chemical stripping may cost as much as $1.40 per square foot ($ft^2$), including personnel, material, and disposal costs, whereas the cost for plastic media blasting is approximately $0.18/$ft^2$, a savings of nearly 90 percent (3). Most plastic media can be reclaimed and recycled, thereby reducing the quantity of inorganic waste generated. The volume of paint removal waste is significantly reduced with the use of plastic media blasting. Media blasting is employed at 12 of the 21 transit agencies surveyed.

WASHING AND CLEANING

Wastes generated by bus and engine washing and cleaning operations include hazardous and nonhazardous wastewater and sludge. From the surveys of the transit agencies, the wastewater is generally treated and discharged to sewers or recycled onsite. Sludge from bus washing operations is disposed of in landfills. Table B-2 in Appendix B shows the wastewater management practices employed by the transit agencies surveyed. Of the 21 transit agencies surveyed, 16 recycle wastewater. Most transit agencies are required to treat wastewater before discharging it. Two transit agencies, Bi-State Development Agency (St. Louis) and Central Oklahoma Transportation Authority, are allowed to discharge wastewater from bus washing directly into sewers. The local sewer authority dictates the degree of treatment required before discharging wastewater into the sewer. Wastewater recycling is an effective way to reduce the quantity generated. In addition, recycling may be necessary for some transit agencies to meet their state and local water discharge regulations.

To reduce the amount of wastewater from bus washing and cleaning operations, the washing can be conducted in a self-contained bay where wastewater is easily collected and reclaimed for recycling. This system consists of a drain collector, a filter or settling basin, and a recycling system. One or two pumps are also required to transfer the water (4). Segregation of the waste stream is very important if recycling or reusing is to be implemented cost effectively. If the wash water contains a significant amount of oil, a separation tank or an oil/water separator can be used to separate the oil from the wash water. Separated oily water can be processed offsite by a waste oil reclaimer. The sludge from the washing operation can be dewatered (dried) to reduce its volume The cost of recycling wastewater from bus washing depends on the flow rate of the wastewater and the amount of sludge generated, which is unique to each transit agency.

PARTS CLEANING

Parts cleaning is accomplished with organic solvents or aqueous cleaners. Wastes generated from parts cleaning using solvents include spent filters, waste sludge, and waste organic solvents such as petroleum naphtha and Stoddard solvents. Wastes generated from aqueous cleaning include detergent-bearing wastewater and waste sludge. Waste solvents and metal-containing solid wastes are the primary wastes generated from parts cleaning operations.

All transit agencies surveyed have parts cleaning operations. The parts cleaning methods reportedly used by each transit agency are shown in Table B-3 in Appendix B. Of the 19 transit agencies that responded to this part of the questionnaire, all but two currently use organic solvents for parts cleaning. Aqueous cleaning is also used at Bi-State Development Agency, Houston Metro, MetroDade, Greater Bridgeport Transit, and Orange County Transportation Authority Houston Metro and LACMTA use the "bake-off' technique for parts cleaning. A discussion of each cleaning method is presented next.

Solvents

Parts cleaning with organic solvents, such as Stoddard solvent, generates hazardous wastes. Substitute solvents can avoid or reduce hazardous solvent wastes from solvent cleaning operations. Reductions in solvent wastes can also be accomplished by minimizing losses associated with solvent use and by recycling waste solvents. Furthermore, leasing solvent sinks, a practice employed by many transit agencies, allows them to conduct parts cleaning onsite while leaving the waste handling responsibilities to a contractor specializing in hazardous waste management.

An example of solvent substitution is the use of terpene cleaners in place of Stoddard solvent. The terpene cleaners are available commercially in net form or as water solutions with surfactants, emulsifiers, rust inhibitors, and other additives. Terpenes, which are not hazardous solvents, have tested favorably as substitutes for halogenated solvents for removal of heavy greases, oily deposits, and carbonized oil. New Jersey Transit is currently using terpene as a substitution for toxic solvents. Tri-Met in Portland, Oregon, has also switched to nonhalogenated solvents for most uses. BiState Development Agency (St. Louis) uses a solvent substitute called methyl-soyate, which is made from soybean, to replace benzene and tetrachloroethylene cleaning compounds. The agency reported that it has totally eliminated hazardous wastes from its parts cleaning operations. Greater Bridgeport Transit in Connecticut uses only biodegradable cleaning solutions for parts cleaning. The waste cleaning solutions they generate can be disposed of more economically than costlier toxic waste compounds.

Solvents should be used in designated areas equipped with selfcontained cleaning systems. The cleaning system must be operated properly to reduce solvent losses and waste generation. Solvent losses from solvent sinks can be reduced by: 1) using a solvent sink with recirculation, 2) removing parts slowly after immersion to reduce drippage, 3) installing drip trays or racks to drain cleaned parts, 4) allowing more drainage time over the sink after withdrawal, and 5) turning off the solvent stream and covering the sink when not in use. Recirculating solvent sinks allow solids to settle out of the used solvent so that it can be reused.

Used solvents that have lost their effectiveness and require replacement can be recycled offsite or onsite. Recycling offsite involves transporting used solvent to a solvent recycler. Several alternatives are available for onsite recycling, including gravity separation and batch distillation. Gravity separation involves settling of solids to recycle solvents for reuse. Centrifuges can be used to accelerate gravity separation. In a distillation unit, the used solvent is heated, vaporized, and the vapors are condensed into a separate vessel Liquids with boiling points as high as 400° F can be recovered. The "still bottom," which is a residue contaminated with solids, may be a hazardous waste and must be disposed of according to RCRA rules and regulations. The cost of a distillation unit can range from $2,000 to $3,000 for a 5-gallon unit, to well over $100,000 for the larger stills. These units are capable of reclaiming solvents to purity standards that meet or exceed new product specifications (4). Pierce Transit currently employs a distillation unit to recycle used solvents. Denver RTD uses individual parts cleaners with nonhazardous solvent and a filtration system. The first year following implementation of this system, RTD did not have to change out any solvent.

Leasing of solvent sinks is another option that can be used to alleviate the transit agency's waste problems from solvent cleaning. For a service fee normally ranging from $32 to $38 per month, solvent service companies will provide a solvent sink with recirculation pump, provide monthly maintenance service, remove spent solvent, and replace used solvents with fresh solvent *(4,5)*. Green Bus Services in New York, and LACMTA indicated on the transit survey that they are using this solvent sink leasing method. Houston Metro owns its solvent sinks and contracts out for maintenance service, removal, replacement, and inspection. One small agency reported purchasing a parts cleaner (as opposed to renting or leasing). They use solvents with a flash point of greater than 140° and dispose of the solvent waste along with used oil and transmission fluid in a used oil furnace that was specially purchased for auxiliary heating of their shop facility.

Aqueous Cleaning

Aqueous cleaners comprise a wide range of cleaning methods that use water, detergents, acids, and alkaline compounds to displace soil. Aqueous cleaners can clean parts as effectively as solvent cleaners, although the drying time is much longer than is necessary with organic solvent cleaners. Detergent-based cleaners, which can perform as well as solvent cleaners, can replace organic solvent or caustic-based cleaners. In addition, precleaning using wire brushes can remove the bulk of the dirt and grime from external surfaces, reducing the cleaning action required of the detergent or solvent. Wastewater from aqueous cleaning operations generally contains heavy metal residue, oil, grease, and sludge. This water can be treated and reused (6).

Bake-off Oven Cleaning

Industrial furnaces can also be used to bake parts clean instead of using solvents or aqueous cleaners. These ovens are designed to pyrolize dirt and grease, leaving a dry residue that can be brushed off (6). This technique, which eliminates the hazardous waste stream associated with solvent-based parts cleaning but may require high capital investment and high energy costs, is being demonstrated at Houston Metro and LACMTA. Recently, Tri-Met (Portland, Oregon) also installed a thermal process cleaner.

FUELING AND FUEL STORAGE

In general, all transit agencies surveyed have safety procedures to contain and treat chemical and fuel spills. Efforts to control chemical spills include using drip pans, proper storage and transfer of chemicals, and using self-closing non-leak safety faucets. For minor cleaning and small spills, leased rags from a laundry cleaning service can be used. The laundry service can pick up the soiled rags, clean them, and return them for use again. Small spills can also be contained using absorbents. However, depending on the nature of the spilled material, the absorbent may become a hazardous waste and be subject to hazardous waste regulations. Oil spills create such a hazardous waste.

Fuel leaks can be costly to cleanup. Pierce Transit in Tacoma, Washington, reported that they recently experienced what they thought was a diesel spill. While attempting to determine how water was getting into one of their underground diesel storage tanks, they observed diesel seeping up through the concrete pad joints. Subsequent excavation revealed a 3/4-inch hole in the top of the tank vent line, apparently caused by a piece of steel re-bar that was improperly installed when the concrete was poured. They excavated 110 cubic yards of dirt which was remediated at a total cost of approximately $25,000.

To minimize fuel spills and leaks, spill containment systems and secondary containment for stored fuels can be used. Some of the containment methods used for fuels included double-walled piping, aboveground piping systems, pipe installed in lined trenches, electronic leak detection within the piping system and around the tanks, and vacuum extraction from the fuel tanks to lessen fuel pressure contributing to leaks (4). Vacuum extraction and leak detection systems can be very expensive Some local city governments may not permit aboveground piping for fuels. Automatic shut-off devices can also be used to minimize fuel spills Houston Metro has such a device for its fueling systems. Periodic monitoring of seals in the fuel system can also prevent leaks. In a recent report (7), it was found that the low-sulfur diesel fuel required in California to limit bus engine emissions is causing malfunction of elastomer seals in some fueling systems.

Employee training and management initiatives to increase employee awareness of the need for and benefits of waste minimization are essential in the pursuit of waste reduction. Houston Metro has had a Productivity Enhancement Team (PET), which evolved into Partners in Progress (PIP). These are employee participation and education programs to increase productivity, decrease waste generation, and prevent accidents and spills. Also, as part of a chemical awareness program, Material Safety Data Sheets (MSDS) for all chemicals used at each Houston Metro facility are available. The following chapter provides an extended review of this and other waste management practices employed at Houston Metro and LACMTA. In general, all transit agencies surveyed have at least one person trained for personal safety, facilities operations and maintenance, and maintaining documentation such as permits, hazardous waste manifests, and MSDS. As required by OSHA, transit facilities with more than 55 gallons of fuel must have at least one person with 40 hours of training in spill prevention and cleanup. Only a few transit agencies surveyed have personnel trained for decontamination procedures and high-hazard operations.

USED OIL AND ANTIFREEZE

Bus maintenance requires changing of oil and antifreeze. Used oil includes many related substances: used motor oil, transmission fluid, lubricating oil, and others. The EPA estimates that as much as 1.4 billion gallons of used oil are generated annually *(8).* Most of the surveyed transit agencies recycle used oil off-site. The used oil is stored and sold to an oil recycler or reclaimer to be used as a fuel. Disposing of used oil and transmission fluid by installing a used oil furnace that provides auxiliary heating, as one small agency has done, has been accepted by EPA and also permitted by the responsible state environmental regulatory agency. This practice solves the "cradle to grave" problem, saves operating dollars, and is extremely convenient.

Two options are available to manage used oil effectively: use of transportable treatment units (TTUs) and recycling used oil offsite. TTUs are transportable used oil treatment units that can be installed at a transit agency. The operator of the TTU then comes to the transit facility to recycle the used oil there, primarily through oil/ water separation. A minimum amount (typically 100 gallons) must normally be accumulated before the TTU operator will travel to the agency to perform this service. If onsite recycling is not an option, then used oil can be sold to an oil recycler or reclaimer. Transporting used oil to the recycler or reclaimer can cost as much as $0 25 per gallon (4). Houston Metro sells its oil to a reclaimer who picks up the oil at Metro and does not charge for transportation.

Storage of used oil must be in compliance with federal and state regulations. These include several specific requirements:

- Drums must be arranged in rows and must be accessible to forklifts and inspectors;
- Department of Transportation (DOT) and/or Hazardous Waste labels must be placed on the storage containers so that they are visible to inspectors;
- The storage area must be designed to prevent flooding, trap all leaks, and contain runoffs;
- The area must be inspected periodically.

At one agency, waste oil is collected in drums and in closed containers. The drums are fitted with a funnel to guard against spills and the closed containers are stored in pits to contain spillage. At another agency used oil is collected via shop floor drains and underground piping and flows to a dedicated underground tank for temporary storage prior to collection by a recycler.

As discussed in the previous chapter, antifreeze is classified as a hazardous waste or CERCLA substance to be regulated in all states under federal law and cannot be discharged to sewers. Instead, antifreeze can be recycled onsite or offsite. Onsite recycling is conducted by recyclers who bring mobile equipment to the transit agency and recycle the antifreeze for immediate reuse. Offsite recyclers of used antifreeze are also available.

FREON REPLACEMENT

As mandated by the Clean Air Act Amendments of 1990, the EPA has established regulations that call for special servicing practices to minimize the release of ozone-depleting compounds. These regulations apply to activities related to the service and disposal of air-conditioning equipment on transit vehicles. In compliance with these regulations, transit agencies currently use special equipment to recycle chlorofluorocarbon (CFC) refrigerants and prevent their release into the atmosphere. Routine leak checks and leak repairs on air-conditioning systems can also minimize refrigerant losses. In addition to the use of certified equipment, the EPA regulations require certification of air-conditioning system technicians beginning in November 1994.

Because of its commitment to eliminate from use many ozone-depleting compounds, the EPA has established a program, the Significant New Alternatives Policy (SNAP), to develop acceptable alternative refrigerants. Hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs) are being examined as short-term replacements for CFCs because they are less harmful to the ozone layer. For CFC-12, which is the refrigerant most widely used in the automotive industry, HFCs-134a, HCFC-22, and other refrigerant blends are being examined as replacements. Currently the EPA recommends substituting HFC-134a in place of either R-12 or R22 for use in automotive air conditioners (9). General Motors is considering replacing the refrigerant in all 1994 and 1995 model vehicles with HFC-234a. Long-term replacement for CFCs is being investigated
(10) In the meantime, EPA is considering a ban of CFC-12 in all vehicles beginning in 1995.

BATTERY REPLACEMENT

On a weight basis, used batteries are one of the largest categories of hazardous waste generated by transit agencies. Transit agencies surveyed currently either sell used batteries to a recycler or return them to the vendor. The batteries are then rebuilt for resale or sent to a processor for material salvage. Usually, the sulfuric acid found in batteries is recovered, recycled, and resold. The batteries then go to a scrap yard where the lead is removed from the batteries and shipped to a mill where it is melted down into ingots and resold to battery manufacturers. A California legislature finding notes that the formerly comprehensive recycling system is "losing its comprehensive nature ... due to a combination of depressed lead prices, higher operating costs, and an erosion in the exchange process between the consumer and retailer of lead acid batteries *(11)."* The finding cited a report that 30 percent of used batteries nationwide are not being recycled, translating to 2.4 million batteries per year in California alone. This means "the introduction of 210,000 tons of lead, 3 million gallons of sulfuric acid, and 3.2 million pounds of polypropylene, all hazardous waste, into the environment each year." While many of these batteries are being stored in private garages, the legislature believes that many are being disposed of illegally in municipal sanitary landfills, on roadsides, in ditches, under bridges, in bodies of water, and at secluded locations. Still, considerable research continues in the area of battery recycling, focused not only on existing lead-acid automotive batteries, but also on other types of batteries, such as those used in laptop computers and those being developed for use in electrically powered vehicles.

To prolong the life of its batteries, Houston Metro monitors battery fluid levels and tries to ensure that complete discharge does not occur When the batteries can no longer hold a charge, they are sold to a recycler.

MTA New York City Transit (MTA NYCT) sells old batteries as scrap or returns them to the battery supplier for a core credit. Unusable batteries are held on pallets in a designated area of the main storeroom. When the vendor arrives with new batteries, an equal number of unusable batteries are returned. Excess batteries not used in this core credit program are sold for scrap. In 1993, (MTA NYCT) sold more than 14 tons of batteries as scrap.

TIRE REPLACEMENT

Retreading is the most common form of tire recycling. Currently, about one-fifth of the vehicle tires made in the U.S. are retreaded. Tires that are in poor condition are used for asphalt paving, brake lining, bumpers, boiler fuel, and new tires. The California Integrated Waste Management Board has performed a study examining the use of old tires as fuel in cement kilns. Although more research is needed, this method may be an effective solution for ultimate disposal of used tires *(12).*

Many landfills do not allow tire disposal because tires never decompose; they collect gases released by decomposing garbage, then gradually float up to the surface of the landfill. For this reason, tires are being "stockpiled" throughout the country. When, as occasionally happens, these piles catch fire, they can release toxic chemicals--and the fire can burn for months. Tire recycling, as is practiced in numerous locales nationwide, can alleviate the stockpiling issue.

FILTER CHANGES

Bus maintenance requires changing air, fuel, and oil filters. Table B-4 in Appendix B shows which of the surveyed transit agencies dispose of filters. Most transit agencies surveyed drain, crush, and drum their used air filters and dispose of them in landfills or sell them to recyclers. However, LACMTA and Orange County Transportation Authority (OCTA) employ innovative air-filter waste management techniques. At LACMTA, air filters are either rebuilt or dry-cleaned to be used again. OCTA also employs reusable air filters that need only to be cleaned before reuse.

The waste management techniques for oil filters used by the surveyed transit agencies are also shown in Table B-4, Appendix B. From the responses of the transit surveys, various waste management practices for used oil filters are employed in any of the following combinations: drained, crushed, and sold as scrap metal; recycled; or disposed of in a landfill. The oil filters are crushed to achieve maximum oil release prior to disposal and to reduce waste volume. Drained oil filters typically are stored in bins for recycling. Some states, including California, require special handling for used oil filters, including draining all free-flowing oil, and storing and transporting the used and drained filters in closed, labeled containers. In California, filter transfers must be documented through a bill of lading that is kept on file for 3 years. If this procedure is not followed, the filters must be handled and disposed of as hazardous wastes.

CHAPTER THREE

CASE STUDIES

To further assess the current waste management practices applicable to bus maintenance operations, two transit facilities were studied in more detail than questionnaires alone could provide. Site investigations were performed at Los Angeles County Metropolitan Transit Authority (LACMTA) and Metropolitan Transit Authority of Harris County (Houston Metro). LACMTA has a fleet size of 2,288 buses that use three different fuel types: low-sulfur diesel, natural gas, and methanol. Houston Metro has 1,267 buses that use three different fuel types: gasoline, low-sulfur diesel, and liquefied natural gas (LNG). The findings from these site investigations are discussed below for each maintenance task.

PAINTING AND PAINT REMOVAL

From the site investigations, it was found that these facilities employ a number of practices to minimize waste generated from painting and paint removal operations. For example, both LACMTA and Houston Metro use HVLP paint spray guns that improve the transfer efficiency of the painting operation. Houston Metro reports that, while the HVLP guns required some initial training for the spray booth operators, less paint is wasted as the transfer efficiency increased from approximately 40 to 80 percent. With proper operator training, the quality of painting with HVLP guns matches or exceeds that achieved by a conventional spray gun.

To reduce emission of VOCs, Houston Metro now uses low-VOC (high-solids) paints and reports a 50 percent reduction in VOC emissions with these paints. This agency is investigating the possibility of using new water-based paints to further reduce VOC emissions.

In an experimental evaluation of paint spray filters, Houston Metro found that roll-down filters require disposal 70 percent less frequently than conventional panel filters when HVLP guns are used. Though more expensive to purchase, roll-down filters are easier to maintain: operators cut off the used filter portion and roll down new filter material in its place. Spent filter material is drummed and shipped for offsite disposal. Filter manufacturers will inspect the paint spray booth operations, recommend an appropriate filter unit, and determine the capture efficiency for a transit facility at no cost

Vehicle painting at LACMTA is carried out in drive-through paint spray booths with roll-down doors at the ends. LACMTA uses a robotic paint system with the option of spraying electrostatically or conventionally. LACMTA has been using a low-VOC (2.8) polyurethane top coat and water-borne paint system (1.1) for the past few years. For painting small parts the agency is considering ultra violet curing paint, which has practically zero VOCs. LACMTA uses a water-wash type paint filtration system along with a paint separator that consolidates paint sludge and recycles chemically treated water back into a filtration system. This reduces waste disposal by 50 percent.

Both LACMTA and Houston Metro employ plastic media blasting, a state-of-the-art technique for paint removal to some degree. While Houston Metro still uses the "old tried and true" method of sanding, their new Fallbrook bus maintenance facility will primarily rely on plastic media blasting for paint removal. Using this technique, the agency can separate and recover plastic media from the paint waste. Recovered plastic media can be recycled for subsequent use After recycling its plastic beads, Houston Metro was able to significantly reduce both the volume of waste and the fugitive emissions associated with abrasive blasting.

Neither transit agency uses chemical stripping for paint removal. In addition to plastic media blasting, LACMTA also uses hand sanding. The solid wastes from these processes are swept up and disposed of in a landfill

WASHING AND CLEANING

Both the Houston Metro and LACMTA facilities have wastewater treatment systems that recycle wash waters from the vehicle washing and cleaning operations. Solids in the wash waters are removed using clarifiers, which allow solids to settle and collect in a hopper at the bottom. Periodically, the clarifiers are pumped out. The sludge removed from the clarifier at Houston Metro is nonhazardous and disposed of in a landfill. The clarifier at Houston Metro also employs a skimmer to collect oil and grease that float at the surface of the water. The skimmed material flows to a storage tank, which is periodically pumped out and hauled away by a waste oil reclaimer. Both facilities report that water consumption costs, sewer discharge costs, and water heating costs are all significantly reduced by recycling bus wash water.

Houston Metro has recently installed a new industrial oven for "bake-off' cleaning of engine parts. Instead of using the conventional technique of washing engines with a high-pressure water spray, the oil and grease residues are baked off in the furnace. After baking, residuals on the engine parts are brushed clean.

PARTS CLEANING

Facilities at both Houston Metro and LACMTA have numerous parts cleaning stations where petroleum-based solvents are used to remove grease and dirt from bus and engine parts. At these agencies, parts cleaning is done on demand, with the supply of solvent to the wash basin controlled by a foot pedal. Once the foot pedal is activated, solvent is pumped from the storage tank to the cleaning basin for use. Used solvent drains back to the storage tank with the dirt and grime from the cleaning operation. Dirt and grime settle at the bottom of the storage tank and are ultimately removed and disposed of as hazardous waste. The tank is periodically replenished with recycled solvent from the contractor. This contracted service is expensive, but prolonging the life of the solvent reduces the overall cost. Houston Metro follows similar procedures for its parts cleaning stations; this agency also reported that it has a spill response plan for each parts cleaning station

FUELING AND FUEL STORAGE

The fueling facilities at both transit properties have vapor recovery units that minimize VOC emissions during dispensing. Both facilities use low-sulfur diesel fuel to decrease bus emissions.

Both transit agencies employ preventive measures to minimize spills from fueling facilities For small spills or leaks, LACMTA staff are trained in spill prevention and response. Employees are instructed in general to apply absorbent material, sweep up the spill, and dispose of it properly as a hazardous waste. For large spills, clean-up is performed by contractors. LACMTA staff are trained as first responders to hazardous material/waste incidents to respond to accidental spills on or off the properties. Each location has an assigned 40-hr hazardous materials coordinator to ensure that it is in compliance with federal, state, and local environmental regulations. For large spills, cleanup is performed by contractors under the supervision of a hazardous materials response supervisor. Environmental inspections are performed on a weekly basis at each location by a quality assurance hazardous materials supervisor.

At Houston Metro, employees are also trained in spill prevention and response. Spills are minimized with good housekeeping practices. Employee participation and education programs such as PET and PIP are used to motivate employees to increase productivity, decrease waste generation, and reduce accidents and spills. Clean work attitudes and motivated employees were found to be the keys to waste minimization at Houston Metro. To minimize fuel spills, Houston Metro installed automatic shut-off devices on all fuel-dispensing equipment.

Houston Metro also reported that fuel spills are minimized by keeping the bus fleet in excellent working condition. Engine tuneups are performed every 12,000 miles. Fluid levels are monitored every 4,000 miles. By keeping the fleet in excellent condition, fuel consumption is minimized, reducing the opportunity for a fuel spill. Exhaust emissions are also minimized.

USED OIL AND ANTIFREEZE

LACMTA generates approximately 242,000 gallons of used engine oil per year. The oil is transported by a licensed hazardous waste transporter to a treatment, storage, and disposal facility where the moisture/water is removed. The oil is then transported off-shore and used as bunker fuel for ships and to out-of-state cement manufacturers to be used in their furnaces An oil change requires replacement of 28 quarts of oil. On the average, approximately 40 gallons of used engine oil are disposed of annually for every LACMTA bus. In contrast, Houston Metro collects used engine oil in an underground storage tank, which is pumped out periodically by a contractor who specializes in waste-oil reclamation. The contractor, who blends the waste oil to produce boiler or ship fuel, pays Houston Metro a premium for its waste oil because it is relatively clean.

Both transit agencies hire contractors to recycle used antifreeze off-site. At LACMTA, antifreeze is changed every 48,000 miles, with monitoring every 6,000 miles. At Houston Metro, the coolant is monitored every 4,000 miles. When it is monitored, Houston Metro staff check the level of nitrate, a compound that protects aluminum in the cooling system; if needed, nitrates are added to the coolant. The antifreeze is also cleaned by filtration occasionally.

By cleaning and maintaining the nitrate levels in the antifreeze, Houston Metro found that the life of antifreeze in buses could be prolonged, reducing waste. LACMTA's contractor checks the nitrate level of its antifreeze on an on-going basis. Houston Metro changes antifreeze only when major work is required on a bus. Furthermore, the aggressive, proactive fluid testing program implemented by both transit agencies prolongs bus life, decreases fluid consumption, and reduces spent fluid waste.

FREON REPLACEMENT

Both Houston Metro and LACMTA recycle used refrigerants from bus air-conditioning systems onsite. LACMTA uses a Freon recovery system manufactured by Van Steenburgh Engineering Labs, Inc. The unit reclaims refrigerant from the air-conditioning system during maintenance repairs. The reclaimed, used Freon is dispensed back into the vehicle air-conditioning system. LACMTA uses refrigerant R-22, R-12, and HFC-134A.

BATTERY REPLACEMENT

Both transit agencies return old batteries for reclamation. LACMTA estimates that it receives $0.05/lb. for every battery (approximately 30 lb. each) returned to the manufacturer. Houston Metro has an active program to prolong the life of batteries by keeping the battery fluid at its proper level and preventing full discharge of batteries.

TIRE REPLACEMENT

These two transit agencies handle tire replacement similarly. Both LACMTA and Houston Metro, as is quite common practice, have tire contracts to maintain the tires on their buses. Under the terms of the agreement, the contractor is responsible for rotating, balancing, and mounting all tires, as well as for disposing of old tires. LACMTA pays the contractor by the hub-mile; the contract is worth upwards of $30 million annually. By having this onsite contractor, LACMTA is relieved of many problems in addition to merely disposing of waste tires. Furthermore, used brake pads are recycled offsite as scrap metal.

At Houston Metro, some used tires are recycled offsite to a supplier who recaps and regrooves tires in good enough condition to be reused. Tires in poor condition are shredded and used for boiler fuel or in road building. Brake drums are rebuilt and recycled whenever possible. Serviceable brake drums are returned to working order with a special metal lathe that removes only a small portion of the drum metal. Drums below their safety tolerance are recycled offsite as scrap metal.

FILTER CHANGES

LACMTA has an air filter recycling program offsite. The filters are sent for cleaning every 6,000 miles. Some of the advantages to this program are that recycled air filters can be used four or five times, the cost of a used filter is lower, the program reduces solid waste and results in annual savings projected to be approximately $100,000. Houston Metro places used air filters in drums for disposal in a landfill. Oil filters are drained, crushed, and sold as scrap metal at both transit agencies. Oil drained from the filters is sold to a used oil reclaimer.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

Examination of the waste management practices currently employed by the 21 transit agencies surveyed in the areas of painting and paint removal, washing and cleaning, parts cleaning, fueling and fuel storage, changing oil and antifreeze, and replacing Freon, batteries, tires, and filters revealed a number of successful waste management practices. Those practices that were implemented by the surveyed transit agencies to reduce or eliminate waste are summarized below.

SUCCESSFUL APPROACHES

Several improved approaches to paint removal and application were identified. For example, painting operations using HVLP spray guns have been effective in reducing wastes at transit agencies. Of the 21 transit agencies surveyed, 7 currently use the HVLP spray guns to minimize overspray. Where conventional spray guns have a transfer efficiency of 20 to 40 percent, the transfer efficiency of an HVLP is more than 65 percent. In addition to reducing wastes, HVLP spray guns also reduce VOC emissions. High-solids paints are also effective in reducing VOC emissions.

Paint removal using media blasting is conducted at 12 of the 21 transit agencies surveyed Media used include sand and plastic beads. Media blasting is preferred to chemical stripping to reduce air emissions as well as costs. Chemical stripping may cost as much as $1.40/ft^2$ (including personnel, material, and disposal costs) whereas the cost for media blasting using plastic beads is approximately $0.18/ft^2$ Because the plastic media can be separated from the paint residue and reused, wastes generated from this media blasting practice are significantly reduced.

Wastewater recycling from bus washing operations has been successfully demonstrated at several transit facilities. Of 21 transit agencies surveyed, 16 recycle wastewater from bus washing operations. Recycling the wastewater involves collecting the water, separating the solids, and recycling the water. Recycling was shown to effectively reduce both water consumption and wastewater discharge.

Parts cleaning with leased solvent sinks is currently practiced at many transit agencies. The solvent sinks are equipped with a recirculation system where used solvents are recycled. Because the sink is maintained by the leasing services, transit agencies can be assured that the system is working properly. By leasing solvent sinks, transit agencies transfer the responsibility for handling solvent wastes to the contractor.

As an alternative to leasing solvent sinks, transit agencies are using methyl-soyate for solvent cleaning, which does not generate hazardous wastes. This solvent substitute was demonstrated at BiState Development Agency in St. Louis. Moreover, this product is an effective parts cleaning agent and may be a suitable solvent substitute.

Parts cleaning using "bake-off' furnaces, a technique in use at Houston Metro, has dramatically reduced the quantity of wastes generated from parts cleaning. Although this method involves high capital and energy costs, the waste disposal cost is significantly reduced. Further research into applications for this cleaning method is recommended.

Wastes generated from fueling and fuel storage operations arise from spills and leaks. Spill containment systems and secondary containment for stored fuel can minimize spills and leaks. Houston Metro has installed an automated shutoff fueling system that monitors the tank pressure during fueling. When the tank pressure gets too high, the fuel dispensers automatically shut off.

Several of the transit agencies surveyed sell used oil to a recycler or reclaimer Storage tanks of used oil are periodically pumped out by waste oil recyclers or reclaimers. Premium prices were offered for used oil because it is relatively clean. Antifreeze is also recycled offsite Houston Metro has successfully demonstrated that by filtering and periodic monitoring of fluids, the life of the antifreeze can be extended.

As required by the CAAA, all transit facilities are effectively collecting Freon and recycling it LACMTA uses a Freon reclaiming system that costs approximately $7,500.

Houston Metro demonstrated excellent waste management of batteries by continually monitoring the fluid level in the battery so that complete discharge does not occur. This technique helps to prolong battery life. Batteries are returned to the vendor for a core refund

Waste management practices for used tires were noted in the two case studies. Houston Metro recaps and regrooves some used tires when they are still in a usable condition. Used tires in poor condition are sold as boiler fuel. LACMTA contracts with a tire vendor to provide, maintain, and dispose of the tires. Essentially, both agencies have onsite tire contractors who operate in the same way. Ultimate disposal of the used tires is the responsibility of the contractor.

Waste management of used air and oil filters was examined. Although many transit agencies surveyed dispose of the air filters in landfills, two transit agencies recycled and reused the air filters. LACMTA either rebuilds or dry cleans used air filters so that they can be used again. OCTA employs reusable air filters, minimizing disposal wastes

Implications

The survey and case studies produced some general conclusions regarding waste management and minimization. Waste management never ends and is everyone's responsibility. Many respondents noted that a key to waste reduction and minimization from an operational standpoint is simply clean, well-organized work stations that result from improved housekeeping. Another key to waste minimization is a dependable and well-trained facility maintenance work force that frequently receives accolades for accomplishing a difficult job. They could use help. Enhanced methods and techniques needed for reducing waste streams and improving performance include: developing alternative solvents and viable bake-off ovens for parts cleaning, enhancing application of HCFC and HFC as refrigerants, optimizing use of reusable air filters or applying sonic dry-cleaning to air filters, expanding the use of HVLP paint spray delivery systems, and fuel tank spill and overfill protection devices. While rules and regulations are forcing transit agencies and other pollution generators to re-examine their procedures, materials, facilities, and overall operations to cutback on the volume and harmful effects of their waste streams, an equally powerful force pushing agency managers to move in the direction of waste minimization is the opportunity to generate significant and longterm cost savings. The combined effects of these efforts therefore provide the public with a double benefit: a cleaner environment with less waste to dispose of, plus a more cost-effective public transit alternative.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future research on several specific waste management practices could provide transit agencies nationwide with additional means of reducing waste streams and improving environmental performance:

- Opportunities for the increased use of alternative solvents for parts cleaning
- Viability of bake-off ovens as a parts cleaning technique
- HCFCs and HFCs as refrigerant substitutes for CFCs
- Ultimate disposal of used tires
- Use of reusable air filters
- Applicability of a sonic dry-cleaning system to clean air filters
- Use of HVLP paint spray delivery systems
- Fuel tank spill and overfill protection devices.

With the possible exception of solvent and refrigerant substitutes, limited research has been conducted on these practices. Research can assist transit agencies in reducing or eliminating toxic hazardous wastes; complying with stringent federal, state, and local environmental regulations; and reducing the costs of operating, servicing, and maintaining their bus fleets.

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GLOSSARY

Antifreeze--a substance, often a liquid such as ethylene glycol or alcohol, mixed with another liquid to lower the freezing point of the latter

Asbestos--ncombustible chemical-resistant fibrous mineral form of impure magnesium silicate, used for fireproofing, electrical insulation, building materials, brake linings, and chemical filters

California Superfund--Carpenter-Presley-Tanner Hazardous Substance Account Act, California's major waste management act

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act)-- a federal statute enacted to define potentially responsible parties for joint and several liability of clean-up and damage to any person or the environment from chemical spills and releases

CFC--Chlorofluorocarbon

CFR--Code of Federal Regulations

CWA (Clean Water Act)--a federal statute governing water emissions, regional water quality

Disposal--the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such a waste or constituent thereof may enter the environment or be emitted into the air or discharged to any waters, including groundwaters

DOT--U.S. Department of Transportation

EPA--U.S. Environmental Protection Agency

Freon--a trademark of any of various nonflammable gaseous or liquid fluorocarbons that are used mainly as working fluids in refrigeration and air conditioning as aerosol propellants

Hazardous Waste--a solid waste that is an RCRA-listed waste or meets the hazardous characteristics under RCRA for ignitability, corrosivity, reactivy, or toxicity

Hazardous Substance--a substance, not including natural gas, natural gas liquids, liquified natural gas, or synthetic gaseous fuels, which is hazardous as defined under the Clean Water Act, Clean Air Act, RCRA, Toxic Substances Control Act, and CERCLA

Hazardous Waste Generation--the act or process of producing hazardous waste

Hazardous Waste Management--the systematic control of the collection, source separation, storage, transportation, processing, treatment, recovery, and disposal of hazardous waste

HCFC--Hydrochlorofluorocarbon

HFC---Hydrofluorocarbon

High-Transfer-Efficiency Paint Spray Equipment-Paint spray equipment designed to minimize paint overspray, thereby maximizing the amount of paint transferred to the substrate

HRS--hazard ranking system

HSWA--federal regulation governing hazardous and solid waste materials

HVLP--high-volume, low-pressure spray painting

HVSDLP--high-volume stepped-down low-pressure spray painting

LACMTA--Los Angeles County Metropolitan Transportation Authority

LNG--liquefied natural gas

Manifest--the form used for identifying the quantity, composition, and the origin, routing, and destination of hazardous waste during its transportation from the point of generation to the point of disposal, treatment, or storage

MSDS--Material Safety Data Sheet

Montreal Protocol on Substances that Deplete the Ozone Layer--treaty signed in 1987 by the United States and 22 other countries that called for the production phase-out of all ozone-depleting chemicals, including CFCs, HCFCs, halons, carbon tetrachloride, methyl chloroform, methyl bromide, and hydrobromofluorocarbons (HBFCs) By controlling their production, the intent of this Agreement was to raise the price of these materials and thereby provide economic incentives to CFC refrigerant substitution, recovery, and reuse.

NFPA--National Fire Prevention Association

NPDES--National Pollutant Discharge Elimination System

OCTA--Orange County (California) Transportation Authority

OSHA--Occupational Safety and Health Administration

Potentially Responsible Parties--those parties, including the owner/operator, the owner/operator at the time of release, any person who arranged for disposal, and any transporter who selected the disposal site, who are jointly and severally responsible for the unauthorized release of a hazardous substance to the environment

RCRA (Resource Conservation and Recovery Act)--a federal statute designed to regulate the generation, treatment, storage, and disposal of hazardous waste

Recycle--the practice of reusing or reclaiming used chemical substances, following the original use, for any purpose, including the purpose for its original use. This term includes in-house reclamation and reuse as well as contractor reclamation

Recycled Oil--any used oil that is reused, following its original use, for any purpose, including the purpose of its original use

Remediation, Removal, or Remove--the cleanup of released hazardous substances from the environment, such actions as necessary to prevent, mitigate, or minimize damage to public health and welfare or to the environment

Resource Conservation and Recovery Act (RCRA)--a statute (42 U.S.Code 6901) enacted as regulation 40 CFR 261 which is designed to regulate the generation, treatment, storage, and disposal of hazardous waste

SARA--Superfund Amendments and Reauthorization Act

Sludge--any solid, semisolid, or liquid waste generated from municipal, commercial, or industrial wastewater treatment processes, water supply treatment processes, or air pollution control processes

SNAP--Significant New Alternatives Policy of the U.S. EPA for development of acceptable alternative refrigerants

Solid Waste--any discarded solid material not otherwise excluded from RCRA that is disposed of, incinerated, or stored and treated without being recycled as ingredients to an industrial process or as effective substitute for commercial products without being reclaimed

Storage--the containment of chemicals or wastes, either on a temporary basis or for a period of years, in such a manner as not to constitute disposal

Transport, Transportation--the movement of waste chemical substances or other wastes by any mode, including pipeline

TTU--transportable treatment unit

Treatment--any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any waste stream so as to neutralize the waste stream or so as to render the waste stream nonhazardous, safer for transport, amenable for recovery, amenable for storage, or reduced in volume

UFC--Uniform Fire Code

Used oil--any oil that has been refined from crude oil, used, and, as a result of such use, contaminated by physical or chemical impurities

UST--underground storage tank

VOC--volatile organic compounds

Waste Reduction--any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or as a fugitive emission thereby reducing the hazard to public health and the environment The term includes equipment and technology modifications, process or procedure modifications, reformulation or redesign of products, and chemical substitution, but excludes practices that alter the physical, biological, or chemical characteristics or the volume of hazardous substance, pollutant, or contaminant through a process that is not integral to and necessary for the production of a product or the providing of a service.

Waste Manangement--the systematic control of the collection, source separation, storage, transportation, processing, treatment, recovery, and disposal of hazardous waste and solid waste

Waste Control Practice--those practices or activities employed in the use, storage, containment, disposal, and treatment of waste streams

APPENDIX A

QUESTIONNAIRES

TRANSIT AGENCY QUESTIONNAIRE

Transit Cooperative Research Program, Topic SC-2:
"Waste Management at Bus Maintenance and Fueling Facilities"

Transit Agency: ______________________ Contact: ___________________
Address: _____________________________ Telephone: _________________

1. What percentage of your transit fleet is dedicated to: Bus_________ Rail _________ Other _________
2. How many buses do you service annually? ____________
3. What fuels do you use to support your bus operations? Please list the types of fuels, the maximum quantity of each stored onsite, and the types of storage tanks.

Fuel Type	Max. Stored (Gal)	Type of Storage
Diesel		
Gasoline		
Natural Gas		
Kerosene		
Methanol		
Ethanol		
Propane		
Other (specify)		

4. Please list hazardous waste regulations that your facility must comply with (e.g., toxic chemical inventories, waste minimization, wastewater discharge) and specify which regulations pertain to your bus maintenance and fueling operations.

Regulation	Requirements

5. Please list the types, the generating processes, the costs, and quantities of hazardous wastes manifested at your facility annually.

Waste Type	Generating Process	Quantity (lbs)	Disposal Cost ($)

6. Please provide a description of the procedures currently used for disposal of these hazardous waste materials including parts cleaning, oil/filter changes, anit-freeze changes, etc. ____________

(If you need more room to respond, extra pages are provided.)

ESD 042-93

7. If you have an inventory of hazardous chemicals used at your facility, please include a copy of the inventory with this questionnaire.
8. Please list the types, the generating processes, and the quantities of non-hazardous solid waste disposed from your bus maintenance or fueling operations annually.

Waste Type	Generating Process	Quantity (lbs)	Disposal Cost ($)

Do you have a solid waste recycling program? ____________

If so, please describe. ____________

9. Please provide a description of the procedures used for disposal of each non-hazardous waste.
10. Are you aware of any chemical substitutions or process modifications that have reduced or eliminated hazardous waste at your facility? If so, please describe them.
11. What hazardous or potentially hazardous waste is recycled at your facility? ____________
12. Please include a copy of your hazardous materials management plan (HMMP) for the most recent reporting year.
13. Please include a copy of your procedure for handling chemical spills (omit if included in the HMMP).
14. Do your fueling facilities have a vapor recovery system? ____________
15. What painting equipment is used at your facility? ____________
16. What depainting equipment is used at your facility? ____________
17. Are wash waters recycled or discharged to a sewer? ____________
18. Describe your procedures for disposing of old batteries. Please include specific steps taken from the time of removal from vehicle until leaving your facility. ____________
19. Describe your procedures for disposing of old tires. Please include specific steps taken from the time of removal from vehicle until leaving your facility. ____________

(If you need more room to respond, extra pages are provided.)

ESD 042-93

20. Describe your procedures for disposing of used air filters, oil filters, and diesel particulate traps. Please include specific steps taken from the time of removal from vehicle until leaving your facility. ______________

____

____

____

21. Does your facility have at least one person trained in the following areas? (If yes, indicate how many staff are trained in each.)

Training for personal safety	________	Facility operation and maintenance	________
Spill prevention and response	________	High-hazard operations	________
Decontamination procedures	________	Maintaining documentation (e.g. MSDSS, permits, etc.)	________

22. Does your facility use a waste exchange to dispose of any wastes? Yes _____ No _____

If so, please identify the waste exchange, contact and telephone number.

Waste Exchange ______________________________

Contact ______________________________

Telephone Number ______________________________

If so, please identify which wastes are sent to the waste exchange(s):

Type of Waste	Quantity of Waste (lb/yr or other measure if appropriate)

THANK YOU!

Please return questionnaire via fax to:

Acurex Environmental Corporation
Attn: Penny Hill
Fax No. (415) 964-5145 through 5/20
Fax No. (415) 254-2496 beginning 5/23

Please mail supporting materials and hard copy of Questionnaire to:

Acurex Environmental Corporation
Attn: Penny Hill
P.O. Box 7044
Mountain View, CA 94039

(If you need more room to respond, extra pages are provided.)

TRANSIT AGENCY QUESTIONNAIRE

Transit Cooperative Research Program, Topic SC-2:
"Waste Management at Bus Maintenance and Fueling Facilities"

Transit Agency: ____________________ Contact: ______________________
Address: ___________________________ Telephone: ____________________

1. Please list the types, the generating processes, the costs, and quantities of hazardous wastes manifested at your facility annually.

Waste Type	Generating Process	Quantity (lbs)	Disposal Cost ($)

2. Please provide a description of the procedures currently used for disposal of these hazardous waste materials including parts cleaning, oil/filter changes, anit-freeze changes, etc. ____________

3. Please list the types, the generating processes, and the quantities of non-hazardous solid waste disposed from your bus maintenance or fueling operations annually.

Waste Type	Generating Process	Quantity (lbs)	Disposal Cost ($)

Do you have a solid waste recycling program? ____________

If so, please describe. ____________

4. Please provide a description of the procedures used for disposal of each non-hazardous waste.

5. Describe your procedures for disposing of old batteries. Please include specific steps taken from the time of removal from vehicle until leaving your facility. ____________

(If you need more room to respond, extra pages are provided.)

AEC 095-94

6. Describe your procedures for disposing of old tires. Please include specific steps taken from the time of removal from vehicle until leaving your facility. ____________

7. Describe your procedures for disposing of used air filters, oil filters, and diesel particulate traps. Please include specific steps taken from the time of removal from vehicle until leaving your facility. ____________

8. Does your facility have at least one person trained in the following areas? (If yes, indicate how many staff are trained in each.)

Training for personal safety	______	Facility operation and maintenance	______
Spill prevention and response	______	High-hazard operations	______
Decontamination procedures	______	Maintaining documentation (e.g. MSDSS, permits, etc.)	______

9. Does your facility use a waste exchange to dispose of any wastes? Yes _____ No ______

If so, please identify the waste exchange, contact and telephone number.

Waste Exchange ____________
Contact ____________
Telephone Number ____________

If so, please identify which wastes are sent to the waste exchange(s):

Type of Waste	Quantity of Waste (lb/yr or other measure if appropriate)

THANK YOU!

Please return questionnaire via fax to:
Acurex Environmental Corporation
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Fax No. (415) 254-2496 beginning 5/23

Please mail hard copy of Questionnaire to:
Acurex Environmental Corporation
Attn: Penny Hill
P.O. Box 7044
Mountain View, CA 94039

(If you need more room to respond, extra pages are provided.)

AEC 095-94

APPENDIX B

TABULATION OF SURVEY RESPONSES

Transit Agency	Conven. Spray Gun	Chemical Stripping	Sand-blasting	Paint Booth
Alameda-Contra Costa Transit (Oakland. CA)	Y	Y		
Bi-State Development Agency (St. Louis, MO)	N/R[a]	Y		
Central Oklahoma Transportation (Oklahoma City, OK)	Y	N		
Command Bus Company, Inc (Brooklyn, NY)	Y	Y		
Green Bus Services (Jamaica. NY)	Y	Y		
Metropolitan Transit Authority (Houston, TX)	N	N		
Los Angeles County MTA (Los Angeles, CA)	N	N		
Metro Dade Transit Agency (Miami, FL)	N	None		
New Jersey Transit (Newark. NJ)	Y	N		
New Yolk City Transit Authority (Brooklyn, NY)	N	N		
Orange Co Transportation Authority (Garden Grove, CA)	Y	N		
Phoenix Transit Systems (Phoenix. AZ)	N/R	Y		
Pierce County Public Transit (Tacoma. WA)	N/R	N		
Regional Transportation District (Denver. CO)	N/R	N		
Sun Tran Public Transit (Tucson, AZ)	Y	N		
Jamaica Buses, Inc. (Jamaica, NY)	N			
Greater Bridgeport Transit District (Bridgeport, CT)	Y	N	Y	
Manistee County Transportation, Inc. (Manistee, MI)	N	N		
Great Falls Transit District (Great Falls, MT)	N	N		
Tri-County Metropolitan (Portland. OR)	Y		Y[b]	Y
Capital Metropolitan Transportation Authority (Austin, TX)	Y	Y[c]	Y	Y

[a]N/R = not reported. [b] = Manual sanding only Recycle waste paints & thinners on site ventilation booths & low-VOC accura spray guns [c] = Recycle paint thinner waste

Transit Agency	Recycle	Treat prior to discharge	Direct discharge
Alameda-Contra Costa Transit (Oakland, CA)	Y	N	Y
Bi-State Development Agency (St. Louis, MO)	N	N	Y
Central Oklahoma Transportation (Oklahoma City, OK)	N	N	Y
Command Bus Company, Inc (Brooklyn, NY)	N	Y	N
Green Bus Services (Jamaica, NY)	N	Y	N
Metropolitan Transit Authority (Houston, TX)	Y	N	N
Los Angeles County MTA (Los Angeles, CA)	Y	N	Y
Metro Dade Transit Agency (Miami. FL)	Y	Y	N
New Jersey Transit (Newark, NJ)	Y	N	Y
New York City Transit Authority (Brooklyn, NY)	Y	N	N
Orange Co.Transportation Authority (Garden Grove, CA)	Y	N	N
Phoenix Transit Systems (Phoenix, AZ)	Y	N	N
Pierce County Public Transit (Tacoma, WA)	Y	N	Y
Regional Transportation District (Denver, CO)	Y	N	Y
Sun Tran Public Transit (Tucson, AZ)	Y	N	Y
Jamaica Buses, Inc. (Jamaica, NY)	Y	N	N
Greater Bridgeport Transit District (Bridgeport, CT)	Y	Y	A
Manistee County Transportation, Inc (Manistee, MI)	N	N	Y
Great Falls Transit District (Great Falls, MT)	Y	N	Y
Tri-County Metropolitan (Portland, OR)	Y	N	Y
Capital Metropolitan Transportation Authority (Austin, TX)	Y	N	N

[A] = Wash waters recycled and discharged to sanitary sewer through oil separator.

Transit Agency	Solvent	Aqueous	Bake-off oven
Alameda-Contra Costa Transit (Oakland. CA)	Y	N	N
Bi-State Development Agency (St. Louis, MO)	N	Y	N
Central Oklahoma Transportation (Oklahoma City, OK)	N/R	N/R	N/R
Command Bus Company, Inc.(Brooklyn, NY)	N/R	N/R	N/R
Green Bus Services (Jamaica. NY)	Y	N	N
Metropolitan Transit Authority (Houston, TX)	Y	Y	Y
Los Angeles County MTA (Los Angeles, CA)	Y	N	N
Metro Dade Transit Agency (Miami, FL)	Y	Y	N
New Jersey Transit (Newark, NJ)	Y	N	N
New York City Transit Authority (Brooklyn. NY)	Y	N	N
Orange Co.Transportation Authority (Garden Grove. CA)	Y	Y	N
Phoenix Transit Systems (Phoenix, AZ)	Y	N	N
Pierce County Public Transit (Tacoma, WA)	Y	N	N
Regional Transportation District (Denver, CO)	Y	N	N
Sun Tran Public Transit (Tucson. AZ)	Y	N	N
Jamaica Buses, Inc. (Jamaica, NY)	Y	N	N
Greater Bridgeport Transit District (Bridgeport. CT)	N	Y	N
Manistee County Transportation. Inc (Manistee. MI)	Y		
Great Falls Transit District (Great Falls, MT)	Y		
Tri-County Metropolitan (Portland, OR)	Y		
Capital Metropolitan Transportation Authority (Austin. TX)	Y		

N/R = not reported

Transit Agency	Dispose air Filters	Dispose oil filters	Particulate trap
Alameda-Contra Costa Transit (Oakland, CA)	Y	Y	N
Bi-State Development Agency (St. Louis, MO)	Y	Y	
Central Oklahoma Transportation (Oklahoma City, OK)	N	Y	N
Command Bus Company, Inc.(Brooklyn, NY)	N/R	Y	
Green Bus Services (Jamaica, NY)	N/R	Y	
Metropolitan Transit Authority (Houston, TX)	N/R	N	
Los Angeles County MTA (Los Angeles, CA)	N	N	Y
Metro Dade Transit Agency (Miami, FL)	Y	N	
New Jersey Transit (Newark, NJ)	N/R	Y	
New York City Transit Authority (Brooklyn, N'Y)	N/R	N/R	Y
Orange Co.Transportation Authority (Garden Grove, CA)	N	N	Y
Phoenix Transit Systems (Phoenix, AZ)	N/R	Y	
Pierce County Public Transit (Tacoma, WA)	Y	Y	
Regional Transportation District (Denver, CO)	N/R	N	N
Sun Tran Public Transit (Tucson. AZ)	Y	N	
Jamaica Buses, Inc. (Jamaica, NY)			N
Greater Bridgeport Transit District (Bridgeport, CT)			N
Manistee County Transportation, Inc. (Manistee. MI)			N
Great Falls Transit District (Great Falls, MT)			N
Tri-County Metropolitan (Portland, OR)			N
Capital Metropolitan Transportation Authority (Austin, TX)			

N/R = not reported

APPENDIX C

TRANSIT AGENCIES SURVEYED

Arizona
City of Phoenix Transit System
City of Tucson Mass Transit System (Sun Tran)

California
AC Transit (Alameda-Contra Costa Transit District)
Los Angeles County Metropolitan Transit Authority
Orange County Transportation Authority
Santa Barbara Metropolitan Transit District

Colorado
Regional Transportation District
Transfort

Connecticut
Greater Bridgeport Transit District
Norwalk Transit District

Florida
Authority
Metro Dade Transit Agency

Illinois
Oregon
Decatur Public Transit System

Michigan
Manistee County Transportation, Inc.

Missouri
Bi-State Development Agency

Montana
Great Falls Transit District

New Jersey
New Jersey Transit Corporation

New York
Command Bus Company, Inc
Green Bus Lines, Inc.
Jamaica Buses, Inc.
Liberty Lines Express
MTA New York City Transit
New York Bus Service
Queens Surface Corporation

North Carolina
AppalCART
Chapel Hill Transit

Ohio
Greater Cleveland Regional Transit Authority

Oklahoma
Central Oklahoma Transportation and Parking

Oregon
Tri-County Metropolitan Transportation District of

Pennsylvania
Lehigh and Northhampton Transportation Authority

Texas
Capital Metropolitan Transportation Authority
Metropolitan Transit Authority of Harris County

Washington
Pierce County Public Transportation

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