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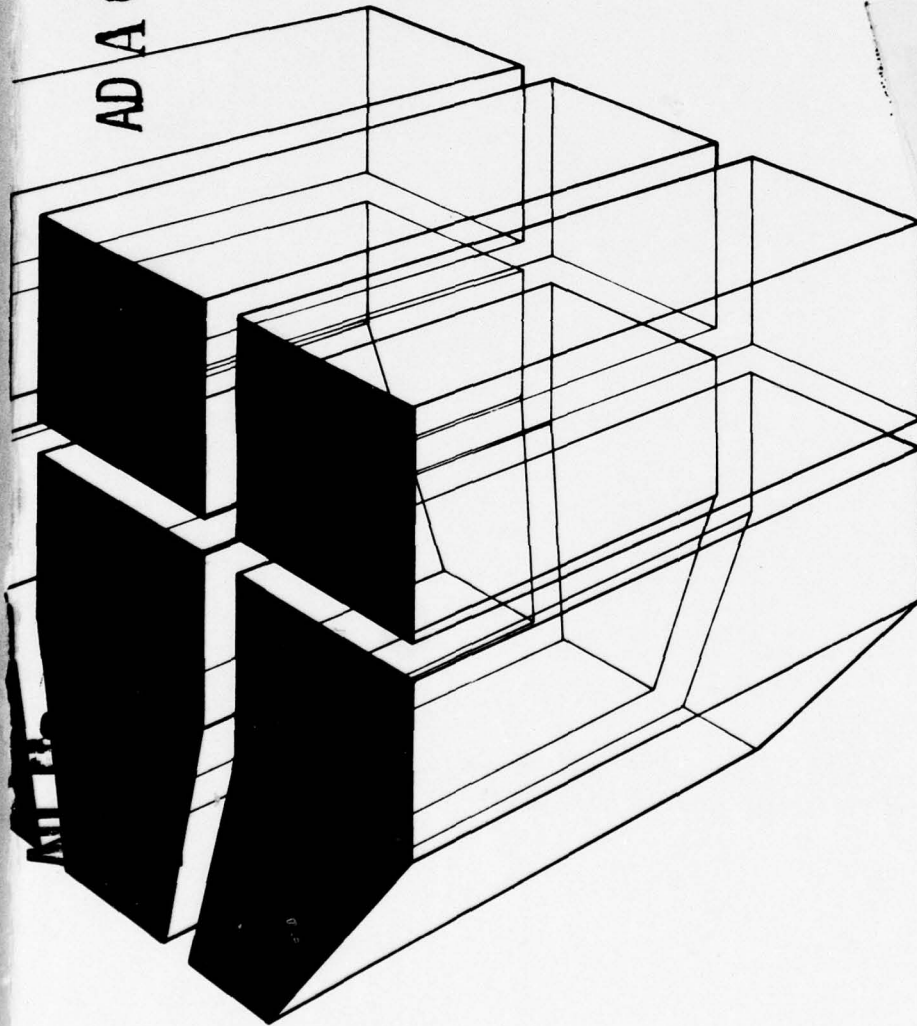
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Solid Waste Management for Military Facilities

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IMPROVED COLLECTION AND CONTAINER-WASHING
SYSTEMS FOR SOLID WASTE MANAGEMENT
AT ARMY INSTALLATIONS

by
G. L. Gerdes
W. J. Mikucki



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Block 20 continued.

The Mobil Toter system was evaluated through an implementation study at Fort Eustis, VA. The 28 percent decrease in collection time noted in the study cannot be ascribed to use of the Mobil Toter container alone; it also reflects the effects of curbside vs. backyard collection, fewer containers (Mobil Toter is larger than a GI can), and power-assisted dumping.

The container wash unit was evaluated by facilities engineering personnel at Fort Leavenworth, KS. The test indicated that the concept was sound, but that greater wash pressure and pickup suction would improve performance.

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FOREWORD

This study was conducted for the Directorate of Facilities Engineering, Office of the Chief of Engineers (OCE), under Project 4A762720A896, "Environmental Quality for Construction and Operation of Military Facilities"; Task T2, "Pollution Control Technology"; Work Unit 007, "Solid Waste Management for Military Facilities." The applicable QCR is 1.03.006. Mr. A. P. Norwood, DAEN-FEU-S, was the OCE Technical Monitor.

The work was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (CERL). Dr. R. K. Jain is Chief of EN.

The assistance of personnel at the Directorates of Facilities Engineering at Fort Eustis, VA, and Fort Leavenworth, KS, is gratefully acknowledged.

COL J. E. Hays is Commander and Director of CERL and Dr. L. R. Shaffer is Technical Director.

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IMPROVED COLLECTION AND CONTAINER-WASHING SYSTEMS FOR SOLID WASTE MANAGEMENT AT ARMY INSTALLATIONS

1 INTRODUCTION

Background

The U.S. Army Construction Engineering Research Laboratory (CERL) is conducting a continuing research program designed to help facilities engineers effectively manage their installation's solid waste. The facet of the program discussed in this report deals with two potential solid waste management systems--improved collection technology and in-situ solid waste container washing.

Objective

The objectives of this study were twofold: (1) to evaluate Rubbermaid Corporation's Mobil Toter* collection system, and (2) to evaluate a portable, modular, multiple-container-washing unit developed at CERL and identify necessary improvements for a second-generation unit.

Approach

The Mobil Toter was evaluated through a study of collection practices and time requirements before implementation of the new system and following implementation at Fort Eustis, VA. In addition, user response to a similar implementation at an Air Force installation (Langley AFB, VA) located near Fort Eustis was obtained.

The portable, modular, multiple-container-washing system developed at CERL was evaluated in two field tests at Fort Leavenworth, KS.

Mode of Technology Transfer

The material in this report will provide input to AR 420-47¹ with respect to container-washing facilities. In addition, change 18 to AR 210-50² requires conversion from backyard collection of solid waste

* Trademark of Rubbermaid Corporation

¹ *Refuse Collection Disposal*, AR 420-47 (Department of the Army, 1967)

² *Family Housing Management*, AR 210-50, change 18 (Department of the Army, 13 April 1976).

to curbside collection; the Mobil Toter unit evaluated in this report can serve as a means of implementing this change. This information will be disseminated in the OCE Facility Engineering Items of Interest and in an Engineer Technical Note issued by the OCE Directorate of Facilities Engineering.

The CERL multiple-container-washing system can be fabricated using information in this report; the component schematic is included along with a list of required off-the-shelf equipment.

2 EVALUATION OF THE RUBBERMAID MOBIL TOTER COLLECTION SYSTEM

System Description

The Mobil Toter system uses individual household refuse containers which are rolled to a collection truck, where hydraulic lifts attached to the truck dump the containers mechanically.

The Mobil Toter container (Figure 1) is a wheeled, square, plastic refuse can with a capacity of 80 gal (303 L). A plastic lid is hinged to the body of the can, which has a handle for rolling the container molded into it. Opposite the handle is a lip which fits over the hydraulic lift. The container is hooked onto the lift, tipped, emptied into the truck, and returned to the street in about 8 seconds (Figure 2). The lift can be attached to most conventional rear- or side-loading compactor trucks, making the system easily adaptable to most current collection systems.

Implementation Study

Test Site

The family housing area at Fort Eustis, VA, was the test site for the Mobil Toter study. On 1 July 1976, Fort Eustis changed from backyard collection of Government Issue individual refuse containers (GI cans) to curbside collection of Mobil Toters. The containers were purchased by the housing division at Fort Eustis, while the contract hauler purchased the lift mechanisms for the collection trucks. July through September 1976 was used as a trial period to determine what changes and/or cost reductions resulted from the container change.

The family housing area at Fort Eustis is divided into four collection routes: two Monday/Thursday routes and two Tuesday/Friday routes. Two trucks having three-man crews travel the routes. Before introduction of the Mobil Toters, a worker had to pull a cart to the front or rear of each housing building--often a distance of more than 100 ft (30 m)--to collect refuse from GI cans. With the Mobil Toter containers, the worker simply pushes the container from the curb to the back of the truck. This is the only change in the collection procedure caused by the introduction of Mobil Toters. Waste is still disposed at a landfill on post.

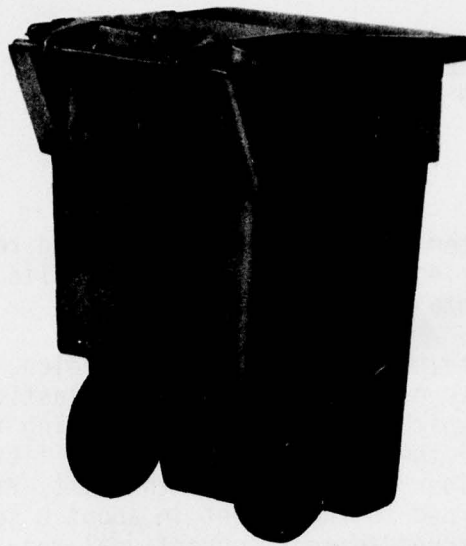


Figure 1. Mobil Toter solid waste container.



a. Hooking container to lift mechanism.



b. Hydraulic lift mechanism emptying container into rear-loading compactor truck.

Figure 2. Collection with the Mobil Toter system.
(Photos reprinted by permission of Rubbermaid Corporation).

Observation of Procedures

The collection procedure before and after initiation of the Mobil Toter system was observed and filmed. Observation of GI can collection indicated that the procedure could easily be improved. The crews spent considerable time traveling to and from the truck. The two transfers of the refuse--from the GI can to an open cart and from the open cart to the truck--increased spilling. Multiple lifts of the refuse also consumed extra time and increased the chances of injury.

Observation of the Mobil Toter collection system 3 weeks after implementation indicated that the operation was generally smoother and more efficient than the GI-can procedure. Occupants rolled the Mobil Toters to the curb so each building's containers were grouped together. The crew was able to collect the waste from each block in only a few stops. The workers seldom had to travel more than 20 ft (6 m) from the rear of the truck to roll a container to the lift. No refuse was observed to be spilled by the lift mechanism. The Mobil Toters have a much better appearance than GI cans. Elimination of manual lifting also makes the Mobil Toter system safer.

However, two aspects of the system at Fort Eustis tended to limit collection efficiency. First, while there were two workers to dump the trash, only one lift mechanism was installed on the truck, resulting in a queuing problem. Since there is room for two lifts on standard rear-loading compactor trucks, a second lift could be installed to reduce this problem. Second, the cycle time of the compactor on the truck slowed the crew when they stopped to collect a large group of Mobil Toters. These two problems indicate that a three-man crew with two lifts may be more efficient in areas of low container density, while one lift and a two-man crew may be better in areas of high container density.

Time of Collection

A time-of-collection study was performed to provide a quantitative comparison of the old and new systems. A person following the collection truck logged the amount of time the trucks spent on each route before the new system was started, and again 2 weeks after. Table 1 presents the data from this survey.

Covering all the routes under the old procedure took 714 minutes. Implementation of the Mobil Toter system reduced the time to 506 minutes. The changeover thus showed an immediate 28 percent decrease in collection time.

Table 1
Results of Collection Time Survey

Route	Time Spent During Collection, Minutes	
	Before Mobil Toter	After Mobil Toter
Mon/Thur, Truck 91	95	124
Mon/Thur, Truck 178	214	141
Tues/Fri, Truck 91	200	115
Tues/Fri, Truck 178	205	126
Total	714	506

This time saving cannot be ascribed totally to the Mobil Toter system. The reduced collection time actually resulted from the following combination of changes:

1. Change from backyard to curbside collection
2. Reduction in number of containers to be emptied
3. Change from manual to mechanical tipping
4. Reduction in handling time due to integral hinged cover.

The data accumulated in this brief evaluation do not permit statistical separation of the influence of these factors. Environmental Protection Agency studies³ have used Methods-Time-Measurement (MTM) techniques to measure standard times for various collection modes, crew sizes, and numbers of cans emptied. These studies show that the standard time required for a three-man crew to collect two cans per house

³ *A Study of Solid Waste Collection Systems Comparing One-Man with Multi-Man Crews*, EPA Report SW-9C (U.S. Public Health Service, Environmental Protection Agency, 1969).

using the backyard collection procedure may be 80 percent longer than that for the same two cans collected at curbside. The reduction of containers from two to one per household can reduce collection time per house by 26 percent.

Evaluation of Customer Satisfaction

Customer satisfaction at Fort Eustis was not sampled because the Mobil Toter system had been in use for a limited time. However, about a year prior to the Fort Eustis changeover to Mobil Toters, Langley AFB, VA, made the same change. To determine the housing occupants' reaction to the new collection system, the Base Civil Engineer at Langley AFB sent out a questionnaire designed to sample opinions about the service before and after implementation of the Mobil Toter system. Responses, which are summarized in the appendix, were in favor of the Mobil Toter system by a 7 to 1 ratio.

3 EVALUATION OF THE PORTABLE MULTIPLE-CONTAINER-WASHING SYSTEM

Current Multiple-Container-Washing Practice

Multiple containers are refuse collection container boxes with capacities varying from 0.5 to 14 cu yd (0.4 to 10.7 m³). They are normally situated in areas with high solid waste generation or in central locations for use by a number of patrons (e.g., residents in a section of family housing). These multiple containers are emptied using special collection vehicles.

Sanitation considerations require periodic washing of multiple containers. AR 420-47 permits construction of centralized multiple-container-washing facilities. To use such facilities, clean containers must be exchanged for dirty ones at the field locations; the dirty containers must then be transported to the washing facility. Transportation of these containers requires use of a vehicle with lifting capability--generally a multiple-container solid waste collection vehicle. It can also be accomplished using a forklift for raising the container and a separate transport vehicle (e.g., a flatbed truck or low-boy trailer).

A typical large military installation may have more than 100 containers which must be washed one or more times each year to prevent harboring of disease vectors (rats, flies, mosquitoes) and to eliminate odors. Obviously, transporting this number of multiple containers to a centralized washing site can be costly in terms of manpower and equipment commitments.

Description of the Portable Multiple-Container-Washing System

The alternative to transporting containers to a centralized wash facility is to transport the washing system to the container. CERL initially considered mounting the washing equipment on the refuse collection vehicle so the container could be washed after emptying. Although collection vehicle manufacturers offer a low-pressure washing hose as an option, it is only marginally effective. Mounting a high-pressure system (fixed- or telescoping-nozzle type) on the collection vehicle to automatically wash the container during the dump cycle was found to be infeasible due to the lack of available physical space in conventional collection vehicles.

Consequently, CERL researchers developed a portable, modular, recycling, multiple-container-washing system (Figure 3). The modular nature of the system facilitates mounting and dismounting from a general-purpose vehicle, thus eliminating the need for a dedicated vehicle. The system's recycle feature permits washing of a succession of containers and eliminates the logistical or redundant travel problems caused by having to return containers to a central washing facility.

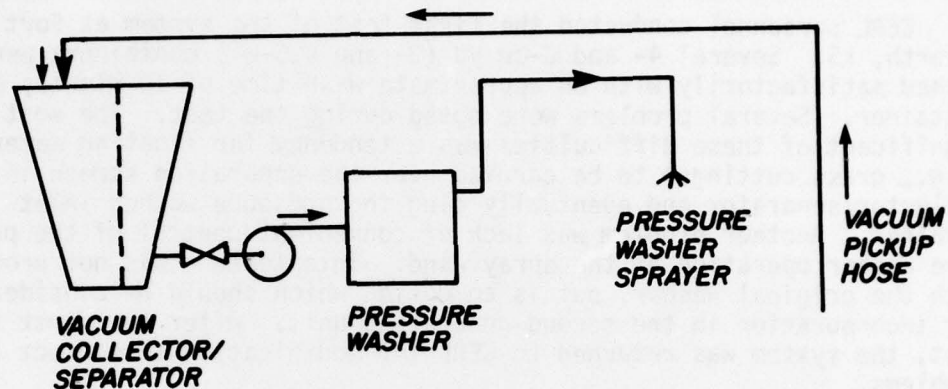


Figure 3. Portable, recycling container-washing system.

The modular system, which was assembled from commercially available equipment, includes a conventional shop-type vacuum cleaner, a 500-psig (35.2 kg/cm²) (discharge) pressure washer, and a 5-gpm (18.9-L/minute) circulating pump. In operation, the circulating pump draws suction on the vacuum collection/separator and pumps water to the pressure washer booster pump, which, in turn, produces a 500-psig (35.2 kg/cm²) discharge pressure. Allowing for pressure drop in the hose, the pressure reaching the spray nozzle is approximately 470 psig (33.0 kg/cm²). The pressure washer used in this system is equipped with a turret containing four spray nozzles: one delivers a solid stream, two provide flat spray patterns at a 15-degree spray angle, and one provides a 40-degree spray angle. All nozzles deliver 1.8 gpm (6.8 L/minute) of wash water. Average impact at the operating pressure is approximately 2.2 psi (0.15 kg/cm²).⁴

⁴ Spraying Systems Company, Wheaton, IL; company drawing No. 12530

The wash water and suspended dirt are retrieved from the container being washed by the suction of the vacuum collector/separator. Within the vacuum system, suspended solids are separated from the transporting water by means of a vertical 30 mesh (6992 μ) screen. A 3.5 kW gasoline engine generator provides electrical power for the system.

Field Evaluations

CERL personnel conducted the first test of the system at Fort Leavenworth, KS. Several 4- and 6-cu yd (3- and 4.5-m³) containers were washed satisfactorily with an approximate wash time of 15 minutes per container. Several problems were noted during the test. The most significant of these difficulties was a tendency for floating material (e.g., grass cuttings) to be carried over the separation screen in the collector/separator and eventually clog the pressure washer inlet strainer. Another problem was lack of convenient control of the pressure washer operation at the spray wand. This feature was not procured with the original washer, but is an option which should be considered for incorporation in the second-generation unit. After the first field test, the system was returned to CERL for modification to correct these problems.

Facilities engineering personnel at Fort Leavenworth conducted a second field test between May and September 1976. This evaluation confirmed the feasibility of the in-situ, recycling, multiple-container-washing system, but also indicated two areas for system improvement--greater washing and vacuum retrieval power.

Improved Washing

The system's washing action could be improved by increasing washing pressure, heating the wash water, or improving the water's cleaning ability. Increased pressure will increase the impact force of the stream. Table 2 shows the effect of increasing pressure 6 in. (15 cm) from the nozzle on the average impact₂ for a 15-degree spray angle. Systems developing 1000-psig (70.3-kg/cm²) outlet pressures are commercially available.

Table 2*

Relation of Impact and Spray Pressure

System Pressure, psig (kg/cm ²)		Average Impact, psi (kg/cm ²)	
400	28.1	2.2	0.15
700	49.2	4.3	0.30
1000	70.3	6.1	0.43

Systems providing heated wash water are also commercially available. One available unit uses a diesel fuel heater nozzle to raise water temperature to 200°F (93°C) at delivery pressures of 800 psi (56.2 kg/cm²). A demonstration of the system conducted by the manufacturer at CERL revealed the need for fuel logistics and a 200-V power source. Use of this device in cool weather posed a severe visibility problem due to steam formation obscuring the work surface.

The probability of excessive scale formation in the heater nozzle as a result of recycling wash water is high. The use of surfactants in the wash water has not yet been fully explored, but steps to suppress foaming due to stream impact on vacuum retrieval will almost certainly be required.

Improved Retrieval

The vacuum collector/separator's capability to transport liquid and solid material from the container is directly related to the air velocity at the pick-up point, which is in turn related to the vacuum van's volumetric air capacity. Industrial-grade vacuum cleaners capable of larger volumetric flow rates and suction air velocities than the vacuum used in this evaluation are available for incorporation into the second-generation system.

* From Spraying Systems Company, Wheaton, IL; company drawing No. 12530.

4 CONCLUSIONS

The implementation study at Fort Eustis indicated that the Mobil Toter collection system, used in conjunction with a change from backyard to curbside collection, resulted in a 28 percent decrease in collection time.

Field tests of the CERL-developed multiple-container-washing unit indicated that the concept of in-situ multiple-container washing with recycled wash water is feasible with respect to component function and portability. Unit performance would be enhanced by increased wash-water discharge pressure and greater retrieval suction.

APPENDIX:

CONSOLIDATED RESULTS OF MOBIL TOWER
USER SATISFACTION SURVEY AT LANGLEY AFB, VA

REFUSE COLLECTION SURVEY RETURNS*

1. Do you believe the quality of service has improved under the container system compared to the old system (re: number of misses, spilled refuse, extra collections)?

YES 90 NO 24 NO COMMENT 20

2. Have you experienced any unusual difficulty in handling the wheeled container?

YES 12 NO 122 NO COMMENT 0

3. Would you agree that the advantages of the container system outweigh any complaints (re: size of container, rolling to the streetside, removing it after pickup)?

YES 107 NO 16 NO COMMENT 11

4. Are you in favor of continuing the container system?

YES 122 NO 7 NO COMMENT 5

5. How would you rate the overall quality of the government refuse-collection service?

EXCELLENT 46 UNSATISFACTORY 3

GOOD 60 NO OPINION 1

SATISFACTORY 24

6. Do you believe that the quality of service has improved?

IMPROVED 66

ABOUT THE SAME 52

* Approximately 500 questionnaires were sent out; 134 replies were received.

WORSE 5

NO OPINION 11

7. Do you favor continuing the current curbside mobile container system?

YES 117 NO 8 NO OPINION 9

8. Do you think the size of the mobile container is right?⁺

TOO LARGE 0 ABOUT RIGHT 92 TOO SMALL 41

NO OPINION 1

9. Would you prefer existing size containers or approximately half as large?

PRESENT 112 HALF PRESENT SIZE 1

NO OPINION 21

10. Have you experienced unusual difficulty in handling the mobile container?

YES 11 NO 123 NO OPINION 0

11. Do you normally place your container at the curb the evening before or early morning?

EVENING 64 MORNING 40 NO OPINION/RESPONSE 30

12. Is the present container large enough to hold weekly garbage as well as weekly yard trash?

YES 36 NO 97 NO OPINION 1

13. If you had a choice, what type of curbside pickup would you prefer?

GARBAGE CANS 2 MOBILE CONTAINERS 130

PLASTIC BAGS 2 NO OPINION 0

⁺ For once-a-week collection.

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