LOW TECHNOLOGY RECYCLING AND RDF SYSTEM AT THE U.S. FACILITY, SUBIC BAY, PHILIPPINES

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INTRODUCTION

The U.S. Facility Subic Bay is located about 50 miles east of Manila, on the East China Sea. The Facility consists of seven major Naval installations. The Facility is essentially a large commercial/industrial complex. The Public Works Center (PWC) Subic Bay is the public works agency responsible for the collection and disposal of the solid waste produced by the facility. A portion of the solid waste is manually sorted and recycled. Although the present manual sorting and recycling system is effective, PWC Subic Bay feels that it can be improved. Therefore, the Naval Civil Engineering Laboratory (NCEL) was requested to study the system and recommend improvements.

OBJECTIVES

The specific purpose of this study was to evaluate the existing solid waste management and resource recovery system and identify improved methods that will meet the following objectives:

1. Make the residual landfilled material unattractive to scavengers.
2. Safeguard the rights of the present recyling center employees while improving their safety and working conditions.
3. Improve the habitability and cleanliness of the base.
4. Increase net revenues by improving the productivity of the recycling center and extracting the energy available in the solid waste residues.

PRESENT SOLID WASTE MANAGEMENT PRACTICES

Industrial/commercial wastes are collected by PWC Subic Bay employees, manually sorted and inspected, recyclable materials recovered, and solid waste residues disposed of at the base sanitary landfill. Housing wastes, hazardous wastes, and special wastes (such as spoiled foodstuffs) are separately handled. Industrial/commercial wastes are generated by: offices, barracks, food services, commercial activities (Navy Exchange and Commissary), wastes from moored ships, construction, and industrial wastes from ship and aircraft repair operations.

The wastes are collected 7 days a week, 365 days a year. Due to the lack of detailed solid waste quantity data, only an estimated range of collected solid waste can be made: 400,000 to 600,000 yd^3/yr. The density of this material is about 140 lb/yd^3. Wastes are collected and transported to the recycling center, where they are dumped on a concrete slab and manually separated. Recyclable materials are baled, stored on-site, and sold by competitive contracts. The most economically significant materials are nonferrous scrap metals (aluminum, brass, copper, and lead batteries), copper electrical wiring, cardboard, and wood. The 9-month record summarized in Table 1 can be extrapolated to about 5,000 tons of materials recycled in 1982.

The actual manual sorting is performed by members of the New Cabalan Negritoes Labor Association, a Philippine government sponsored corporation. The Labor Association supplies between 45 to 57 laborers, 7 days/week, to the recycling facility. The Labor Association is paid on a lump sum basis. Terms of the contract are negotiated yearly.

After separation, nonrecyclable material is hauled to the base sanitary landfill in rear loading compactor trailers. Based on incomplete volume records, and one set of density measurements, approximately 15,000 tons/yr (40 tons/day) to 30,000 tons/yr (80 tons/day) of solid waste residue are buried at the base sanitary landfill. One continuing problem at the landfill site has been scavengers recovering materials from the landfill before the daily cover is placed. On occasion they have also dug up and removed landfilled materials. There are obvious safety and health dangers in such a practice.

PROPOSED ALTERNATIVE RECYCLING AND RESOURCE RECOVERY SYSTEM

Manual separation of solid waste has historically proven to be the most effective method for recovering resources from solid waste, although a wide variety of mechanical systems has been proposed. Most of these mechanized systems have been designed to minimize manual labor and thus employ sophisticated technology, including shredders, flail mills, and air classifiers. The majority of these systems have suffered from high capital and operating costs in addition to being less effective than manual separation. However, it is possible to design a hybrid system with lower capital costs and greater use of labor (Vesilind et al., 1979). Such a system can be economically viable in an environment where there is a strong market for the recovered material and an abundant and inexpensive labor force relative to the value of the material. One of the objectives of this study was to recommend alternatives which will preserve the employment rights of the Negrito contract employees. Thus, a less capital intensive, but still labor intensive, semi-mechanized Recycling Facility was proposed. Such a facility could employ partial mechanization to effect a separation and distribution of wastes using a low cost trommel screen and simple conveyor belts to improve worker productivity and safety. Capital- and energy-intensive size reduction equipment (i.e., shredders) would not be required. A flowsheet of such a facility is shown as Figure 1. The facility and other alternatives which were also evaluated are described in detail in Vigil and Brunner (1984).

The facility will be housed in a covered, wall-less shelter. Solid waste will flow through the facility from left to right on belt conveyors. Wastes will be loaded onto the feed conveyor with a skip loader. Oversize metal wastes which might damage the feed conveyor will be manually removed. A two-stage trommel screen with 6- and 18-inch holes will be the primary separation device. Disk screens will be used as secondary separators. A 6-inch disk screen will be used to remove undersized material from the minus 18-inch trommel fraction. An optional 1-inch disk screen will be used to remove grit (i.e., sand, broken glass) from the residue stream in the event that an incinerator is used for residue processing. Simple magnetic separators will be used on each trommel underflow line to separate iron. Workers at stations along the underflow conveyors will manually remove recyclable materials, such as aluminum cans, and nonferrous metals and load them into adjacent transportable bins. Nonrecyclable residues will roll off the ends of the side conveyors into residue containers. Oversize materials (>18 inches in diameter) will flow through the trommel screen to the oversize discharge conveyor where additional recyclable materials can be recovered. Oversize materials that will pass through the trommel screen include cardboard, wood pallets, tires, and large plastic sheets.

The semi-mechanized Recycling Facility will enhance worker productivity and safety because individual workers will not have to lift or carry materials great distances. Also personnel movement, in addition to being significantly reduced, will be more structured and directed. This will result in a lower potential for accidental injury from vehicle and equipment traffic. The conveyors will also spread out the waste into a thinner layer than is now possible with the existing manual system. Key to the efficient operation of the facility is the rapid removal of both recyclable materials and residues. Recovered materials will be placed into bins at each worker station. This will allow for easy replacement of the bins as they fill up. Solid waste residues will be directly loaded from the conveyor into the compactor trailer for direct haul to the sanitary landfill, eliminating the existing crane operation.

ENERGY RECOVERY POTENTIAL

Energy can be recovered from the solid waste residue with a heat recovery incinerator (HRI). Any of several types of commercially available HRIs could be used, including excess air incinerators or starved air incinerators coupled to waste heat boilers. Since a good portion of the combustible material has already been removed from the residue, a conservative steam rate of 2 pounds steam/pound of solid waste is possible. Assuming an equipment availability factor of 85%, 5,900 to 11,300 pounds steam/hour could be recoverable from the 42 to 80 tons/day of solid waste residue presently landfilled. With the current PWC Subic Bay utility rate for steam of $13.00/million Btu, the energy recovered would be worth $813,000 to $1,545,000 per year. (This is a gross estimate which does not take into account the actual composition and Btu value of the residue since these data were not available.) Steam consumers are available on base to utilize this steam.

CONCLUSIONS

The semi-automated recycling center and heat recovery incinerator described in this paper will meet all of the objectives previously discussed.

1. Eliminate Scavenging - Since the residues are burned in an incinerator, the resultant ashes would have no value to potential scavengers.

2. Employment - Present jobs will be maintained but upgraded as workers will be involved in less heavy lifting than in the present operation. Some employees may be retrained to perform minor maintenance (i.e., lubrication, etc.). Overall productivity and efficiency will improve. Additional skilled workers will also be required.

3. Habitability and Cleanliness - Throughput of solid waste will be substantially increased over the previous alternatives; thus, odors will be significantly reduced. Odors at the landfill site would be substantially reduced since an inert ash would be buried.

4. Increase Net Revenues - Recycling productivity will increase, resulting in increased revenues from recycled materials. Additional revenues will accrue from steam sales. Although the system

described will be located at a Naval base, the principles involved could be applied in any city where similar conditions exist. Such a semi-automated system would be feasible where high unemployment, good markets for recycled materials, and steam users exist.

REFERENCES

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Table 1. Materials Recovered by PWC Subic Bay (October 1982 through June 1983)

Material	Unit Value ($/metric ton)	Quantity (metric tons[b])	% by Weight	Gross Income ($)	% of Total Income
Aluminum cans	323.81	15.10	0.4	4,890	1.5
Aluminum scrap	283.31	112.94	3.2	31,997	10.1
Automotive parts	46.91	36.77	1.0	1,725	0.5
Batteries	241.00	57.99	1.7	13,976	4.4
Brass	902.14	24.73	0.7	22,310	7.1
Cardboard	71.75	749.25	21.4	53.759	17.0
Copper	902.14	58.84	1.7	53,082	16.8
Electrical wire	846.56	53.42	1.5	45,223	14.3
Mixed metals	46.91	282.01	8.0	13,229	4.2
Mixed paper	129.40	47.71	1.4	6,174	2.0
Motors	46.91	3.27	0.1	153	<0.1
Plastic (baled)	61.23	67.94	1.9	4,160	1.3
Rubber (including tires	40.44	154.05	4.4	6,230	2.0
Stainless steel	340.00	13.91	0.4	4,729	1.5
Steel	46.91	748.58	21.4	35,116	11.1
Wood	15.86[a]	1,078.51	30.8	19,460	6.2
Totals		3,505.02	100.0	316,212	100.0

[a] Unit value was $23.49/metric ton through February 1983.

[b] One metric ton = 1.1016 U.S. tons.

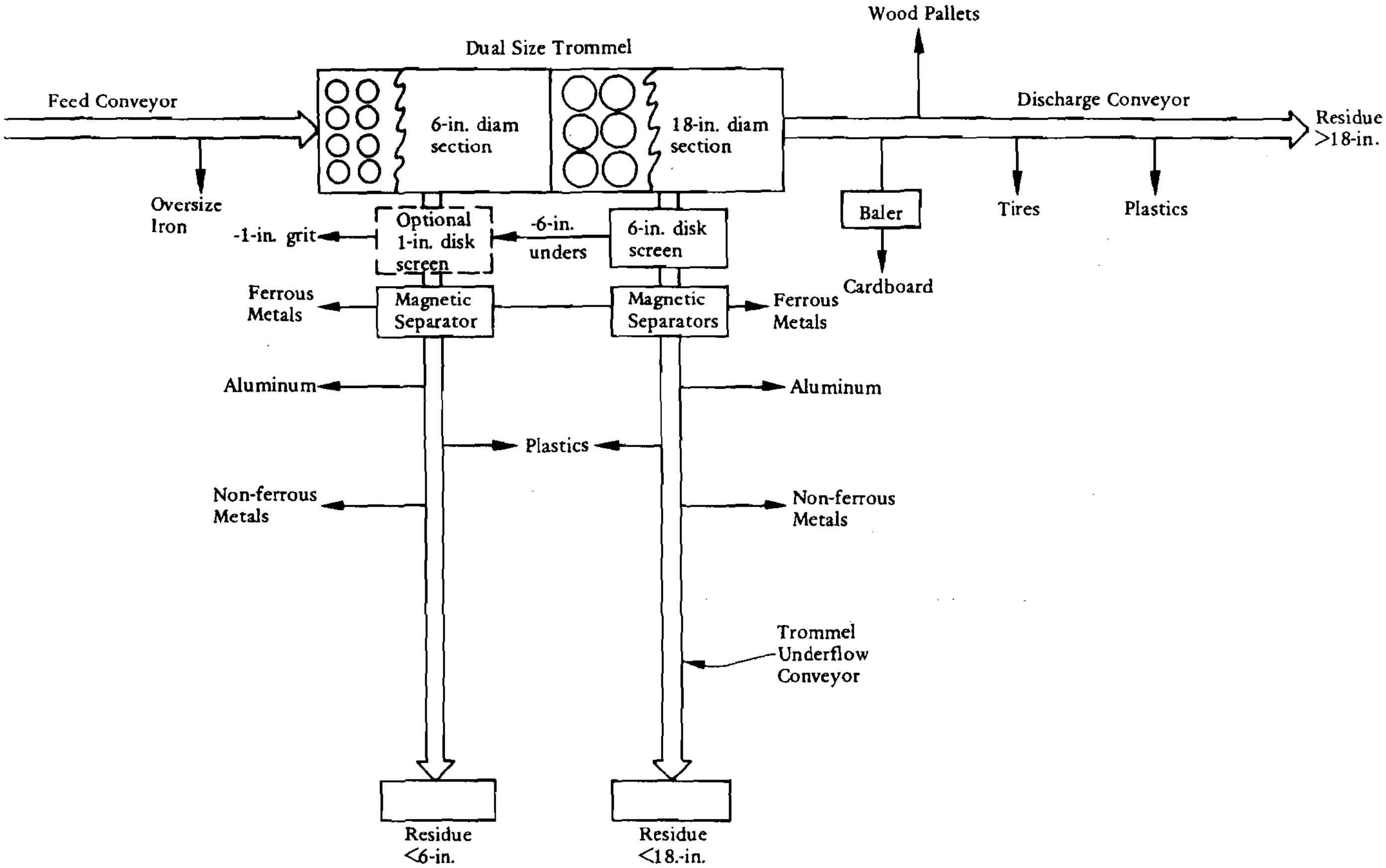

Figure 1. Flowsheet, semi-mechanized recycling facility.