FRONT-END PROCESSING FOR WTE PLANTS

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Introduction

Legislation calling for 25% or more recycling of paper, metals, glass, and plastics currently exists in many states, either as a mandated requirement such as California AB939, or as a state goal. Such recycling requirements or goals can be achieved by combinations of several methods including:

1. Curbside pickup at the household level and drop-off centers for recyclables, or
2. Mixed Waste Material Recovery Facilities (MRF's) that stand alone, or
3. Front-end processing MRF's for Waste-To-Energy plants.

This paper will discuss National Ecology's (NEC) experience in the design of front-end processing facilities at the North County Regional Resource Recovery Facility in Palm Beach County, Florida, the design of a MRF for the Solid Waste Reduction Facility in San Marcos, California and the NEC Front-End Material Processing Plant (MRF) design for mass burners. The paper will summarize the impact of Front-End Processing on WTE plants using a computer model.

North County Solid Waste Reduction Facility, San Marcos, California

The San Marcos facility is a state-of-the-art material recovery facility (MRF) designed to recover all recyclables from 2,115 TPD of municipal solid waste (MSW). NEC and Babcock and Wilcox are currently constructing this facility and NEC and the project owner, Thermo Electron Energy Systems, will jointly operate and maintain the facility under a 24 year contract. First waste is scheduled to be processed during start-up operations in June 1993.

The San Marcos facility uses 5 stage trommel screens for initial bag breaking and size separation followed by magnetic separation of ferrous metal with magnets and separation of aluminum with eddy-current separators. Other materials such as HDPE, PETE, film plastics, newspaper, mixed paper, corrugated cardboard, and glass (three colors) will be recovered by hand picking. The paper products, corrugated cardboard, plastics, and aluminum cans will be baled for shipment. Broken glass, stones, grit, dirt, trommel undersize materials, and minus 2 inch organics such as grass and leaves, will be removed as residue and landfilled. The balance, which consists of non-recyclable trommel oversize materials, will be shredded. This fraction, which consists of dry combustibles, could make an ideal feed for a Waste-To-Energy (WTE) Facility using an RDF Boiler. If the material were not shredded, it would be suitable as feed for a mass burner. In either case, the heating value of the fuel will be high because it is relatively dry, and very low in ferrous, non-ferrous metals, glass, and other non-combustibles.

The flow sheet for the San Marcos Facility is shown in Figure 1, and a pictorial diagram of the process is shown in Figure 2. Highlights of the San Marcos Facility are presented in Table 1.

Although this is not a part of a WTE facility, the San Marcos design could be suitable for a mixed-waste MRF for use in a waste-to-energy facility where state or local requirements stipulate that a high percentage of recyclables must be recovered.

North County Resource Recovery Facility, West Palm Beach Florida

NEC was selected as the MSW processing system contractor for the North County Resource Recovery Facility in West Palm Beach, Florida. Under this contract, NEC performed design, procurement, start-up and acceptance testing, as well as the continued operation and maintenance of the 2000 TPD facility. This state-of-the-art facility is guaranteed to process over 624,000 tons of MSW per year using two of three RDF lines, each of which produces over 800 tons of RDF daily. This facility also recovers ferrous metal and aluminum cans, and shreds oversized bulky waste including refrigerators, washing machines, furniture, and tree limbs. A separate tire line can shred and screen up to 500 tires per hour for use as tire-derived fuel that is mixed with the RDF. Less than 5% of the original volume of MSW is landfilled as process residue. The RDF is burned in dedicated on-site boilers that generate 61 MW of electricity. A Mass Balance is provided in Figure 3 and a Process Flow diagram is provided in Figure 4.

The Palm Beach County Facility is part of a County-wide integrated waste management operation that also includes composting and a co-mingled MRF that handles up to 400 tons per day of co-mingled source separated recyclables. The co-mingled MRF processes substantial quantities of newspaper, as well as HDPE, PETE, aluminum cans, and glass bottles in 3 colors. Since the resource recovery facility also recovers ferrous metal and aluminum, the combined operations represent an optimum system for recovery of recyclables.

The net effect of Front-End Processing at the Palm Beach County Facility has been to improve the fuel value of the MSW from the "Reference Waste" level of 4,728 btu/lb to a level of 5300 btu/lb for the RDF, while reducing the ash content from a Reference Waste level of 23.65% to a level of approximately 10% for the RDF.

The higher heating value of the RDF based upon the "Reference Waste" for Palm Beach County was predicted, prior to construction, to be 5500 btu per pound as shown in Table 4. The average heating value during the period July 17 thru July 28, 1989 was 5,548 btu per pound, very close to the predicted value. The heating value ranged from 3538 to 6442 btu per pound, and the ash content ranged from a low of 6.7% to a high of 14.1% with an average of 9.42% during this period. Moisture which varied between 19% and 35%, undoubtedly affected the btu values.

During the period of October 25 thru October 30, 1989 the average heating value was 5301 btu per pound and ranged from a low of 5037 to a high of 5613 btu per pound with a moisture range of 30.59% to 35.55%.

During both of the above periods Palm Beach County was in the early stages of a curbside recycling program that involved newspapers, plastics, and aluminum cans. Since that time the co-mingled MRF has been built and has been operating at increasingly larger tonnages. The 1992 input was 68,000 tons, of which 70% is newsprint. The higher heating value of the RDF at the Palm Beach County Facility during 1992 was 5300 btu per pound which is reasonably close to the heating values obtained in 1989, thus implying that the substantially greater amount of co-mingled recycling of newspapers, plastics and glass occurring at the MRF had very little impact on the heating value of the RDF at the resource recovery facility. Since the boiler is a "btu machine" it is capable of burning a greater tonnage of lower btu RDF than high btu RDF. This means that the total RDF throughput can increase with low btu RDF, but the total steam and electrical power generated will remain essentially the same. Total MSW processed at Palm beach increased from the 624,000 TPY guaranteed minimum to 701,000 tons in 1992.

The percent of aluminum in the MSW, originally estimated at approximately 1%, has decreased to a level of 0.11% to 0.16% because of curbside recycling. Recovery is still worthwhile, however, despite the lower aluminum content in the MSW, since it removes the aluminum from the RDF being fed to the boiler, thereby minimizing the problems caused by aluminum melting on the boiler grates.

With the recovery of aluminum cans, ferrous metals, and RDF, this facility continues to be one of the most cost effective components of the county's integrated waste management programs.

<u>Proposed Front-End Materials Processing Plant</u>

National Ecology Company has prepared a design (for proposal purposes) for a 1150 ton per day MSW input Front-End Materials Processing Facility for use with a mass burner. The nominal design throughput is 55 TPH of MSW, plus 5 TPH of source-separated co-mingled recyclables, plus 6 TPH of whole tires. The processing facility will recover ferrous metal, aluminum cans, glass (three colors), PETE, HDPE, cardboard, office paper, and non-ferrous such as brass, copper, etc. The proposed facility will have 2 lines: 1) an MSW/co-mingled recyclable processing line and 2) a tire chopping line. The non-recovered materials from the processed MSW will fuel a mass burner at a rate of 728

TPD, 7 days per week, 24 hours per day. Removal of glass and aluminum from the MSW is desirable because of problems with molten glass and aluminum clogging some types of boiler grates. In addition, glass slags on the furnace walls resulting in reduced heat transfer. Glass fines, which are very abrasive, cause excessive grate wear and tube erosion.

This front-end facility is a simplified version of the San Marcos Facility, but does not include shredding. A mass balance and flow diagram are provided in Figure 5. The fuel output of this Facility is suitable as feed to an RDF type boiler if shredding capability is installed.

Impact of Front-End Processing on WTE Facilities

Because of the wide variability in the composition of municipal waste throughout the United States, as well as the seasonal variability, it is difficult to answer a frequently asked question: What will be the impact of front-end processing on a waste-to-energy facility? In order to answer this question, a simplified computer model was devised assuming that all recyclables are recovered in a front-end processing facility (i.e. no curbside recycling) assuming two levels of recycling: 21% and 30%. The amounts of each recyclable removed during front-end processing are shown in Table 6. Markets for recovered materials have been historically erratic. For this reason any front-end processing operation must be flexible so that the output of recovered materials can be adjusted to meet market conditions. A boiler operation, either mass burn or RDF, following a front-end processing facility can provide the flexibility required for adjusting to market conditions since the boiler can accommodate variations in the fuel quantity and composition.

For the purpose of this study, the computer analysis is based upon the average solid waste composition in the United States as shown in Table 7.

The results of the computer analysis are provided in Table 8 which compares fuel heating values, ash and moisture content, boiler efficiency, relative fuel quantity, and recyclables recovered for WTE facilities with and without front-end processing. Data on mass burn and RDF facilities are provided for two levels of recyclable recovery: 21% and 30%. Data on 7.7% recycling (ferrous metal and aluminum plus ONF only, are provided as a "base case" for comparison purposes. Table 8 shows that the calculated difference in fuel heating value for the 21% recyclable recovery system versus the 30% recyclable recovery system is negligible and therefore it is reasonable to conclude that front-end processing does not have an adverse effect on the heating value of the combustible fraction. However, the table does show a substantial reduction in the ash content of the fuel, and also of the aluminum and glass content of the fuel which is important since the aluminum and glass have an adverse effect on the boiler grates and tubes. As mentioned previously, the heating value of the combustible fraction from a front-end processing facility is substantially greater than that of the raw MSW feed to a mass burner, but relative fuel tonnage is less. The computer analysis shows that the moisture content of the combustible fuel fraction may increase substantially as a result of front-end processing, which, in turn, causes a slight decrease in boiler efficiency.

To Shred or not to Shred

A front-end processing system provides a high btu, low ash combustible fraction that can be used as fuel in either a mass burner, or if shredded, in an RDF boiler or a "Shred and Burn Boiler". The "Shred and Burn Boiler" is similar in design to an RDF Boiler, but the fuel feed has the same composition as that for a Mass Burner following a front-end processing system (see Table 8). This fuel consists not only of the shredded combustible fraction (ie. RDF), but also the lower BTU, higher ash, higher moisture reject fraction that is normally landfilled in an RDF facility. Table 8 shows that the boiler efficiency for an RDF type boiler with shredded combustibles as the feed material (RDF) is higher than that of a shred and burn boiler or a mass burner. Although the cost of RDF and Shred and Burn boilers is lower than that of the mass burner, it should be recognized that the capital and processing cost for shredded combustibles is greater than for unshredded fuel. A cost tradeoff would have to be conducted to determine the optimum system for converting the combustible fraction into energy.

Summary

A. Front-end processing provides the following benefits to Waste-To-Energy projects:

1. A combustible fraction that is higher in heating value than raw, unprocessed MSW.

2. A combustible fraction with substantially lower ash content thereby reducing boiler grate maintenance as well as landfill requirements for the ash.

3. A combustible fraction with substantially less aluminum content, thereby eliminating problems caused by aluminum melting on the grates of the boiler.

4. A combustible fraction with less glass content thereby minimizing glass fines eroding the grate and possible glass slagging on the furnace walls.

5. A combustible fraction with substantially less ferrous metal, thereby negating the requirement to remove ferrous metal from the incinerator ash.

6. A combustible fraction with less chlorine content if the polyvinyl chloride (PVC) plastics are removed in the front-end processing, resulting in reduced boiler tube corrosion.

7. A combustible fraction whose heating value is relatively unaffected by the degree of recyclable recovery in the front-end processing system.

8. A substantial reduction in landfill through the marketing of recyclable materials.

B. A boiler provides the following benefits to a Front-End Processing Facility:

1. The "non-marketable" combustible fraction left over after recovery of the "marketable recyclables" can be used as a fuel to generate steam and electricity in mass burn or RDF type boilers, thereby substantially reducing landfill.

2. The boiler can act as a "flywheel" to absorb fluctuations in the unmarketable fraction of the combustibles.

C. Additional Comments:

Front-End Processing may result in a boiler fuel with higher moisture content, which, in turn, can cause a decrease in boiler efficiency. In addition, if paper, corrugated, and plastics are recycled, the net tonnage of combustibles available to the boiler is reduced. On the other hand this does allow the boiler to accept additional MSW, if available.

If only ferrous metal, glass, and aluminum are recovered and recycled, and the inert non-recyclable fraction is landfilled (i.e. if no paper, corrugated, or plastics are recovered and recycled) the tonnage of combustibles is not reduced and the heat value of the fuel is increased substantially. Under these conditions, which are ideal for WTE, there is no reduction in steam or electricity generation, landfill is reduced, and three materials -ferrous metal, aluminum, and glass - are recycled.

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BIBLIOGRAPHY

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RHH:laa/230

AREA SERVED:	NORTHERN SAN DIEGO COUNTY, CALIFORNIA
OWNERSHIP:	NORTH COUNTY RESOURCE RECOVERY ASSOCIATES
CONSTRUCTION PERIOD:	24 MONTHS
OPERATING PERIOD:	24 YEARS
COMMERCIAL OPERATION:	JANUARY 1, 1994
PROCESSING SYSTEMS:	
SUPPLIED AND OPERATED BY:	NATIONAL ECOLOGY COMPANY
SYSTEM CAPACITY:	OVER 2,100 TONS PER DAY MSW
NUMBER OF LINES:	FIVE
PLANT OPERATIONS	
HOURS OF OPERATIONS:	16 HOURS PER DAY, 5 DAYS PER WEEK
ANNUAL THROUGHPUT:	550,370 TONS MSW PER YEAR
MATERIALS RECOVERED	
ALUMINUM CANS	FILM PLASTIC
FERROUS METALS	NEWSPAPER
MIXED NON-FERROUS METAL	MIXED PAPER
HDPE	CORRUGATED CARDBOARD
PETE	GLASS (3 COLORS)

TABLE 1
SAN MARCOS FACILITY HIGHLIGHTS

AREA SERVED:	PALM BEACH COUNTY, FLORIDA
OWNERSHIP:	SOLID WASTE AUTHORITY OF PALM BEACH COUNTY
CONSTRUCTION PERIOD:	35 MONTHS
OPERATING PERIOD:	21 YEARS
COMMERCIAL OPERATION:	NOVEMBER, 1989
PROCESSING SYSTEMS:	
DESIGNED, SUPPLIED AND OPERATED BY:	NATIONAL ECOLOGY COMPANY
SYSTEM CAPACITY:	OVER 3,000 TONS PER DAY
NUMBER OF LINES:	THREE
NORMAL OPERATING CAPACITY:	1,000 TONS PER DAY PER LINE
TIRES	
OPERATING CAPACITY:	500 TIRES PER HOUR
NUMBER OF LINES:	ONE LINE
OVERSIZE BULKY WASTE	
NUMBER OF LINES:	ONE LINE
RECOVERY/RECYCLING PERFORMANCE:	
RDF PRODUCTION:	83% OF PROCESSIBLE WASTE
COMBUSTIBLE RECOVERY:	96%
FERROUS METAL RECOVERY:	90%
ALUMINUM RECOVERY:	60%

TABLE 2
PALM BEACH COUNTY RESOURCE RECOVERY FACILITY HIGHLIGHTS

	RECOVERED MATERIALS: ALUMINUM	FERROUS	% ALUMINUM IN MSW	% FERROUS IN MSW
1990 - 1991	741 TONS	29,307 TONS	0.11	4.3
1991 - 1992	1151 TONS	29,800 TONS	0.16	4.23

TABLE 3
PALM BEACH COUNTY RESOURCE RECOVERY FACILITY RECOVERED MATERIALS

SOURCE	DATES	HIGHER HEATING VALUE btu/lb	ASH CONTENT %	MOISTURE %
Palm Beach County Reference Waste MSW (See Table 5)	1986	4728	23.65	25.30
Palm Beach County Reference Waste MSW (See Table 5)	1986	5500	13.63	27.14
Palm Beach County Resource Recovery Facility RDF	July 17-18, 1989	5548 (3538-6442)	9.42 (6.7-14.1)	26.86 (19.80-35.90)
Palm Beach County Resource Recovery Facility RDF	Oct. 25-30,1989	5301 (5037-5613)	13.62 (11.67-15.95)	32.78 (30.59-35.55)
Palm Beach County Resource Recovery Facility RDF	1992	5300	---	30-32

TABLE 4
HEAT VALUE, ASH, AND MOISTURE CONTENT
OF PALM BEACH COUNTY MSW AND RDF (AS RECEIVED BASIS)

Component Analysis	Reference MSW (% by Weight)	Refuse-Derived-Fuel (% by Weight)
Corrugated Board	5.46	--
Newspapers	17.16	--
Magazines	3.44	--
Other Paper	19.46	--
Plastics	7.24	--
Rubber, Leather	1.94	--
Wood	0.83	--
Textiles	3.07	--
Yard Waste	1.11	--
Food Waste	3.71	--
Mixed Combustibles	17.52	--
Ferrous	5.43	--
Aluminum	1.80	--
Other Non-Ferrous	0.32	--
Glass	11.51	--
Total	100.00	
Ultimate Analysis		
Carbon	26.65	31.00
Hydrogen	3.61	4.17
Sulfur	0.17 (max. 0.3)	0.19 (max. 0.36)
Nitrogen	0.46	0.49
Oxygen	19.61	22.72
Chlorine	0.55 (max. 1.0)	0.66 (max. 1.2)
Water	25.30	27.14
Ash	23.65	13.63
Total	100.00	100.00
Heating Value	4728 btu/lb	5500 btu/lb
Fuel Value Recovery, Percent of MSW		96
Mass Yield, Percent lb RDF/lb MSW		83

TABLE 5
PALM BEACH COUNTY
REFERENCE WASTE

COMPONENT	RECYCLABLES RECOVERED DURING FRONT-END PROCESSING, % OF EACH	
	AT 21% RECYCLING	AT 30% RECYCLING
PAPER	20	30
CARDBOARD & CORRUG	45	50
YARD WASTE	0	10
PLASTICS	10	10
WOOD	0	20
FERROUS METAL	92	92
ALUMINUM	75	75
OTHER NON FERROUS	67	67
GLASS	20	30
STONES & CERAMICS	0	0
FINES (1/4 INCH)	0	0
% OF MSW RECYCLED:	21	30

TABLE 6
RECYCLABLES RECOVERED DURING FRONT-END PROCESSING

COMPONENT	% OF MSW
Paper products	30.0
Cardboard	11.0
Yard waste	17.9
Plastics	6.5
Food, rubber, textiles, wood	16.0
Ferrous	6.8
Aluminum	1.2
Other non-ferrous	0.7
Glass	8.2
Stone, ceramics	0.6
1/4" Fines	1.1
TOTAL	**100.0**

TABLE 7

AVERAGE SOLID WASTE COMPOSTION, UNITED STATES[1]

1 "Characterization of Municipal Solid Waste in the United States 1960-2000," Franklin Associates LTD., March 30, 1988.

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	NO FRONT-END PROCESSING	FRONT-END PROCESSING								
		AT 7.7% RECYCLABLE RECOVERY (BASE CASE)			AT 21% RECYCLABLE RECOVERY			AT 30% RECYCLABLE RECOVERY		
	MASS BURNER	MASS BURNER	RDF BOILER	SHRED & BURN	MASS BURNER	RDF BOILER	SHRED & BURN	MASS BURNER	RDF BOILER	SHRED & BURN
TYPE OF FUEL	MSW	MSW LESS RECOVERABLES	RDF	SHREDDED MSW LESS RECOVERABLES	MSW LESS RECOVERABLES	RDF	SHREDDED MSW LESS RECOVERABLES	MSW LESS RECOVERABLES	RDF	SHREDDED MSW LESS RECOVERABLES
FUEL HEAT VALUE BTU/lb	4654	5027	5641	5027	4863	5460	4863	4729	5345	4729
BOILER EFFICIENCY	69.5	69.5	73.3	72.1	68.4	72.4	71.3	67.5	71.7	70.5
ASH, %	22.0	16.13	9.63	16.13	15.94	9.78	15.94	16.05	9.78	16.05
FUEL QUANTITY, RELATIVE	1	0.92	0.74	0.92	0.79	0.63	0.79	0.70	0.56	0.70
MOISTURE, %	28.1	30.34	29.66	30.34	33.19	32.48	33.19	35.22	34.42	35.22
FERROUS METAL	0	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28	6.28
ALUMINUM	0	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38	1.38
GLASS	0	0	0	0	1.64	1.64	1.64	2.46	2.46	2.46
HDPE, PETE, FILM PLASTIC	0	0	0	0	0.65	0.65	0.65	0.65	0.65	0.65
PAPER - PRODUCTS	0	0	0	0	6.00	6.00	6.00	9.00	9.00	9.00
CORRUGATED	0	0	0	0	4.95	4.95	4.95	5.50	5.50	5.50
WOOD	0	0	0	0	0.00	0.00	0.00	4.99	4.99	4.99
TOTAL		7.66	7.66	7.66	20.90	20.90	20.90	30.26	30.26	30.26

TABLE 8
COMPARISON OF FRONT-END PROCESSING VS.
NO FRONT-END PROCESSING SYSTEMS

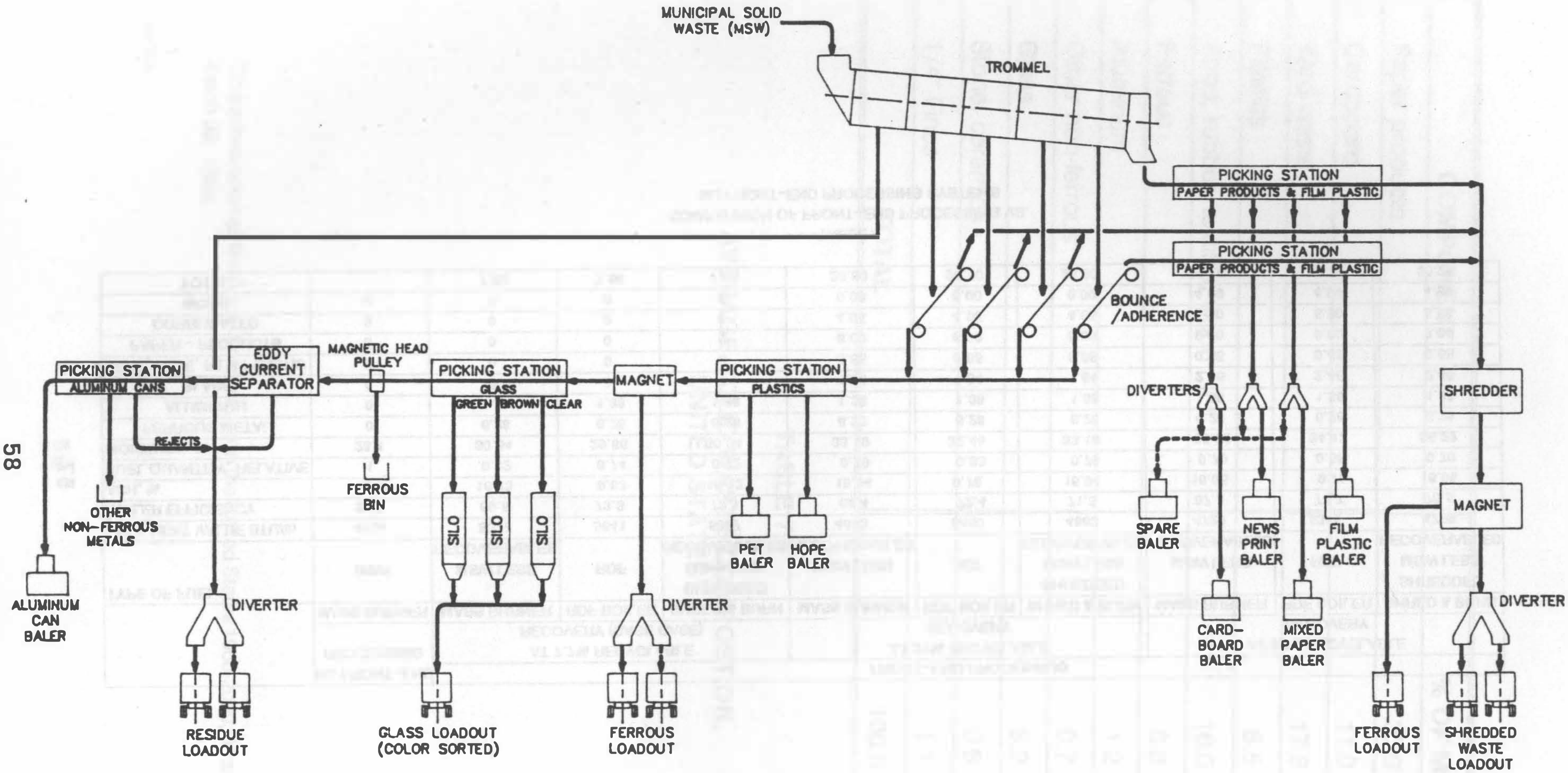

FIGURE 1

SAN MARCOS MIXED WASTE MATERIAL RECOVERY FACILITY (MRF) FLOW DIAGRAM

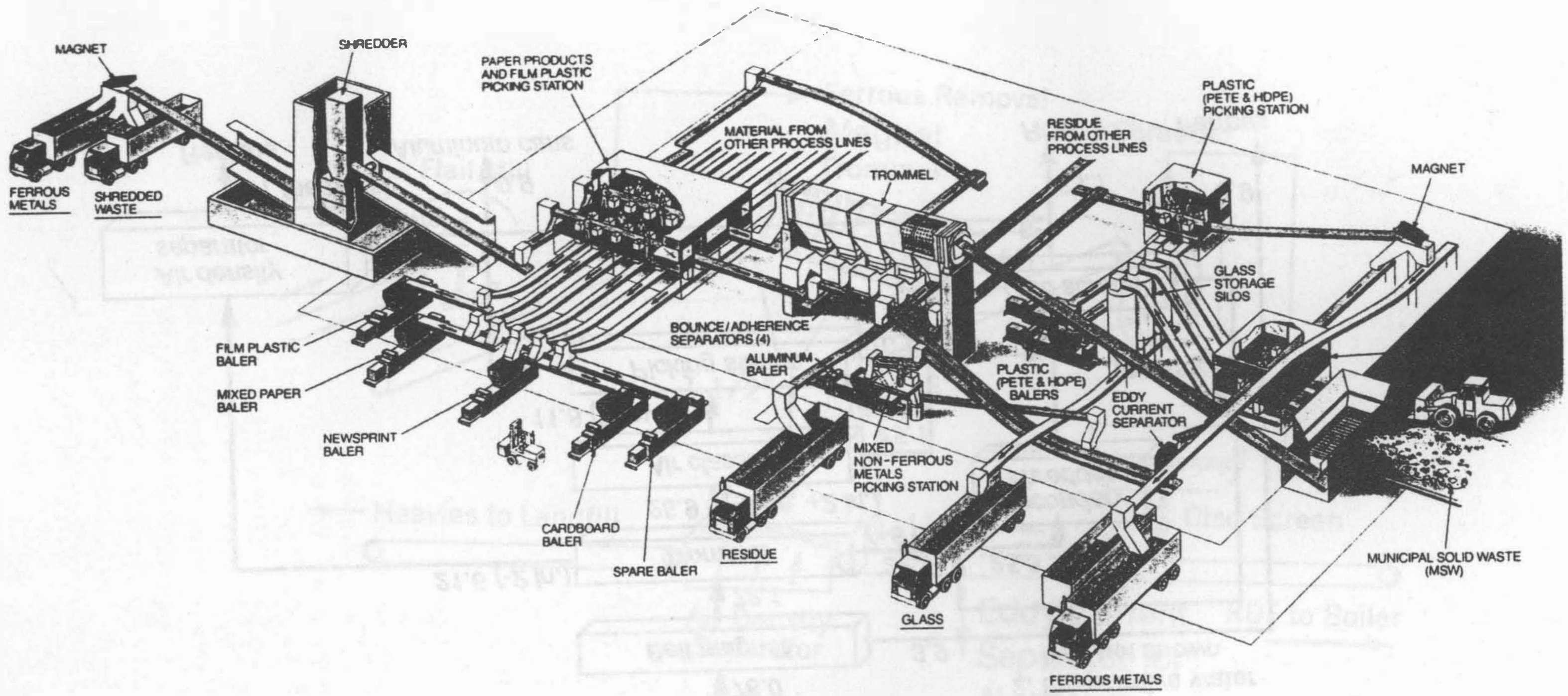

FIGURE 2

SAN MARCOS MIXED WASTE MATERIAL RECOVERY FACILITY (MRF)

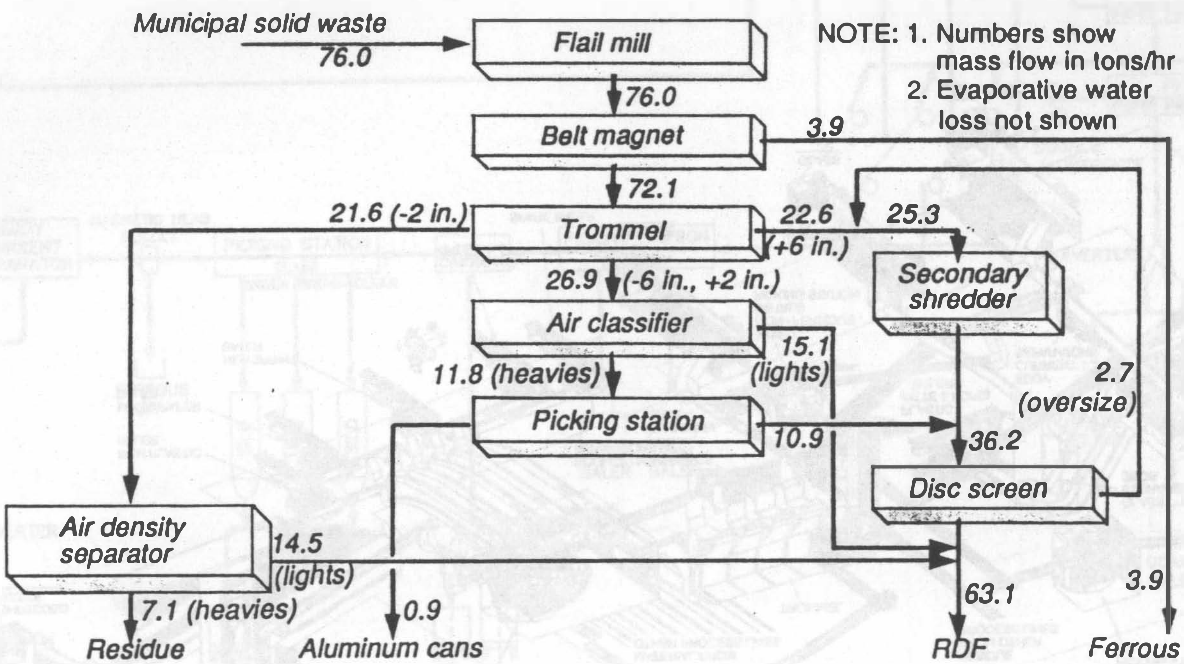

FIGURE 3

PALM BEACH COUNTY RESOURCE RECOVERY FACILITY MASS BALANCE

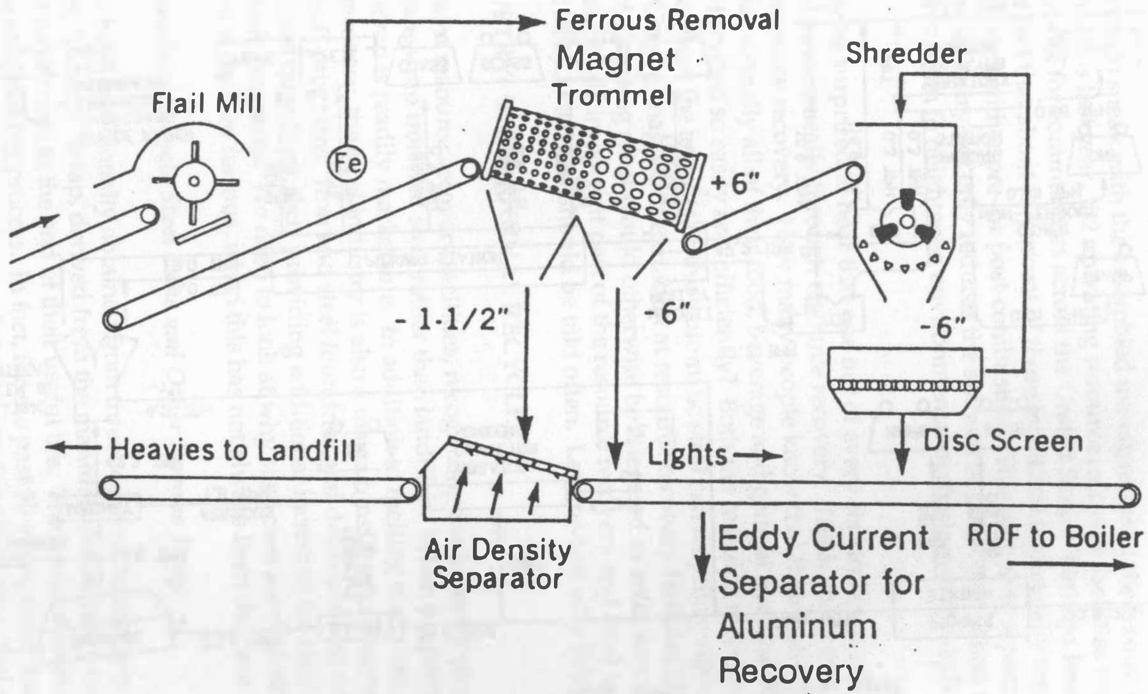

FIGURE 4

PLAM BEACH COUNTY RESOURCE RECOVERY FACILITY
PROCESS FLOW DIAGRAM

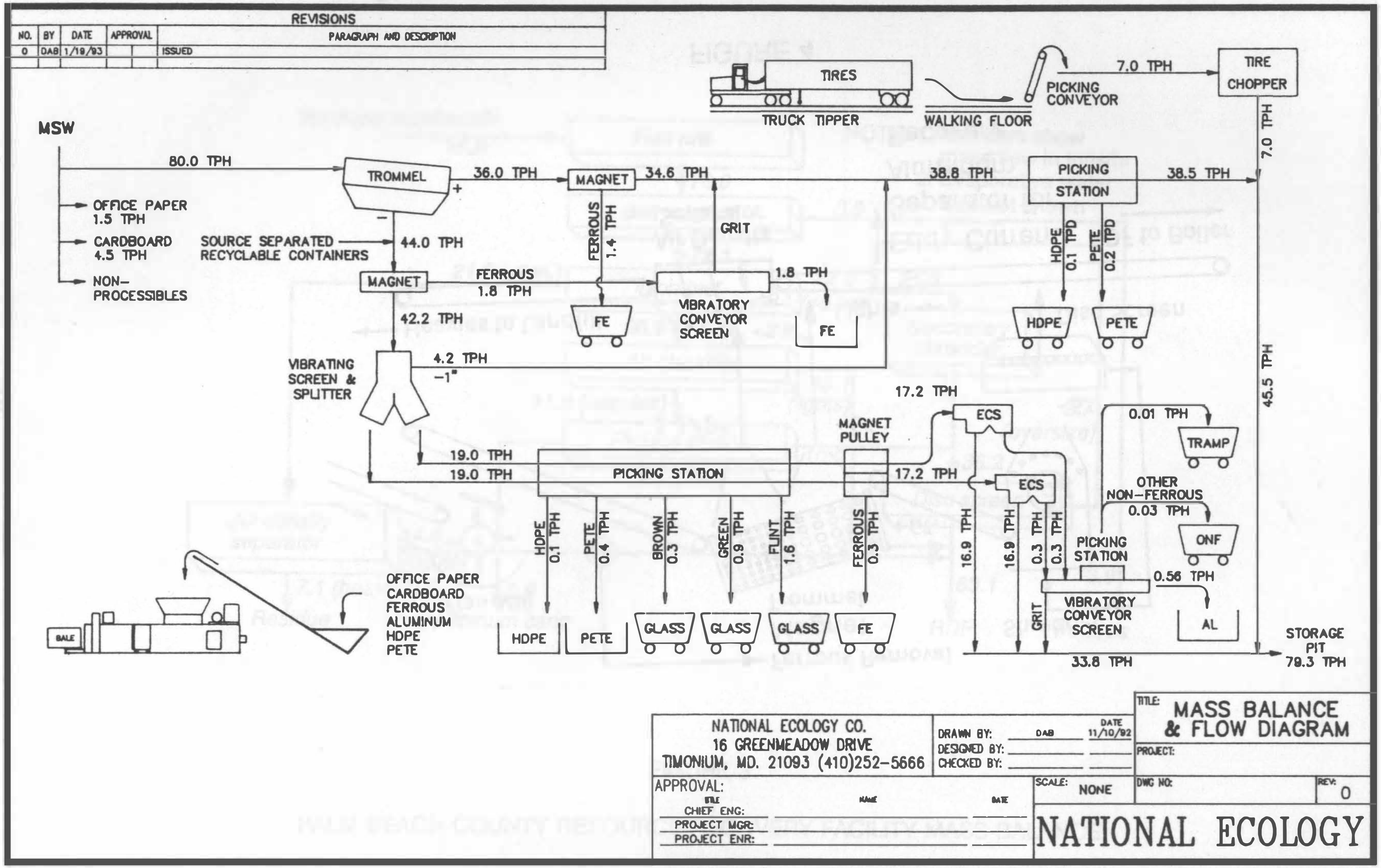

FIGURE 5

NEC FRONT-END MATERIALS PROCESSING FACILITY