ANNUAL SNAPSHOT OF SIX LARGE SCALE RDF PROJECTS

CRAIG F. DAVIS
R. W. Beck and Associates
Denver, Colorado

ABSTRACT

This paper provides a brief technical description of six large scale refuse-derived fuel projects, a snapshot of 1990 performance figures and a summary of average cost of operation. The six projects discussed are: the Mid-Connecticut project in Hartford, Connecticut; the Southeastern Public Service Authority project in Portsmouth, Virginia; the Dade County project in Miami, Florida; the SEMASS project in Rochester, Massachusetts; the Detroit Resource Recovery Facility in Detroit, Michigan; and the Columbus Solid Waste Reduction Facility in Columbus, Ohio. The technical description will include a discussion of the type of process, a summary of recent or proposed modifications to the facilities (if any), an outline of current contractual issues (if any), and a summary of solid waste management programs that are part of the project.

NOMENCLATURE

ABBRSS = Asea Brown Boveri Resource Recovery Systems
APC = Air Pollution Control
BBC = Brown Boveri Corp.
Btu/lb = British thermal unit per pound
cm = Centimeters
°C = Degrees Celsius
CSWRF = Columbus Solid Waste Reduction Facility
CRRA = Connecticut Resources Recovery Authority
ESP = Electrostatic precipitator
°F = degrees Fahrenheit
GDRRA = Greater Detroit Resource Recovery Authority
GDRRF = Greater Detroit Resource Recovery Facility
gr/dscf = grains per dry standard cubic foot
HHV = Higher Heating Value
HHW = Household Hazardous Waste
hp = horsepower
hp-m = horsepower-metric
kg/h = kilogram per hour
kPa = kilo Pascal
kJ/h = kiloJoules/hr
lb/hr = pounds per hour
MPC = Montenay Power Corporation
mmBtu/hr = million Btu per hour
MSW = Municipal Solid Waste
psig = pounds per square inch gage
RDF = Refuse-Derived Fuel
SEMASS = Southeastern Mass Waste-to-Energy Facility
SPSA = Southeastern Public Service Authority
TPD = tons per day
t/d = metric tons per day
t/h = metric tons per hour
TPH = tons per hour
TPW = tons per week
t/w = metric tons per week

INTRODUCTION

In the pages that follow, six large scale RDF projects are presented as they were in 1990. The presentation is divided into four sections: Facility Discussions; Performance; Cost of Operation; and Summary and Conclusions.

Facility Discussions is divided by project and includes brief discussions titled: Overview; Technical Description; Recent and Proposed Modifications; Contractual Issues; and Solid Waste Management Programs for each project.

Performance is a tabular summary of performance for the six facilities during 1990. The Detroit facility was not in commercial operation and was operating under the provisions of a Consent Order during 1990, and therefore parts of their data are not representative of expected long term operation.

Cost of Operation presents average cost data in tabular format. The data are not project specific for confidentiality reasons. Care should be taken when making conclusions with respect to the cost data for numerous reasons, such as: not all the facilities are represented in each line item; some costs were projected, etc. (see table notes).

Summary and Conclusions briefly summarizes and draws general conclusions.

FACILITY DISCUSSION

Mid-Connecticut Project

Overview

The Mid-Connecticut project is located in Hartford, Connecticut. It is owned by the Connecticut Resources Recovery Authority (CRRA) and serves 44 municipalities in the state and provides spot waste disposal for an additional 15 communities. The system includes four transfer stations, two landfills, a fleet of rolling stock, a waste processing facility, a power block facility, and an electric generating facility.

The facility has been in commercial operation since October 1988. The waste processing facility, landfill, transfer stations and transportation functions are operated by the Metropolitan District Commission. The power block facility and electric generating facility are operated by Asea Brown Boveri Resource Recovery System (ABBRRS), formerly Combustion Engineering.

Technical Descriptions

The two 100-TPH (90.78 t/h) process lines at Mid-Connecticut each include two stages of shredding, ferrous recovery and two stages of separation. The MSW is fed by front-end loaders onto apron pan conveyors and passes a picking station where nonprocessible waste is removed by a hydraulically controlled grapple. The fuel is conveyed into the primary shredder, which is a horizontal flail mill system driven by a 500 hp (507 hp-m) motor, complete with explosion suppression and dust control systems. The coarsely shredded material then passes a drum magnet system, which removes approximately 80% of the ferrous metals in the fuel stream. After passing the magnets, the stream is split and conveyed through the primary trommels. The primary trommels are two stage separators. The first stage consists of approximately 1-in. (2.5 cm) holes which remove glass and grit from the stream. The second stage consists of 4-in. (10 cm) holes and removes material that does not require further size reduction. The oversized material is conveyed to the secondary shredder, a horizontal hammermill arrangement driven by a 1000 hp (1014 hp-m) motor, which reduces the fuel to a nominal 4-in. (10 cm) particle size. The 4-in. (10 cm) material from the primary trommel second stage is conveyed to the secondary trommel for additional removal of glass and grit. The RDF is stored on a storage floor and conveyed to the boiler house when required. The waste processing facility is nominally rated at 12,000 tons (10,894 tons metric) of MSW per week.

The RDF metered to the power block is fed into one of three livebottom auger bins, one for each boiler. The auger bins meter the RDF into four vibrating pan conveyors which level the RDF being blown into the boilers. Each of the three boilers is rated for 326 mmBtu/hr (344 $\times 10$ kJ/h) while burning RDF producing 231,000 lb/hr (104782 kg/h) of superheated steam at 850 psig (5860 kPa), 825°F (440°C). The boilers can also burn coal at a permit limit of 249.9 mmBtu/hr (263.7 $\times 10$ kJ/h) which produces approximately 188,500 lb/hr (85,504 kg/h) of steam.

The steam from the three boilers is headered together to feed either of two turbine generator sets. Each turbine generator set is rated for approximately 48 MW gross at 0.85 power factor. The facility design point anticipated two units on RDF and one on coal, producing 68.5 MW gross electrical production. Exhaust steam is condensed using single pass condensers and river water as cooling water.

The air pollution control equipment includes spray dryer absorbers and fabric filter baghouses for each unit. Other components of the power block facility include a coal barge unloader, a standby oil fired boiler and typical auxiliaries (i.e., compressors, closed cycle cooling, lime slakers, boiler feed pumps, condensate pumps, etc.).

Recent and Proposed Modifications

Notable modifications for the Mid-Connecticut project have been distributed between both the waste processing and the power block facility.

During start-up, the bottom ash drag flight ash system used for conveying the bottom ash to the storage bin was changed-out to a rubber belt system.

Just after commencement of commercial operation, the boilers were modified by adding a protective weld overlay to the water walls and leading edges of the convection zone tubes. Over the past 2 years, numerous other modifications have been made to the grate and siftings system, fuel feed and distributor systems, including control and logic changes.

The waste processing facility recently upgraded the primary shredder motors to 500 hp (507 hp-m) from 300 hp (304 hp-m). Both the MSW storage floor and RDF storage floor have undergone repair programs and are being expanded to better support the design through-put of 12,000 TPW (10894 t/w). Spillage and dust control measures have been added, impact tables have replaced impact idlers on the shredder discharge conveyors, maintenance platforms and ferrous loadout changes have been made, and numerous safety, logic and control changes have been implemented.

Contractual Issues

The operating agreements and waste supply agreements for Mid-Connecticut are secured and in place. ABBRRS operates the power block and electric generating facility on a fixed price basis with provisions for escalation, revenue sharing and passthroughs. The Metropolitan District Commission operates the waste processing plant, transfer stations, landfill, and transportation system on an annual budget basis.

Current contractual issues relate to negotiations for spot market waste, a ferrous enhancement system, development of an intermediate processing center and a dedicated vehicle maintenance facility.

Solid Waste Management Programs

The Mid-Connecticut system has performed various pilot studies as they relate to the process and power plants. An ash stabilization study was performed, a process residue composting program is being developed, and a ferrous enhancement program has been developed, all intended to reduce the quantity of material destined to the landfill.

In addition, a landfill gas and leachate collection program has been established, a white goods capacitor removal and compaction program is in service, and municipalities can participate in Household Hazardous Waste (HHW) collection programs provided by the Connecticut Department of Environmental Protection.

An intermediate processing center is being developed to achieve the 25% recycling goal mandated by the State of Connecticut.

SPSA Project

Overview

The Southeastern Public Service Authority (SPSA) facility is located in Portsmouth, Virginia. It is owned and operated by SPSA, except for the boiler house, which is owned by the U.S. Navy. The system includes seven transfer stations, a fleet of rolling stock, a landfill, a vehicle maintenance facility and a power block facility. The facility has been in commercial operation since January 1988.

Technical Descriptions

The SPSA facility utilizes the RDF process system commonly referred to as the Heil system. The process facility is nominally rated for 2000 TPD (1816 t/d) MSW and includes three independent process lines.

The MSW is fed to the process line by front-end loaders. Each process line has a hydraulically operated picking grapple for removal of non-processible waste. The processible MSW is conveyed to the primary trommel, which opens bags and separates materials smaller than 6 in. (15.2 cm). The 6-in. (15.2 cm) minus material is conveyed to the secondary trommel which is a two-stage separator. The front section contains 1¼-in. (3.2 cm) holes which separate the glass and grit. The rear section (second stage) has 2½-in. × 6-in. slots (6.4 × 15.2 cm) holes that separate materials adequately sized for RDF. The second stage of the secondary trommel contains the aluminum rich stream and passes a picking platform where aluminum cans are manually removed. The primary trommel and secondary trommel overs are conveyed to the vertical hammermill shredder, which is driven by a 1000 hp (1014 hp-m) motor. The shredder discharge and the secondary trommel picked stream make up the RDF product.

Three stages of ferrous removal are performed. First, a magnet is located between the primary and secondary trommels; second, a magnet is located after the shredder; and third, a stationary magnet is located on the RDF transport belt. The finished RDF material is conveyed to the power plant located on the Norfolk Naval Shipyard. The power plant burns RDF or coal in any of four steam generator boilers. The RDF can be directed into any of the boiler hoppers or diverted into the RDF storage pit. Cranes reclaim the RDF in the pit to charge the boiler hoppers. Coal is delivered by rail car and conveyed to the storage pile, where it is

reclaimed using front-end loaders and a series of rubber-belt conveyors.

The four boilers are each rated for 180,000 lb/hr (81,648 kg/h) of steam flow at 650 psig (4462 kPa), 700°F (371°C). The turbine generator capacity is 40 MW gross. Both steam and electricity are used by the shipyard. Electro-static precipitators are used for particulate control. Fly ash is removed and conveyed to the quench basin, which removes both the bottom ash and fly ash to the ash storage bins. There are provisions to directly load ash transfer vehicles.

Recent and Proposed Modifications

The SPSA facility took over operation of the power plant in 1990. The notable modifications included extension of the RDF feed conveyors, changes to the fuel distributor system, replacement of the rotary valves on the fly ash collection systems with double-dump valves, as well as addition of numerous spillage/dust control and cleanup provisions. Further, a protective weld overlay was applied to sections of the water walls due to tube wastage. Stoker material changes and siftings removal modifications were also completed.

Recently the facility experimented with a disk screen to control oversize RDF flow to the power plant. The disk screen significantly decreased throughput and was isolated subsequent to the RDF feed modifications. Other changes in the waste processing facility include hammer material changes, apron pan conveyor wheel bearing change-outs, various improvements for dust and spillage control, change-out of bag breaking spikes in the primary trommels, and improvements of the picking grapple integrity.

Contractual Issues

SPSA's waste supply agreements are in place, as are the operating agreements. Negotiations between SPSA and the Navy are completed and resulted in improved incentives to burn RDF in the Navy boilers. The new contract defines, on a monthly basis, a most economical operating point which will relate to the tons of RDF that will be reimbursed at a higher price. Additional tons of RDF in excess of the most economical operating point will be reimbursed at a rate equal to the cost savings between the actual monthly cost and the calculated most economical operating cost.

Solid Waste Management Programs

The SPSA project includes a curbside collection program that initially included 7000 households in 1990. Additional compartmented trucks have been procured and participation is currently at 25,000, with 50,000 households expected by December 1991.

SPSA will eventually expand the program to 300,000 households. SPSA also provides permanent drop-off centers for recyclables, household hazardous waste and white goods.

A yard waste composting facility is being considered. A landfill gas program is in service, and a ferrous enhancement program is operational.

Dade County Project

Overview

The Dade County project is located in Miami, Florida. The project is owned by Dade County and operated by Montenay Power Corporation (MPC). The system includes two independent process facilities and a power block facility which houses the steam and electric generating equipment. The project has been in operation since 1982; however, the recent capital improvement program has been on-going since 1987 with completion in April 1991, which included the addition of a process facility and other modifications described later in this paper.

Technical Descriptions

The Dade County facility utilizes two independent process schemes to prepare RDF. The "trash" processing plant handles mostly commercial, light industrial and tree trimmings waste, and uses a shred-and-burn process with ferrous recovery. The "garbage" processing plant utilizes the Heil system design, modified with horizontal hammermills and eddy current aluminum can recovery systems.

The trash system has three lines fed by overhead cranes. Two of the process lines are nominally rated at 20 TPH (18 t/h) each, with the third process line being rated at 40 TPH (36 t/h). Ferrous recovery is achieved through use of rotary drum magnets. The garbage system has two process lines similar to the SPSA arrangment, which are fed by overhead cranes. The Heil system discharge can be fed directly to the boilers or be routed to RDF storage. Ferrous in the garbage system is recovered by belt magnets.

Four boilers burn the RDF to produce steam for electricity generation. The Zurn boilers are nominally rated for 180,000 lb/hr (81648 kg/h) while producing 625 psig (4309 kPa), 720°F (382°C) steam. Each boiler is expected to burn 28 TPH (25.4 t/h) RDF at 5000 Btu/lb (2778 kgcal/kg), which equates to 280 mmBtu/hr (295×10^6 kg/h) gross heat input. The steam is routed to two BBC turbine generators, each rated for 38.5 MW. An induced-draft cooling tower is used for turbine exhaust heat rejection.

Currently, the APC equipment includes ESPs for particulate control. The existing permit allows 0.08 gr/dscf particulate and 20% opacity for up to 3 min.

Recent and Proposed Modifications

In 1991, Montenay Power Corporation completed a capital improvement program which included installation of the Heil system, enlargement of the tipping bays, improvements in the RDF feed and return systems, addition of the 40 TPH (96 t/h) crunch-and-burn line, boiler modifications, and installation of a new boiler instrument and control system. In addition, odor and dust control changes were completed.

Dade County is currently planning a capital expansion program which would increase the facility's capacity from 3000 TPD (2723 t/d) to 4500 TPD (4085 t/d). This program would include two new boilers, a new fuel pit, as well as a turbine generator, dump condenser and fuel feed conveyor system. Additionally, the expansion would upgrade the existing two 20 TPH (18 t/h) crunch-and-burn lines to 40 TPH (36 t/h) each, and would replace the single drum compression feeders with dual drum feeders. The Heil system would be modified to allow pretrommeled and processed fuel to be conveyed directly to the new boiler fuel pit while allowing full processing for the existing boilers. The expansion plans also call for installation of dry scrubbers and fabric filter baghouses on both the new boilers and all four existing boilers, along with improvement and expansion of the existing wastewater treatment system. Montenay Power, in conjunction with NAMCO, has installed equipment for an on-site ferrous enhancement system.

Contractual Issues

The operating contract and waste supply agreements for Dade County are secured. Currently, the operator receives the tipping fee revenues for operating and maintaining the plant. Residue and ash disposal are provided by the County.

In the event of facility expansion, tipping fee revenues will be negotiated to account for the additional costs of operating the new APC equipment.

Solid Waste Management Programs

The County provides a yard waste composting facility and is operating an MSW composting plant as well. A curbside collection system is in service, as is a bulky waste shredding operation. Drop-off centers for recyclables and household hazardous waste are available.

The process plant performs a tire shredding function, removes ferrous metals and aluminum. A ferrous metal enhancement system is being developed on site.

SEMASS Project

Overview

The SEMASS project is located in Rochester, Massachusetts and is owned by the SEMASS Partnership. The system includes a process facility, a power generating facility, an ash processing facility, transfer stations, a landfill, a transportation fleet and a rail car unloading system. The process plant and power plant are operated by Bechtel Civil Inc., while the transfer stations, landfill and ash processing plant are operated by Energy Answers Corporation. The facility has been in commercial operation since February 1989.

Technical Descriptions

The SEMASS facility has three 100% capacity process lines directly feeding two incinerator boilers. The process plant receives MSW by truck and rail which is moved by front-end loader to the shredder infeed conveyors. The fuel is conveyed past a picking platform where non-processible waste is removed. Each horizontal hammermill is rated for 75 TPH (68 t/h) and driven by 1500 hp (1521 hp-m) motors. The shredder discharge is conveyed past dual-pickup belt magnets that remove precombustion ferrous metals.

The fuel is conveyed en masse along each boiler front and is diverted into any of five vibrating surge bins serving each boiler. The surge bins discharge directly onto vibrating feed conveyors. The fuel is then pneumatically distributed into the boiler. Excess fuel is routed back to the storage floor for future reclaim. Each boiler is rated for 280,000 lb/hr (127,008 kg/h) of 600 psig (4137 kPa), 750°F (399°C) steam flow. The steam is expanded through the 50 MW (gross) turbine generator and condensed by an air-cooled condenser. The SEMASS facility is a zero discharge plant. Water is provided through on-site wells. Each boiler is fitted with a dry scrubber for acid gas removal and an ESP for particulate control.

The facility handles the fly ash and the bottom ash streams separately. Dry bottom ash is conveyed from the boiler grate hoppers by vibrating conveyors which discharge onto a rubber belt conveyor. The bottom ash is conveyed to the ash processing building for removal of post-combustion ferrous, nonferrous and boiler aggregate. The proprietary bottom ash process includes belt magnets, shredding and trommel sorting. Fly ash is conveyed to an ash silo for stabilization. The proprietary stabilization process includes the addition of kiln dust and landfill leachate as part of the ash conditioning and stabilization process.

Recent and Proposed Modifications

SEMASS has recently completed a carbon monoxide reduction program, performed a weld overlay boiler

tube protection program and has undertaken various odor control programs. SEMASS is expecting to perform an expansion program that would add a fourth shredding line, a third boiler, an additional storage and recycling area and increased turbine generator and air cooled condenser capacity. The expansion would increase capacity from approximately 1900 TPD (1725 t/d) MSW to 2700 TPD (2451 t/d) MSW and includes changes to the nonprocessible load-out and RDF feed systems.

Contractual Issues

The operating agreement between the SEMASS partnership and Bechtel Civil has not been secured. Negotiations are ongoing to change the cost plus arrangement to a fixed-price contract. Waste supply, transfer stations and ash processing agreements are secured.

In the event of expansion, additional waste supply agreements will be required.

Solid Waste Management Programs

The SEMASS facility provides a pilot program for the host community which entails a recyclables bag program. All recyclables are placed in a recognizable trash bag and are picked up with the other garbage. The recycle bags are pulled from the tipping floor and taken to a separate building for sorting of aluminum, glass (by color), ferrous metals and plastics.

In addition, the facility dramatically reduces the quantity of ash destined for the landfill by removing post-combustion ferrous, nonferrous and Boiler Aggregate.

Detroit Facility

Overview

The Greater Detroit Resource Recovery Facility (GDRRF) is located in Detroit, Michigan and is owned by the Greater Detroit Resource Recovery Authority (GDRRA). The system includes a process facility and power block facility which are operated by ABBRRS. The facility began operations in July 1989 and, for several reasons discussed later, were not in commercial operation at the time this paper was prepared (July 1991).

Technical Descriptions

The GDRRF has three 100 TPH (90.78 t/h) process lines. The ABBRRS process is similar to that used in Hartford. Raw MSW is fed by front-end loaders to the infeed conveyors, passes a picking grapple for removal of nonprocessible material, and the remaining processible material is directed to the primary shredder. The primary shredder is a 500 hp (507 hp-m) flail mill which discharges past dual drum magnets. The material is then split prior to primary trommeling. The primary trommel is two-stage, with unders being removed and mid-size fragments being routed to the secondary trommel. The primary trommel overs are conveyed to the secondary hammer mill shredder.

The secondary trommel feed consists of 4-in. (10 cm) minus material with ferrous and residue removed.

The trommel is intended to remove additional residue from the fuel stream.

The secondary trommel discharge and the secondary shredder discharge make up the RDF stream.

The fuel is stored on a tipping floor prior to feeding to any two of three boilers. Only two boilers can be on-line at the same time. The fuel is metered through auger bins and vibrating conveyors into the boilers at a rate of 45 TPH (40.9 t/h). The boilers produce 360,000 lb/hr (163,296 kg/h) of superheated steam at 900 psig (6205 kPa), 825°F (441°C). The reference HHV of the RDF is 5690 Btu/lb (3161 kgcal/kg). The superheated steam is expanded through a 68 MW turbine. Process steam can also be extracted and distributed to the energy customer, Detroit Edison. Both extraction steam and electricity are sold to Detroit Edison. The boilers use ESPs for particulate control.

Recent and Proposed Modifications

The Detroit facility is undergoing a change out of the existing air pollution control equipment. The ESPs will be replaced with dry scrubber and fabric filter baghouses to meet the new Clean Air Act legislation.

For a period of time, GDRRF was required by a Consent Order to bypass the secondary trommel fuel stream to minimize emissions of heavy metals. This requirement kept the Authority from securing additional long-term waste supply agreements and delayed performance testing. The bypass was achieved by removing the screens from the secondary trommel so that the material was handled as process residue.

The GDRRF boilers have been protected with the weld overlay material, and various grate components have been changed from carbon steel to stainless steel.

Contractual Issues

The GDRRF has secured the operating agreement and continues to secure long-term waste supply agreements. In addition, negotiations are in progress with the energy customer, Detroit Edison, to change the rates paid for steam and electricity.

The facility staff is also trying to rectify the conditions of the Consent Order from the Wayne County Air Pollution Control Division regarding emissions.

Solid Waste Management Programs

The GDRRA is considering the implementation of permanent drop-off centers for recyclables and household hazardous waste.

Columbus Facility

Overview

The Columbus Solid Waste Reduction Facility (CSWRF) is located in Columbus, Ohio and is owned and operated by the City of Columbus. The system includes three shredding transfer stations, a process facility, and a power generating facility. The system has been in operation since June 1983 and completed a major modification program in 1986.

Technical Descriptions

The Columbus facility utilizes two centrally located vertical-mill "crunch-and-burn" process lines and three satellite shredding stations to produce RDF for a six-boiler municipal electric plant. The process lines use 1000 hp (1014 hp-m) vertical hammermills and belt magnets for ferrous removal. The fuel is conveyed into the boiler with the aid of auger bins, vibrating conveyors and a fuel distribution fan. Each boiler is rated for 165,000 lb/hr (78,844 kg/h) of 700 psig (4826 kPa), 725°F (385°C) steam. The steam is routed to any of three turbine generator sets, each rated for 30 MW gross. The flue gas particulate is controlled through the use of ESPs and mechanical dust collectors.

Recent and Proposed Modifications

The Columbus facility underwent major modifications in 1985/1986, which included a complete changeout of the RDF feed systems, ash handling systems and fly ash conditioning equipment.

Recently, a condition and capability study was completed which was intended to assist the Franklin County Solid Waste Management Authority in their preparation of a comprehensive regional solid waste management plan. The study included a summary of plant performance, outage events, shredder availability, conceptual alternative configurations, comparative cost data with other facilities and environmental considerations.

The Columbus plant is planning on adding a shredder at the central plant and considering several types of front-end separation systems.

Contractual Issues

Recently, the Regional Solid Waste Authority purchased the Franklin County Landfill and are currently negotiating to purchase the Columbus facility.

Solid Waste Management Programs

A portion of the service area served by the Columbus facility can participate in a curbside collection program, and there are permanent drop-off centers for recyclables available. Household hazardous waste is periodically collected.

The key points in the foregoing discussion are presented in Table 1.

PERFORMANCE

Table 2 summarizes performance figures for the six RDF plants discussed herein. The figures presented include MSW received, RDF produced, auxiliary fuel consumed, electricity and steam generated, ferrous and aluminum removed.

Calculated ratios of pound of steam per pound of RDF and kWh per ton of RDF are presented and were adjusted based on auxiliary fuel usage.

The available GDRRF data is not representative of long-term operation due to start-up and Consent Order issues.

The monthly electrical production for SPSA was only part of the energy produced and therefore kWh/ton RDF was not reported.

A graphical comparison of cumulative MSW throughput is presented in Fig. 1.

In 1990, the six facilities discussed herein accepted and processed approximately 3.5 million tons of MSW, separated approximately 124,000 tons of ferrous metals and generated over 15 billion pounds of steam to help produce over 2 billion kWh/yr of electricity.

COST OF OPERATION

Table 3 presents a range of costs associated with various typical budget line items. The average cost, minimum cost and maximum cost are presented. Care should be taken when drawing significant conclusions from Table 3 due to the differences between the systems discussed herein.

Table 4 presents similar information, but separates the system costs. Only those facilities where the system component costs were available are presented. Again, the average, minimum and maximum costs are presented for each system.

SUMMARY AND CONCLUSIONS

In summary, all of the facilities discussed herein utilize either the ABBRRS process, the crunch-and-burn

TABLE 1 SUMMARY INFORMATION FOR SIX RDF PLANTS

I. FACILITY NAME	MID CONNECTICUT PROJECT	SPSA	DADE COUNTY RESOURCE RECOVERY FACILITY
II. FACILITY LOCATION	HARTFORD, CONNECTICUT	PORTSMOUTH, VIRGINIA	MIAMI, FLORIDA
III. FACILITY OWNER	CONNECTICUT RESOURCES RECOVERY AUTHORITY	SOUTHEASTERN PUBLIC SERVICE AUTHORITY	DADE COUNTY
IV. FACILITY OPERATOR(S)	ABB-RRS POWER BLOCK METROPOLITAN DISTRICT COMMISSION-PROCESS PLANT	SOUTHEASTERN PUBLIC SERVICE AUTHORITY	MONTENAY POWER CORPORATION
V. COMERCIAL OPERATION DATE	OCTOBER 1988	JANUARY 1988	1982
VI. PROCESS DESCRIPTION	FLAIL MILL SHREDDING; FERROUS REMOVAL; TWO STAGE PRIMARY TROMMEL;HAMMERMILL SHREDDING; SINGLE STAGE SECONDARY TROMMEL.	SINGLE STAGE PRIMARY TROMMEL; FERROUS REMOVAL; TWO STAGE SECONDARY TROMMEL;HAMMERMILL SHREDDING SECONDARY FERROUS REMOVAL;HAND PICKED ALUMINUM.	TWO PROCESS FACILITIES, A 3 LINE "CRUNCH AND BURN" WITH FERROUS RECOVERY AND A TWO LINE HEIL SYSTEM WITH HORIZONTAL HAMMERMILLS AND ALUMINUM MAGNETS.
NUMBER OF PROCESS LINES	2	3	1-40TPH AND 2-20THP CRUNCH AND BURN, 2-85 TPH HEIL LINES
PER LINE NOMINAL THROUGHPUT	100 TPH	85 TPH	
PROCESS FACILITY RATING	12000 TONS PER WEEK	2000 TPD	3000 TPD
NUMBER OF BOILERS	3	4	4
STEAM FLOW-EACH	231000 LBS/HR ON RDF; 188500 LBS/HR ON COAL	180000 LBS/HR	180000 LBS/HR
STEAM CONDITIONS			
PSIG	850	650	625
DEGREES F	825	700	720
NUMBER OF TURBINE/GENERATORS	2	3	2
NOMINAL OUTPUT	68.5 MWHR/HR	EACH 16 MWHR/HR EXTRACTING; 20 MWHR/HR FULL CONDENSING	77 MWHR/HR
VII. AIR POLLUTION CONTROL SYSTEM	DRY SCRUBBER BAGHOUSE	ELECTROSTATIC PRECIPITATORS	ELECTROSTATIC PRECIPITATORS
VIII. PROCESS MATERIALS RECOVERED	FERROUS AND PROCESS RESIDUE	PROCESS RESIDUE, FERROUS METALS, ALUMINUM	PROCESS RESIDUE, FERROUS METALS, ALUMINUM
IX. RECENT AND/OR PROPOSED MODIFICATIONS	MSW AND RDF STORAGE FLOOR EXPANSION; LARGER PRIMARY SHREDDER MOTORS; BOILER TUBE OVERLAY	TOOK OVER POWER BLOCK OPERATIONS IN 1990; RDF FEED MODIFICATIONS; FLY ASH REMOVAL MODIDICATIONS; BOILER TUBE WELD OVERLAY.	COMPLETED CAPITAL IMPROVEMENT PROGRAM WHICH INCLUDE THE 40 TPH AND BOTH 85 TPH PROCESS LINES, RDF FEED AND RETURN CHANGES, BOILER CONTROL SYSTEM UPGRADE & ODOR AND DUST CONTROL MEASURES.
X. CONTRACTURAL ISSUES	NONE	COMPLETED NEGOTIATIONS WITH U.S. NAVY TO INPROVE INCENTIVES ASSOCIATED WITH FIRING RDF.	NONE
XI. SOLID WASTE MANAGEMENT PROGRAMS	DEVELOPING INTERMEDIATE PROCESSING CENTER; WHITE GOODS CAPACITOR REMOVAL & COMPACTION; LANDFILL GAS & LEACHATE COLLECTION; PROCESS RESIDUE COMPOSTING PILOT PROGRAM.	CURBSIDE COLLECTION SYSTEM; HOUSEHOLD HAZARDOUS WASTE AND RECYCLABLES DROPOFF; FERROUS ENHANCEMENT SYSTEM; YARD WASTE COMPOSTING; TIRE SHREDDING AND HAVE LANDFILL LEACHATE AND GAS COLLECTION.	YARD WASTE AND MSW COMPOSTING; CURBSIDE COLLECTION; DROPOFF LOCATIONS FOR HHW AND RECYCLABLES; FERROUS ENHANCEMENT AND TIRE SHREDDING.

I. FACILITY NAME	SEMASS	GREATER DETROIT RESOURCE RECOVERY FACILITY	COLUMBUS SOLID WASTE REDUCTION FACILITY
II. FACILITY LOCATION	ROCHESTER, MASSACHUSETTS	DETROIT, MICHIGAN	COLUMBUS, OHIO
III. FACILITY OWNER	SEMASS PARTNERSHIP	GREATER DETROIT RESOURCE RECOVERY AUTHORITY	CITY OF COLUMBUS
IV. FACILITY OPERATOR(S)	BECHTEL CIVIL-PROCESS AND POWER PLANT; ENERGY ANSWERS CO.-ASH PROCESS, TRANSFER STATIONS & LANDFILL	ABB-RRS	CITY OF COLUMBUS
V. COMERCIAL OPERATION DATE	FEBRUARY 1989	STARTUP NOVEMBER 1989	JUNE 1983
VI. PROCESS DESCRIPTION	HAMMERMILL SHREDDING AND FERROUS REMOVAL; DRY ASH PROCESSING PLANT; RAIL CAR UNLOADING SYSTEM.	FLAIL MILL SHREDDING; FERROUS REMOVAL; TWO STAGE PRIMARY TROMMEL;HAMMERMILL SHREDDING; SINGLE STAGE SECONDARY TROMMEL.	THREE SHREDDING TRANSFER STATIONS AND TWO SHREDDING STATIONS ON SITE INCLUDING FERROUS REMOVAL AND POST COMBUSTION ALUMINUM RECOVERY
NUMBER OF PROCESS LINES	3	3	5
PER LINE NOMINAL THROUGHPUT	75 TPH	100 TPH	AVERAGE 45 TPH
PROCESS FACILITY RATING	1900 TPD	3300 TPD-NOMINAL, 4000 TPD-MAX.	2000 TPD
NUMBER OF BOILERS	2	3	6
STEAM FLOW-EACH	280000 LBS/HR	360000 LBS/HR	165000 LBS/HR-DESIGN; 140000 LBS/HR-DERATED
STEAM CONDITIONS			
PSIG	600	900	700-DESIGN
DEGREES F	750	825	750-DESIGN
NUMBER OF TURBINE/GENERATORS	1	1	3
NOMINAL OUTPUT	50 MWHR/HR	68 MWHR/HR	90 MWHR/HR
VII. AIR POLLUTION CONTROL SYSTEM	DRY SCRUBBERS AND ELECTROSTATIC PRECIPITATORS	ELECTROSTATIC PRECIPITATORS	MECHANICAL DUST COLLECTORS AND ESP'S
VIII. PROCESS MATERIALS RECOVERED	PRE AND POST COMBUSTION FERROUS, POST COMBUSTION NON FERROUS METALS AND BOILER AGGREGATE	FERROUS AND PROCESS RESIDUE	FERROUS AND ALUMINUM
IX. RECENT AND/OR PROPOSED MODIFICATIONS	FACILITY EXPANSION PLANNED TO ADD FOURTH SHREDDING LINE, THIRD BOILER, ADDITIONAL BOILER FEED SYSTEM, ENLARGED TIPPING FLOOR, AND REVISED REJECTS LOADOUT PROVISIONS.	REPLACING ESP'S WITH DRY SCRUBBERS AND BAGHOUSES	NEW SHREDDER PLANNED FOR PLANT AND CONSIDERING FRONT END SEPARATION SYSTEMS.
X. CONTRACTURAL ISSUES	FINALIZING NEGOTIATIONS WITH BECHTEL FOR FIXED PRICE OPERATING AND MAINTENANCE AGREEMENT.	ATTEMPTING TO RENEGOIATE THE ENERGY PURCHASE PRICE FOR STEAM AND ELECTRICITY WITH DETRIOT EDISON.	FRANKLIN COUNTY NEGOTIATING FOR PURCHASE OF FACILITY.
XI. SOLID WASTE MANAGEMENT PROGRAMS	RECYCLE BAG PILOT PROGRAM; PROPRIETARY ASH PROCESSING SYSTEMS.	CONSIDERING DROP OFF CENTERS FOR RECYCLABLES AND HOUSEHOLD HAZARDOUS WASTE.	SMALL CURBSIDE COLLECTION SYSTEM, DROP OFF CENTERS FOR RECYCLABLES AND PERIODIC HHW COLLECTION.

TABLE 2 PERFORMANCE SUMMARY 1990

	JAN	FEB	MAR	APR	MAY	JUN	JUL
MSW THROUGHPUT							
MID–CT	48,512	40,555	54,590	47,044	56,923	57,047	51,681
SPSA	40,298	32,875	31,998	27,312	18,007	26,843	38,146
DADE CO.	69,976	58,675	53,786	59,705	71,436	71,033	69,202
SEMASS	48,073	40,668	54,502	24,929	56,199	43,790	49,152
GDRRF	41,555	39,031	52,040	29,662	57,186	59,845	56,993
COLUMBUS	45,901	38,648	27,853	42,934	54,112	39,467	42,326
RDF CONSUMED							
MID–CT	38,208	34,952	41,081	39,351	45,506	49,602	43,490
SPSA	28,611	19,476	21,924	21,163	4,768	19,209	25,644
DADE CO.	62,858	49,985	53,585	51,258	63,409	59,858	63,758
SEMASS	45,727	38,120	51,819	8,271	53,877	41,793	47,213
GDRRF	24,710	22,177	27,490	15,168	29,691	29,110	38,775
COLUMBUS	43,146	37,132	30,538	41,824	53,610	39,832	40,405
AUX FUEL BURNED							
MID–CT–COAL TONS	4,024	769	6,048	7,938	5,997	4,304	5,557
SPSA–COAL TONS	1,447	3,974	4,256	4,453	375	1,959	3,682
SPSA–OIL GAL	9,740	15,255	3,763	0	19,332	21,492	14,564
GDRRF–OIL GAL	88,590	42,179	50,644	31,141	36,421	459,095	229,698
COLUMBUS–COAL TONS	1,707	1,638	4,183	1,939	2,104	6,155	5,750
STEAM MEASURED (LBS)							
MID–CT	343023000	294323000	450976000	441997000	444872000	460373000	432915000
SPSA	232936000	232861000	251662000	271777000	34133500	122057300	244675000
DADE CO.	372096000	308044000	328906000	302628000	374366000	353400000	360928000
SEMASS	331834000	279446000	376793000	59303000	365271000	309224000	330155000
COLUMBUS	287446000	235123000	260925000	266823000	278383000	288786000	289734000
ELECT. PRODUCED							
MID–CT GROSS	35260000	27966000	45214000	45219000	45153000	45064000	41311000
MID–CT NET	29959000	23790000	39320000	39830000	39520000	39560000	36200000
SPSA–NET	7769000	7169000	8137000	8192000	892000	7929400	15894300
DADE CO.–GROSS	31776000	25896000	26062000	24456000	30912000	31344000	31576000
DADE CO.–NET	25319300	20230000	19957800	19060400	24720000	25181000	25182400
SEMASS–NET	27157000	22477000	32103000	5583000	31441000	25668000	26483000
GDRRF NET	3598000	4032000	1342500	1926500	6565500	7981500	17835000
COLUMBUS–GROSS	27360000	23184000	25968000	25536000	27504000	27648000	27744000
FERROUS RECOVERED (TONS)(4)							
MID–CT	2,061	1,794	2,045	1,876	2,429	2,306	2,071
SPSA	734	536	645	452	125	415	588
DADE CO.	4,024	1,944	2,083	3,065	3,567	2,784	3,681
SEMASS (3)	2,183	1,799	2,606	444	2,457	2,034	2,166
GDRRF	2,761	2,100	3,820	1,980	2,706	3,170	3,349
ALUMINUM RECOVERED (4)							
SPSA	48	47	54	32	19	32	60
DADE CO.	38	41	36	29	29	17	0
SEMASS(NON FE)	196	196	232	53	259	128	283
KWHR/TON RDF (1)(5)							
MID–CT GROSS	744	762	824	787	763	758	735
MID–CT NET	632	648	716	693	667	666	644
DADE CO.–GROSS	506	518	486	477	488	524	495
DADE CO.–NET	403	405	372	372	390	421	395
SEMASS–NET	594	590	620	675	584	614	561
GDRRF (2)							
COLUMBUS–GROSS	628	618	825	604	508	670	665
LB STM/LB RDF (1)(5)							
MID–CT	3.62	4.01	4.11	3.84	3.76	3.87	3.85
SPSA	3.63	4.05	3.97	4.34	2.90	2.55	3.57
DADE CO.	2.96	3.08	3.07	2.95	2.95	2.95	2.83
COLUMBUS	3.05	2.88	3.25	2.88	2.38	2.68	2.71
SEMASS	3.63	3.67	3.64	3.58	3.39	3.70	3.50

NOTES:

(1) ADJUSTED FOR AUXILLIARY FUEL USAGE: USED 13000 BTU/LB COAL; 150,000 BTU/GAL OIL AND 5690 BTU/LB RDF.

(2) ONLY COMPUTED KWHR/TON RDF DURING MONTHS OF 0 STEAM EXPORT

(3) INCLUDES PRE AND POST COMBUSTION FERROUS

(4) IF FERROUS AND ALUMINUM RECOVERED QUANTITIES WERE NOT AVAILABLE, THEN PROJECT NOT LISTED

(5) RATIOS NOT COMPUTED FOR PLANTS THAT EXPORT STEAM AND ELECTRICITY, UNLESS OTHERWISE NOTED

TABLE 2 PERFORMANCE SUMMARY 1990 (CONT'D)

	AUG	SEP	OCT	NOV	DEC	TOTAL	AVERAGE
MSW THROUGHPUT							
MID–CT	57,821	51,010	57,340	51,373	45,113	619,009	51,584
SPSA	31,953	26,841	40,400	38,235	40,924	393,830	32,819
DADE CO.	71,451	64,982	78,954	68,784	59,044	797,028	66,419
SEMASS	57,622	50,796	46,816	46,473	40,453	559,473	46,623
GDRRF	59,940	54,698	59,947	56,233	41,439	608,569	50,714
COLUMBUS	53,580	48,560	56,081	48,282	42,916	540,660	45,055
RDF CONSUMED							
MID–CT	48,510	43,750	45,877	41,104	41,846	513,278	42,773
SPSA	19,538	21,562	27,920	28,348	30,687	268,851	22,404
DADE CO.	56,910	64,766	67,528	56,175	52,552	702,642	58,554
SEMASS	55,387	47,940	43,755	44,747	37,286	515,935	42,995
GDRRF	30782	27,135	31,467	32,026	23,809	332,341	27,695
COLUMBUS	45,441	51,440	54,821	46,239	44,636	529,063	44,089
AUX FUEL BURNED							
MID–CT–COAL TONS	4,758	5,961	5,462	3,077	2,094	55,989	4,666
SPSA–COAL TONS	4,536	2,546	1,391	823	854	30,295	2,525
SPSA–OIL GAL	17,605	17,776	6,668	6,875	8,458	141,528	11,794
GDRRF–OIL GAL	22,069	22,529	17,735	43,719	38,108	1,081,928	90,161
COLUMBUS–COAL TONS	3,486	1,872	1,931	2,408	2,309	35,482	2,957
STEAM MEASURED (LBS)							
MID–CT	440177000	450690000	438178000	377343000	376781000	4951648000	412637333
SPSA	231112400	183322600	213395600	209253000	231930200	2459115800	204926300
DADE CO.	314618000	369620000	383206000	326554000	299190000	4093556000	341129667
SEMASS	362204000	374037000	282377000	363474000	277842000	3711960000	309330000
COLUMBUS	283701000	305195000	309672000	295391000	289898000	3391077000	282589750
ELECT. PRODUCED							
MID–CT GROSS	42880000	44001000	43900000	37696000	37081000	490745000	40895417
MID–CT NET	37550000	38750000	38430000	31920000	31760000	426589000	35549083
SPSA–NET	11968200	11427900	12561400	11345200	12011400	115296800	9608067
DADE CO.–GROSS	26880000	31632000	32832000	28224000	24528000	346118000	28843167
DADE CO.–NET	20933400	25431200	26253400	22247000	18322600	272838300	22736525
SEMASS–NET	29506000	31224000	23377000	29080000	21041000	305140000	25428333
GDRRF NET	18390000	17854500	19515000	21016500	15010500	135067500	11255625
COLUMBUS–GROSS	27600000	29328000	31008000	30288000	29232000	332400000	27700000
FERROUS RECOVERED (TONS)(4)							
MID–CT	2,211	1,902	1,928	2,152	1,891	24,666	2,056
SPSA	706	746	940	1,051	1,093	8,031	669
DADE CO.	2,657	2,488	2,873	2,906	2,027	34,099	2,842
SEMASS (3)	2,335	2,431	1,956	2,175	1,685	24,271	2,023
GDRRF	3,219	2,935	2,936	2,724	2,138	33,838	2,820
ALUMINUM RECOVERED (4)							
SPSA	42	40	48	65	61	547	46
DADE CO.	0	69	26	41	71	398	33
SEMASS(NON FE)	197	247	292	176	180	2,439	203
KWHR/TON RDF (1)(5)							
MID–CT GROSS	722	767	752	783	795		766
MID–CT NET	632	675	659	663	681		665
DADE CO.–GROSS	472	488	486	502	467		492
DADE CO.–NET	368	393	389	396	349		388
SEMASS–NET	533	651	534	650	564		597
GDRRF (2)	471	651	616	645	617		600
COLUMBUS–GROSS	597	565	561	647	647		628
LB STM/LB RDF (1)(5)							
MID–CT	3.71	3.93	3.75	3.92	4.04		3.87
SPSA	3.83	3.32	3.42	3.45	3.54		3.55
DADE CO.	2.76	2.85	2.84	2.91	2.85		2.92
COLUMBUS	2.66	2.74	2.61	2.85	2.90		2.80
SEMASS	3.27	3.90	3.23	4.06	3.73		

TABLE 3 SUMMARY OF AVERAGE COST OF OPERATION

CATEGORY	PROJECTS AVERAGE	MINIMUM	MAXIMUM
TOTAL SOURCES OF FUNDS			
TIPPING FEES MSW	$28,875,317	$16,343,000	$43,080,000
TIPPING FEES–OTHER	$5,234,365	$2,481,352	$7,987,378
ELECTRICITY SALES	$19,271,455	$7,339,000	$32,793,365
STEAM &/OR RDF SALES	$13,667,500	$3,420,000	$23,915,000
INTEREST EARNINGS	$3,237,656	$1,262,031	$7,083,936
MISCELLANEOUS	$157,405	$50,000	$337,000
RECYCLING SALES	$680,245	$48,142	$1,338,000
REIMBURSABLES	$10,045,116	$10,045,116	$10,045,116
OTHER	$1,176,883	$104,695	$2,249,071
TOTAL SOURCES (9)	$59,106,101	$37,067,000	$80,176,349
TOTAL USES OF FUNDS			
–O&M USES:			
OPERATING BUDGET/PERSONNEL	$14,627,740	$9,048,000	$25,204,177
EQUIPMENT,MAINT&SUPPLIES	$3,050,852	$606,000	$4,074,181
SERVICES	$1,988,520	$569,604	$4,000,956
UTILITIES	$958,394	$674,182	$1,220,000
COAL	$2,278,037	$1,672,267	$2,883,806
LIME	$1,362,645	$272,290	$2,453,000
DISPOSAL FEES	$2,899,468	$1,152,601	$5,924,000
–TOTAL O&M USES (9)	$20,798,393	$12,013,000	$29,018,784
–NON O&M USES:			
DEBT SERVICE I	$21,175,525	$4,573,901	$36,695,000
DEBT SERVICE II	$6,885,468	$2,763,345	$13,149,060
EQUIPMENT REPLACEMENT FUND	$637,500	$275,000	$1,000,000
LANDFILL CLOSURE/RESERVE	$377,057	$200,000	$554,113
TAXES,PAYMENTS,OFFSETS	$3,995,016	$190,000	$6,073,000
HOST FEES/LEASE/LAND RENT	$815,196	$773,391	$857,000
PERFORMANCE PAYMENTS	$3,167,516	$1,469,032	$4,866,000
INSURANCE	$936,460	$122,157	$1,458,000
ENVIRONMENTAL TEST/CEM	$323,985	$129,000	$583,956
CAPITAL/CONSTRUCTION/DESIGN	$845,874	$470,467	$1,221,280
RESERVES AND CONTINGENCIES	$496,000	$400,000	$588,000
RECYCING FUND	$438,472	$282,463	$594,480
GENERAL ADMINISTRATION	$2,540,649	$1,164,000	$4,049,000
OTHER	$210,779	$4,970	$526,000
–TOTAL NON O&M USES	$24,322,609	$1,132,000	$52,700,000
TOTAL USES OF FUNDS	$45,121,002	$16,133,000	$75,026,000
PLANT VITALS:			
MSW RECEIPTS TPY	649099	443473	876000
DESIGN MSW TPD	2366	1895	3300
# OF PROCESS LINES	3	2	5
# OF BOILERS	3	2	6
# OF TRANSFER STATIONS	2	0	7
# OF LANDFILLS	1	0	2
# OF OPERATING GROUPS	1	1	2
O&M $/TON	$33	$18.80	$46.50
TOT.USES $/TON(EXCL.DEBT SERV)	$44	$20.21	$72.12

NOTES: DUE TO FISCAL VS. CALENDER YEAR DIFFERENCES AND DUE TO DATA AVAILABILITY
FIGURES USED VARY FROM 1989$ TO 1991$ AND FROM ACTUAL TO PROJECTED EXPENDITURES.

1. DETROIT SOURCES AND USES OF FUNDS USED WERE PROJECTED IN 12/90 CONSULTING ENGINEERS REPORT.
2. SEMASS EXPENDITURES AND TPY THROUGHPUT WERE ACTUALS FOR STARTUP YEAR.
3. DADE COUNTY EXPENDITURES WERE FOR OPERATOR ONLY AND DO NOT INCLUDE COSTS INCURRED BY OWNER.
4. MID-CT COSTS WERE ACTUAL EXPENDITURES BY THE CRRA FOR FISCAL YEAR ENDING 6/30/90.
5. SPSA COSTS WERE BUDGETED AMOUNTS FOR FISCAL YEAR 1990-1991 & INCLUDE THE FIRST YEAR OF POWER BLOCK OPERATION.
6. COLUMBUS COSTS USED WERE ACTUAL COSTS FOR 1990.
7. ASSUMED TPY THROUGHPUT WERE USED FOR SPSA AND COLUMBUS, DETROITS TPY THROUGHPUT IS PROJECTED.
8. NO SOURCES OF FUNDS INFORMATION WAS USED FOR DADE AND COLUMBUS
9. TOTAL SOURCES AND USES ARE NOT THE SUM OF LINE ITEMS SINCE NOT ALL THE PROJECTS USE ALL THE LINE ITEMS.

TABLE 4 COST SUMMARY BY SYSTEM COMPONENT

SYSTEM BREAKDOWN	AVERAGE	MINIMUM	MAXIMUM
WASTE TRANSPORT	$4,979,234	$4,393,166	$5,565,301
WASTE PROCESSING	$7,999,020	$3,746,490	$12,251,549
POWER PLANT	$12,559,719	$9,033,000	$16,133,000
GENERAL ADMINISTRATION	$1,715,748	$1,164,000	$2,408,947
LANDFILL(S)	$2,587,237	$1,359,000	$4,552,879
SERVICE SHOP/OFFICE	$768,708	$595,000	$942,415
ENVIRONMENTAL MANAGEMENT	$391,668	$259,000	$524,336
REGIONAL RECYCLE FACILITY	$564,838	$282,463	$847,212
OTHER	$1,665,787	$11,935	$5,458,000
TRANSFER STATIONS	$332,474	$14,812	$1,345,000

NOTES:

(1) LINE ITEMS ARE NOT INTENDED TO BE ALL INCLUSIVE. ONLY THOSE ITEMS THAT INFORMATION WAS AVAILABLE AND WERE COMMON TO MORE THAN ONE PLANT ARE SHOWN

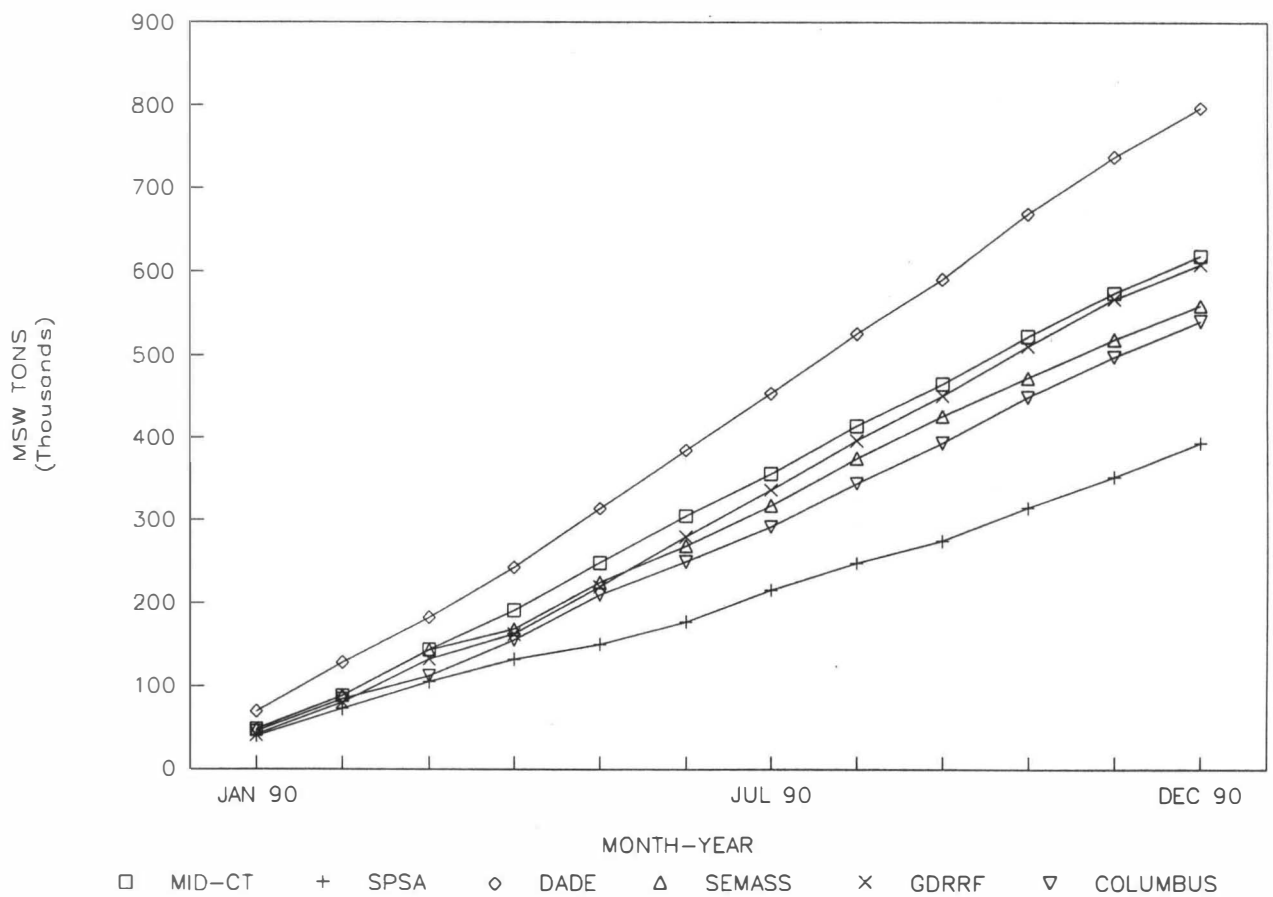

FIG. 1 1990 CUMULATIVE MSW PROCESSED
(Six Large Scale RDF Facilities)

process or the Heil process. Mid-Connecticut and Detroit are ABBRRS processes, SEMASS and Columbus are crunch-and-burn plants and SPSA and Dade County use the Heil system process. All of the projects have additional features which distinguish them from each other and make each facility unique.

The conclusions that can be drawn from this paper include the following:

(a) Several RDF processes are available. They are of proven technology and are adequately performing their function of solid waste volume reduction.

(b) Protective weld overlay of boiler tubes is a recent trend that will probably continue to be a part of waste incinerators for the foreseeable future due to tube wastage problems.

(c) Three (3) of six (6) plants are in various stages of expansion planning.

(d) Air pollution equipment will change from ESPs to dry scrubber/baghouses. Four (4) of the six (6) plants discussed herein will require retrofits by 1995 to meet the Clean Air Act legislation.

(e) RDF system owners and operators are actively pursuing solid waste management programs including recycling, composting and materials recovery to improve the solid waste management programs provided in their service areas.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the Project Managers and Plant Managers who allowed their facilities to be discussed; they reviewed the information presented in this paper for accuracy and completeness.

The author also thanks these managers for supplying the operating data that forms the basis for this analysis.