

# STARTUP AND OPERATIONS OF THE MID-CONNECTICUT RESOURCE RECOVERY PROJECT

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## ABSTRACT

The 2000 TPD (1818 tpd) Mid-Connecticut plant began construction in the spring of 1985 with startup in the fall of 1987 and full scale commercial operation in the fall of 1988.

This paper reviews the startup and initial operations of the Mid-Connecticut project.

## FACILITY DESCRIPTION

The Mid-Connecticut Resource Recovery facility was designed and constructed by Combustion Engineering, Inc. (C-E) and is owned by the Connecticut Resources Recovery Authority (CRRA).

The Mid-Connecticut Resource Recovery Facility is located at Connecticut Light and Power's (CL&P's) South Meadows generating station along the Connecticut River on the south side of Hartford, Connecticut. Coal fired boilers at this site were previously removed allowing the vacated boiler building to be rebuilt with the new power block facilities. The new waste processing facilities were built on land adjacent to the existing generating station.

The waste processing portion of the facility is operated by the Metropolitan District Commission

(MDC) and the power block facility (PBF) is operated by C-E. The facility receives residential, commercial and light industrial waste from 44 cities and towns in the Mid-Connecticut Region. Waste is delivered by municipal and private haulers either by direct haul or through transfer stations.

The Waste Processing Facility (WPF) has a nominal capacity of 2000 tons (1818 t) of Acceptable Waste per day with a guaranteed capacity of 12,000 tons (10,909 t) per week. Processible waste is processed to produce refuse derived fuel (RDF) which is burned in boilers to produce steam which is used to generate electrical energy.

The refuse derived fuel technology prepares solid waste for combustion by first removing non-combustible materials such as dirt, metals and glass and then sizing the fuel for improved combustion. The MSW processing scheme includes five main components:

- (a) Inspection/picking ahead of processing
- (b) Flail shredding
- (c) Magnetic separation
- (d) Screening
- (e) Secondary shredding

The facility has two parallel, separate identical processing lines (Fig. 1) each with a nominal capacity rating of 100 tons/hr (90.9 t/h). The process lines are operated two shifts per day, Monday through Friday and one shift on Saturday with equipment maintenance being performed during off shift hours.

<sup>1</sup> Formerly: Combustion Engineering, Inc., Resource Recovery Systems. This merger occurred after this paper was written; hence, the reference to Combustion Engineering in the text.

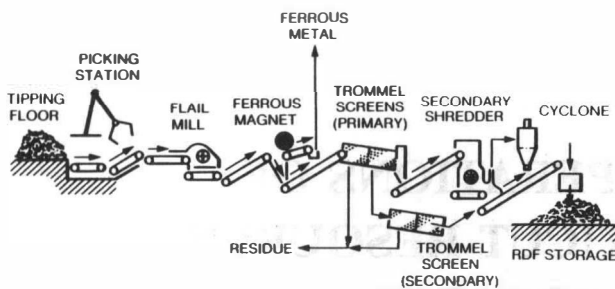


FIG. 1 WASTE PROCESSING SYSTEM

## RECEIVING AND STORAGE

Weighed incoming trucks are directed to the MSW receiving area where acceptable waste is discharged onto the receiving building tipping floor. Once on the tipping floor, large wheeled bucket loaders are used to stockpile material, up to 20 ft (6 m) high, and to feed the process lines. This initial waste handling provides an early opportunity for the loader operators to spot and remove nonprocessable, bulky and hazardous material in the arriving waste.

## PROCESS INFEEED

After inspection and sorting on the receiving floor, the first and most important step in processing MSW is metering the waste onto the process line at a closely controlled rate. To accomplish this, bucket loaders are used to remove material from the stockpile and load it onto the horizontal feed conveyor at the beginning of the process line.

Three infeed conveyors are used to progressively reduce the material burden depth so that the waste can be visually inspected for nonprocessable items. The material is then conveyed past a picking station booth where an operator again inspects the waste and removes nonprocessable items.

## PRIMARY SHREDDING

Primary shredding is the key step in preparing the MSW for further processing. The primary shredder is a flail-type mill. The flail mill consists of a horizontal rotor which is belt driven by an electric motor. Replaceable swing hammers are arranged on four (4) axial rows on the rotor. The spacing and pattern of the hammers maximizes the area over which impact occurs across the infeed. The waste is impacted by the

hammers, thrown against the breaker plate and then discharged onto a rubber belt conveyor.

The primary shredder is located in a blast resistant bunker for explosion protection. The bunker has thick reinforced concrete walls which are designed to contain an explosion and direct the energy released out the bunker roof vent away from the plant personnel.

Four noteworthy explosions have been experienced to date, three due to 20 lb (9.09 kg) propane (gas grill) tanks and one due to a large quantity of volatile fluid from a cosmetics supply house. In all cases, the bunker functioned as designed, safely relieving the overpressure out the roof. Down time from the explosion was minimal and primarily associated with checking for equipment damage and repairs to the roof.

The primary shredder has a dedicated dust control system consisting of a baghouse filter and exhaust fan. The dust system is also isolated from the main process area in a blast resistant bunker for explosion protection.

## FERROUS SEPARATION

Following primary shredding, the coarsely shredded waste is conveyed to the double-drum magnetic separation system. The purpose of this system is to recover ferrous metal from the process stream for recycling as well as reduce wear in the secondary shredder and to minimize the quantity of metals delivered to the boiler.

The ferrous metal is then transported by conveyor to the ferrous metal air classifier which removes loose nonferrous material carried over with the magnetically separated material.

## PRIMARY SEPARATION

With most of the ferrous metal removed, the main waste process stream is divided into two approximately equal streams which are fed into two parallel separation units in each process line. The separation units are totally enclosed trommels (rotary screens) with replaceable screen sections, variable speed drives and adjustable pitch angle to allow fine tuning of the separation process. Material movement through the rotary screens and material separation efficiency is controlled by the slope and rpm of the screen, the lifting and tumbling action caused by the screen and internal lifting baffles, and sizing of the holes in the screen.

Three streams are discharged from the primary separators:

- (a) A residue stream consisting of sand, glass, dirt, and a small quantity of combustible materials.
- (b) A sized fraction consisting primarily of small

combustible products together with some heavy particles of rock, glass, etc.

(c) An oversized fraction consisting mainly of paper and cardboard.

## SECONDARY SEPARATION

The sized material fraction discharged from the second stage of the primary separators is conveyed and discharged into the secondary separation unit of similar design to the primary units.

There are two discharges from this unit:

(a) A residue stream.

(b) Sized combustibles which are transferred to RDF storage.

## SECONDARY SHREDDING

The oversized fraction from the primary separators is conveyed to the secondary shredder. The function of the shredder is to size reduce the material for proper feeding to, and complete burning in, the RDF boilers.

## DUST CONTROL

The process line dust control system provides dust collection from the trommels, collection of tramp material from the ferrous air classifier, and negative draft to control dust and assist movement of material through the secondary shredder. A system for each process line is comprised of a cyclone separator, a fabric filter (baghouse), and an induced-draft exhaust fan. Most of the material collected is removed from the air stream in the cyclone. The air stream from the cyclone is cleaned in the fabric filter. Material from the cyclone and baghouse is directed to RDF storage.

## RDF STORAGE

The final step in RDF processing is placement of RDF into storage. A stationary packer, such as used in solid waste transfer stations to load transfer trailers, is used to discharge RDF into the storage area from each process line.

The stationary packer outlet penetrates the concrete push wall which is located between the process area and RDF storage. The discharge end of the packer is flush with the inside of the storage area wall so that it can not be hit by the front loader in the storage area. RDF conveyed to the packer from the process equipment is pushed through the wall by the continuously

cycling ram in the packer. This operation is relatively dust free and allows the rubber-tired wheel loader freedom to maneuver and stockpile RDF while material is being pushed into the room by the packer.

## POWER BLOCK FACILITY

The Power Block Facility (PBF) consists of three (3) C-E VU40 boilers that generate 231,000 lb/hr (105,000 kg/h) of steam while firing 100% RDF; 188,000 lb/hr (85,455 kg/h) steam while firing 100% coal; or can co-fire RDF and coal in any combination and generate up to 231,000 lb/hr (105,000 kg/h) steam. Steam is headered to either of two (2) 45MW, 465,000 lb/hr (211,364 kg/h) turbine generators. Following is a general description of the fuel feed systems, steam generating and flue gas cleaning systems of the PBF.

### RDF FEED METERING SYSTEM

RDF from the storage area is transported approximately 600 ft (183 m) from the process plant to the boilers using two parallel conveyor systems. One conveyor system is required for normal operation with the second as standby. RDF is fed out of storage by pushing it with a front loader into one of two fuel feed conveying systems.

Each fuel feed system consists of a horizontal and an inclined steel pan apron conveyor located along the back wall of the RDF storage room. The inclined conveyor discharges onto a rubber belt conveyor which transports the RDF to the boiler metering bins. At the boiler house the RDF can be discharged into a metering bin for the first boiler or can be diverted onto a second belt to feed the metering bin for the second boiler. If RDF is required at the third boiler, RDF can also be diverted past the second metering bin to feed the third bin.

The RDF surge and metering functions at the boilers are accomplished by the use of a dedicated "live bottom" auger bin for each boiler. The augers meter the RDF into the four (4) feed chutes to the boiler. Each boiler feed chute contains a vibrating metering conveyor to provide a smooth RDF flow to the boiler.

### COAL HANDLING SYSTEM

Coal consignments reach the plant in river barges. The existing barge-docking and unloader support was rebuilt and a new clam-shell barge unloader installed.

Arriving coal is conveyed to a transfer building from which it may be directed to the plant coal silos or sent

to a spout discharge in the coal yard. The coal may be either placed in inactive storage or left in the stock-out pile as active storage for demand usage.

The coal yard provides storage of up to 30,000 tons (27,216 t) of coal. The area has a synthetic liner to prevent contamination of the groundwater system by coal leachate. A stormwater-runoff detention pond is provided to collect rainfall from the storage pile.

Washdown water, process overflow and storm drainage from the entire Air Quality Control System area drains into this same pond and is recycled for use in the flue gas scrubbing system. This design permits zero discharge of plant water containing ash, coal fines or chemicals.

## FUEL FIRING SYSTEM

The steam generators incorporate spreader stokers as the fuel firing system for RDF. The type of stoker used for refuse firing is a specially designed Refuse Combustor (RC) stoker (Fig. 2). This is a catenary grate design that eliminates the need for a tensioning device. The stoker has operator controlled multiple undergrate air zones to optimize combustion from the front to the rear of the grate.

The RDF feed system utilizes a pneumatic distributor air (PDA) fan to inject the fuel into the boiler. Coal is introduced into the furnace within the same combination fuel distributor housing using a rotating drum to throw the coal toward the rear of the furnace.

Combustion air is introduced as either undergrate air (UGA) or overfire air (OFA). Operation of an RDF steam generator normally requires 50–70% excess combustion air. About 60% of the combustion air is introduced as UGA with the balance being OFA. When burning RDF, the preheated OFA is introduced through four separate tangential windboxes located above the stoker. The UGA is preheated to aid in drying of fuel on the stoker. The RC undergrate air temperature is limited to approximately 550°F (288°C) to maintain structural integrity and minimize clinkering.

Combustion of both RDF and coal on the grate has been a success. Operators must, however, be especially attentive during transition from coal to RDF in order to avoid localized hot spots. Aluminum plugging problems experienced with virtually all other RDF grates have not been experienced at Mid-Connecticut.

## STEAM GENERATORS

The three steam generators, capable of burning both coal and RDF in any combination, have a total steam-

ing capability of 650,000 lb/hr (295,454 kg/h) at 880 PSIG (59.8 bar) and 825°F (440°C) when two units are burning RDF and one unit is burning coal.

Waterwall screens are provided to reduce the flue gas temperature entering the superheater. The screens act as a “buffer” to help maintain the gas temperature entering the superheater. The screen assemblies are placed on wide transverse spacings with the tubes tangent in the direction of gas flow to minimize ash deposition.

The superheater is located above the furnace nose arch to protect it from the direct radiation of the furnace and excessive metal temperatures. Mid-Connecticut has a two-stage superheater with an interstage desuperheater for final steam temperature control and to minimize metal temperatures. The two stages are arranged with steam flow parallel to flue gas flow. Superheater metallurgy is critical in the design of an RDF steam generator due to the corrosive environment in which the superheater exists. The Mid-Connecticut superheater is provided with chrome-moly tubes in the first stage and chromized tubes in the second stage. Experience to date has not indicated any significant corrosion in the superheater.

## FLUE GAS CLEANING EQUIPMENT

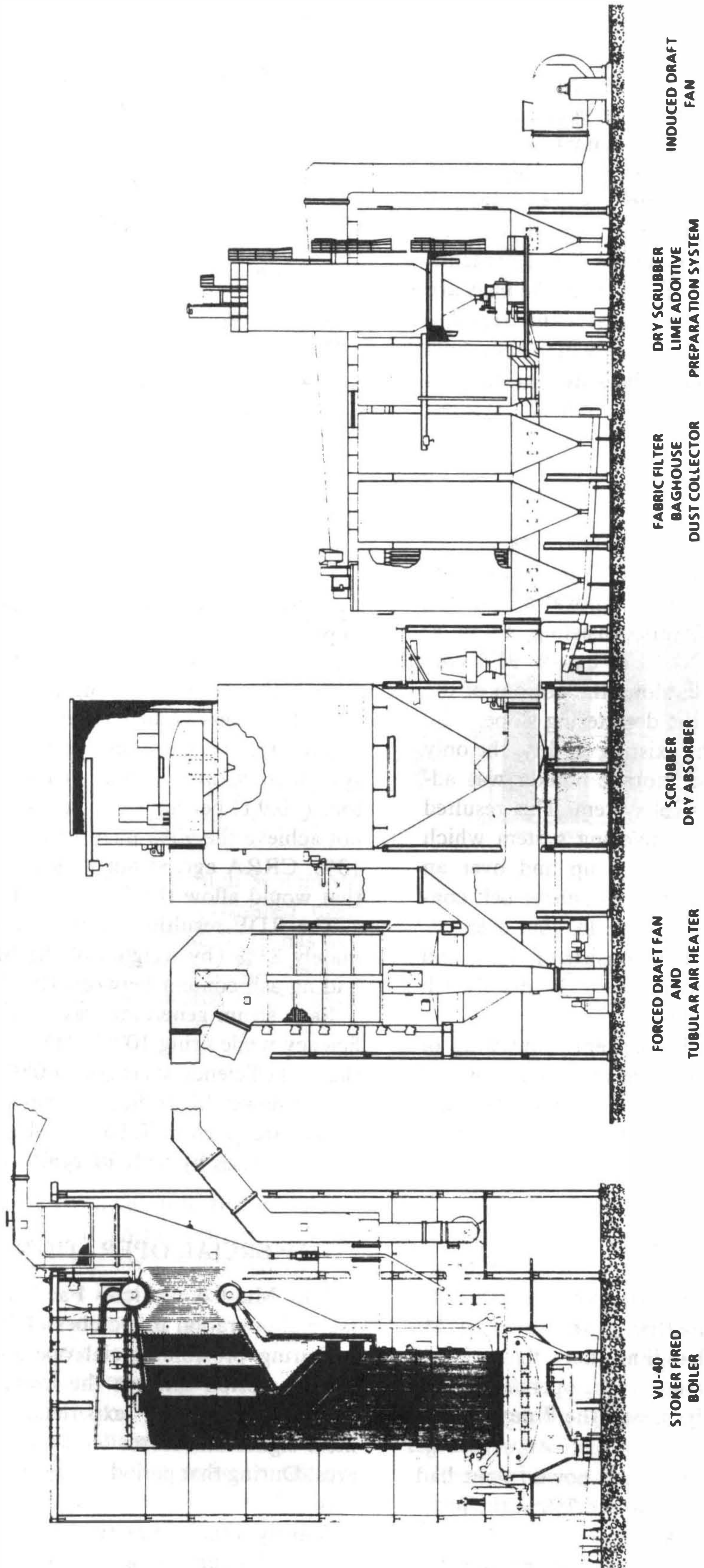
The removal of acid gases and particulate matter from the flue gas stream at Mid-Connecticut is accomplished by a spray dryer absorber followed by a fabric filter (baghouse).

A spray dryer absorber vessel for each boiler is used to remove acid gases with lime, producing a dry end product for disposal. The absorber vessel is sized to provide intimate contact and sufficient residence time for the sorption and drying processes to occur. This is accomplished by introducing a finely atomized cloud of alkaline slurry into the flue gas stream using a high speed (12,000 rpm) rotary atomizer. One operating atomizer and one spare are provided per absorber vessel. The reaction product is a dry mixture of calcium sulfite/sulfate, calcium chloride, calcium fluoride, some unreacted lime, carbonate and fly ash. The other key scrubbing system components include an additive preparation system consisting of a lime storage silo, slaker, and lime slurry storage and additive feed tanks with installed mixers, slurry feed pumps, plus field and control room instrumentation and control devices.

## PARTICULATE CONTROL

The particulate removing fabric filter for each boiler consists of two rows of six modules, each with an air





VU-40  
STOKER FIRED  
BOILER

FORCED DRAFT FAN  
AND  
TUBULAR AIR HEATER

SCRUBBER  
DRY ABSORBER

FABRIC FILTER  
BAGHOUSE  
DUST COLLECTOR

DRY SCRUBBER  
LIME ADDITIVE  
PREPARATION SYSTEM

INDUCED DRAFT  
FAN

FIGURE 2

to cloth ratio of 2:1 with two modules removed from service for cleaning or maintenance. The particulate matter collects on the inside of cylindrical fiberglass bags forming a cake-like coating. This coating is made up of the residue from the dry scrubbing system and contains some unreacted lime. As the gases pass through this cake, additional acid gas neutralization takes place. The cake is not removed from the bag until the flue gas pressure drop across the bag reaches a preset limit. When the limit is reached, the bags are cleaned by blowing cleaned flue gas over the bags dislodging the caked particulate matter which then falls into the collection hoppers below the bags. The hoppers direct the particulate into the fly ash removal system.

## ASH HANDLING

The use of large, heavy-duty submerged scraper conveyors (SSC) was adopted for Mid-Connecticut. The SSC provides for the continuous removal and dewatering of bottom ash. Steel flights consisting of 4 in. × 4 in. × 36 in. (10.16 cm × 10.16 cm × 91.4 cm) long angles transport the ash along the bottom of the water-filled trough and up the dewatering slope.

Due to the retrofit into the existing facility, the only suitable location for the ash storage bunker was adjacent to the air quality control system. This resulted in an extensive bottom ash conveying system which included elevating the bottom ash up and over an existing warehouse. A single train of rubber belt conveyors transports the ash to the ash loadout area.

The fly ash conveying system consists of single and double chain conveyors that transport the dry fly ash to the fly ash conditioning system.

Redundant ash conditioning systems consisting of surge bins, rotary feeders and pug mills are provided to wet the fly ash for dust control prior to its being deposited on the conveyor which transports the combined ash to storage.

## FACILITY PERFORMANCE

The Waste Processing Facility passed the facility capacity test processing more than 11,000 tons (10,000 t) in five days and easily handling more than 12,000 tons (10,909 t) in less than six, 16 hr operating days. The power block also easily passed the 7 day facility capacity test.

The waste processing facility and power plant had a combined total combustible loss of 6.7% in the process residue and power plant ash.

The waste processing facility passed the process line

**TABLE 1 MID-CONNECTICUT RESOURCE RECOVERY PROJECT**  
**Summary of Emissions — 100% RDF**  
**May–June 1988**

| Emissions                                  | Connecticut DEP Standard                         | Average Measured Emission Value Average (All Boilers) |
|--------------------------------------------|--------------------------------------------------|-------------------------------------------------------|
| PCDD/PCDF <sup>a</sup>                     | 1.95 ng/Nm <sup>3</sup>                          | <.0278                                                |
| Particulate Matter                         | 0.015 gr/DSCF at 12% CO <sub>2</sub>             | 0.0057                                                |
| Hydrochloric Acid (HCl)                    | 90% removal or<br>50 ppmv at 12% CO <sub>2</sub> | 99.5<br>1.7                                           |
| Sulfur Dioxide (SO <sub>2</sub> )          | 0.32 lb/million BTU                              | 0.01                                                  |
| 100% RDF                                   |                                                  |                                                       |
| Nitrogen Oxides (NO <sub>x</sub> )         | 0.6 lb/million BTU                               | .34                                                   |
| Carbon Monoxide (CO/CO <sub>2</sub> Ratio) | 0.002                                            | 0.00156                                               |
| Volatile Organic Compounds (VOC)           | 70 ppmdv at 12% CO <sub>2</sub>                  | <1                                                    |

<sup>a</sup>2, 3, 7, 8-TCDD Toxic Equivalent

capacity tests achieving an average of 1412 tons (1284 t) per day for process line 100 and an average of 1433 tons (1303 t) per day for process line 200 for three consecutive 16 hr operating days.

Each process plant ferrous recovery system, which at this time uses a double drum single stage magnet system to remove ferrous metal from more than 100 tons (90.9 t) per hour of coarsely shredded MSW, did not achieve the 90% guarantee and was low by about 10%. CRRRA agreed not to add additional equipment that would allow the 90% level to be achieved.

The RDF resulting from the process was approximately 83% (by weight) of the MSW processed and had an ash content between 10–15% by weight.

Each steam generator was tested for its thermal efficiency while firing 100% RDF. The steam generator thermal efficiency averaged 77.05% for the three units.

The power block flue gas emission control system results are given in Table 1. All guarantees were met, in many cases by wide margins.

## COMMERCIAL OPERATION

The Mid-Connecticut Facility commenced commercial operation in October of 1988.

During pre-commercial operations of the boilers, tube corrosion rates in the lower furnace area were monitored. Industry experience suggested that the most significant corrosion would likely occur in this area. During that period, there was no significant metal loss.

Shortly after commercial acceptance, Boiler 12 experienced a rupture of the waterwall in an area above

**TABLE 2 STARTUP AND OPERATIONS OF THE MID-CONNECTICUT RESOURCE RECOVERY PROJECT FACILITY PERFORMANCE**

September 1987 thru September 30, 1989

|                                       | Tons    | t metric | % of Total |
|---------------------------------------|---------|----------|------------|
| Total Unprocessable                   | 26,826  | 24,387   | --         |
| Total MSW Processed                   | 801,228 | 728,388  | 100.00     |
| Total Process Residue                 | 86,474  | 78,613   | 10.79      |
| Total Ferrous Metal                   | 32,988  | 29,989   | 4.12       |
| Total RDF Burned*                     | 656,787 | 597,078  | 81.97      |
| Other Losses (H <sub>2</sub> O, etc.) | 24,979  | 22,708   | 3.12       |

\* During initial operations some RDF was bypassed.

the monitored zone. Metallurgical inspection of the other boilers found excessive tube wastage from lead chloride corrosion in the same relative areas. The boilers were subsequently taken down one at a time to correct the problem. The ruptured unit was retubed and Inconel overlay was added to the waterwall tubing of all three boilers to reduce future corrosion to acceptable levels.

As confirmed by subsequent monitoring, the problems relating to the accelerated boiler tube corrosion observed after commercial acceptance were accurately identified and corrected.

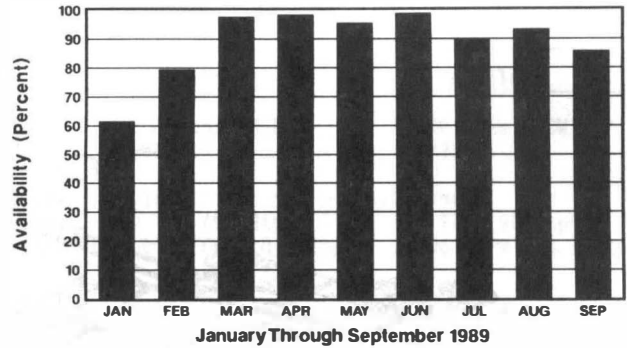
The plant is now running well. Through September 1989, the facility has received and processed over 800,000 tons (727,273 t) of waste. The RDF has averaged 83.8% of the processed waste, the residue 10.79% and the ferrous metal recovered 4.12% (see Table 2).

## SUMMARY AND CONCLUSIONS

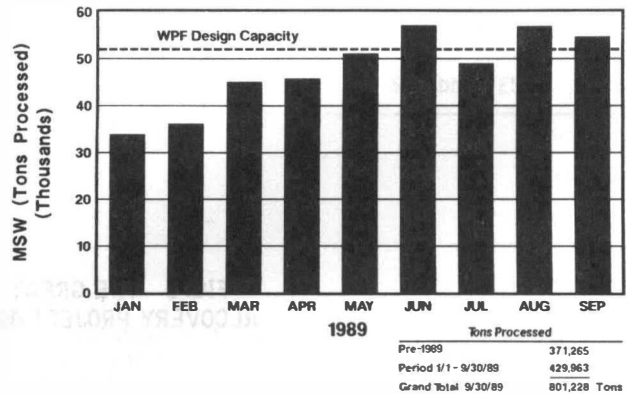
We believe that major advances in RDF technology have been demonstrated by the Mid-Connecticut project (Figs. 3 and 4). This has been reaffirmed by the performance observed at the Detroit Facility (Fig. 5).

As shown by performance testing, high energy conversion efficiencies are being achieved and facility air emissions are among the best ever reported.

The Mid-Connecticut facility was chosen by EPA and Environment Canada as the state-of-the-art RDF facility to conduct a comprehensive emission testing program. Starting in late November, 1988 and going through January, 1989, one of the boilers (Boiler #11) at the Mid-Connecticut facility was operated under a



**FIG. 3 MID-CONNECTICUT FACILITY BOILER AVAILABILITY (hr)**

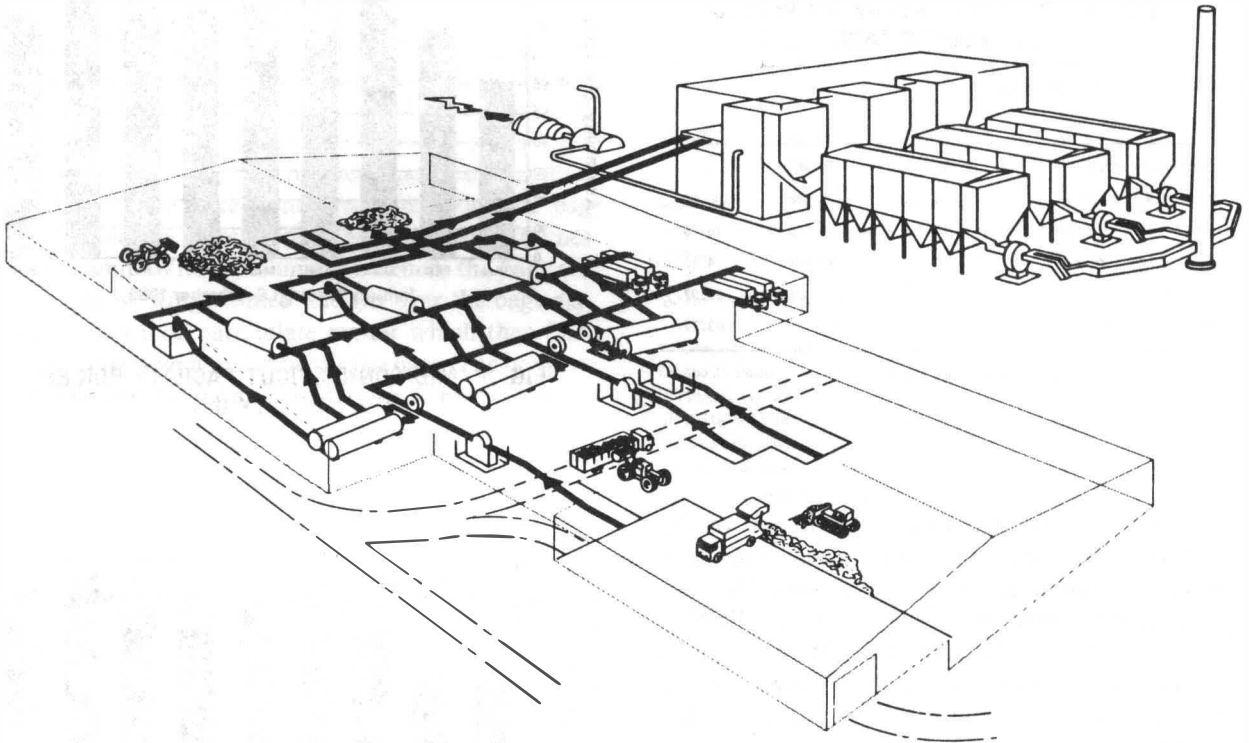


**FIG. 4 MID-CONNECTICUT FACILITY MSW PROCESSED BY MONTH—1989**

wide range of operating conditions with the air and ash emissions monitored at various points in the facility. The detailed results of that program are not available as of this writing, but will be available in the Spring of 1990.

We believe prepared fuel resource recovery technology, achieving an improved quality of fuel for efficient burning while providing flexibility for materials recovery for recycling, has been demonstrated to be environmentally sound and technically proven for integrated waste management programs of the future.

Prepared fuel technology similar to that utilized in Mid-Connecticut has been installed in the cities of Detroit and Honolulu. Project comparisons are shown in Tables 3 and 4.



**FIG. 5 THE GREATER DETROIT RESOURCE RECOVERY PROJECT 4000 TPD—COGENERATION**

**TABLE 3 REFUSE DERIVED FUEL PROJECTS**

| Project         | Waste Processing Capacity<br>Tons/Day (tm/d) | Facility Guaranteed Capacity<br>Tons/Year (tm/y) | Startup Date | Commercial Operation |
|-----------------|----------------------------------------------|--------------------------------------------------|--------------|----------------------|
| Mid-Connecticut | 2,000 (1,818)                                | 624,000 (567,273)                                | Sept 1987    | 1988                 |
| Greater Detroit | 4,000 (3,636)                                | 850,000 (772,727)                                | Fall 1988    | 1990                 |
| Honolulu        | 2,160 (1,964)                                | 561,000 (510,000)                                | Fall 1989    | 1990                 |
| Total           | 8,160 (7,418)                                | 2,035,000 (1,850,000)                            |              |                      |



TABLE 4 PROJECT DESCRIPTIONS

|                                                                             | Mid-Connecticut                                                                                                  | Detroit                                                                                | Honolulu                                                             |
|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| 1. Receiving and Storage                                                    | 3,000 Tons (MSW)<br>(2,727 t)                                                                                    | 4,200 Tons (MSW)<br>(3,818 t)                                                          | 3,000 Tons (MSW)<br>(2,727 t)                                        |
| 2. Processing:<br>Nominal Design Capacity/Line<br>Guaranteed Capacity (MSW) | 2 Lines<br>100 TPH (90.9tph)<br>12,000 TPW (10,909tpw)                                                           | 3 Lines<br>100 TPH (90.9tph)<br>20,000 TPW (18,182tpw)                                 | 2 Lines<br>100 TPH (90.9tph)<br>12,960 TPW (11,782tpw)               |
| 3. Refuse Derived Fuel Storage                                              | 2,000 Tons (RDF)<br>(1,818 tm)                                                                                   | 5,000 Tons (RDF)<br>(4,545 tm)                                                         | 4,000 Tons (RDF)<br>(3,818 tm)                                       |
| 4. Steam Generators                                                         | 3-231,000 Lbs/hr<br>(3-105,000 Kg/hr)<br>VU-40 Boilers<br>(100% RDF)<br>Co-Firing Capability<br>with Stoker Coal | 3-362,800 Lbs/hr<br>(3-164,909 Kg/hr)<br>VU-40 Boilers<br>(100% RDF)<br>1 Unit Standby | 2-244,000 Lbs/hr<br>(2-110,909 Kg/hr)<br>VU-40 Boilers<br>(100% RDF) |
| 5. Electricity Generation                                                   | 68.5 MW <sub>e</sub>                                                                                             | 68 MW <sub>e</sub> *                                                                   | 61.5 MW <sub>e</sub>                                                 |
| 6. Emission Control                                                         | Scrubber/Baghouse                                                                                                | ESP                                                                                    | Scrubber/ESP                                                         |

\* Includes 100,000 Lbs/Hr (45,455 Kg) 225 psig (15.3 bar) steam export

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**Keywords:** Boiler; Corrosion; Performance; Refuse-Derived Fuel; Spreader-Stoker