

THE MAINE ENERGY RECOVERY COMPANY AN RDF SUCCESS STORY

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ABSTRACT

This paper describes the continuing design and operational changes to the Maine Energy Recovery Company and the resulting beneficial impact on plant performance, environmental compliance, and host community relations. The 600 ton/day (TPD) municipal waste combustion (MWC) facility is located in the center of downtown Biddeford, Maine and began operations in 1987 utilizing a refuse-derived (RDF) technology in the production of steam for electric power generation.

In August 1988, KTI Operations, Inc. assumed operations responsibility at the Maine Energy Recovery Company facility after the plant experienced a multitude of design and operational problems resulting in low municipal solid waste (MSW) processing and electrical availability, nuisance impacts to the host communities of Biddeford and Saco, and a Consent Agreement for environmentally related problems. During the ensuing three year period, a major retrofit/modification program for the facility was undertaken and numerous changes in operations were made which dramatically improved the MSW processing capability and reliability, significantly increased electrical generation, minimized nuisance impacts, and reduced the emissions of pollutants. Relative to environmental compliance, the facility's most recent stack test demonstrated the lowest mercury emissions, and the third lowest dioxin/furan emissions of any MWC in the EPA database.

INTRODUCTION

To solve a regional solid waste problem in Southern Maine during 1984, the Cities of Biddeford and Saco contracted with Kuhr Technologies, Inc. (KTI) a New Jersey corporation for it to develop, construct, own and operate the Maine Energy Recovery Company (Maine Energy) waste-to-energy facility. Because of the favorable electric power rates available at that time and given the large seasonal variations in MSW volume in Southern Maine and neighboring New Hampshire, KTI selected the refuse derived fuel (RDF) technology as the most appropriate choice. Specifically, RDF technology provided the

facility with the capability to burn alternative fuels, such as woodchips derived from whole trees and urban woodwaste in conjunction with RDF, thus allowing the plant to be sized to meet the peak waste volume generated during the summer and to maximize power generation during any seasonal shortfalls in MSW deliveries.

In December 1984, KTI awarded the turnkey design and construction contract to the General Electric Company (GE) in conjunction with a five year operating contract. The 22 MW, 600 TPD facility was built in the center of downtown Biddeford, Maine and began operating in June 1987. Soon after commercial operation, deficiencies in the design and construction of the facility became apparent. As a result, the facility was incapable of; a) consistently processing enough RDF to feed the boilers; b) suffered from poor boiler availability; c) was unable to produce the expected levels of power generation; and, d) was plagued by numerous environmental problems. The on-going environmental problems ultimately resulted in a stiff fine from the State of Maine coupled with a Consent Agreement that required Maine Energy to implement agreed upon specific modifications to the facility's design and operation.

Since GE had not cured the design and operational deficiencies to the satisfaction of Maine Energy, GE was subsequently removed as operator of the facility in August 1988 and replaced by KTI Operations, Inc., a subsidiary of KTI Energy, Inc.

In response to the continuing design and operational problems experienced by the facility and the resulting financial losses suffered by Maine Energy, KTI with the financial support of its limited partners: CNA Realty, Energy National, Inc. and Project Capital, embarked on a comprehensive retrofit program to correct the facility deficiencies and to improve the plant operation.

Having established the backdrop, the balance of this paper will focus on each of three major systems integrated

within the plant, namely in Front End Processing and Fuel Delivery Systems; Steam Generator System; and, Pollution Control System. Included hereinafter is a discussion of the problems encountered, the respective modifications made and the performance of the system following retrofit.

FRONT END PROCESSING AND FUEL DELIVERY SYSTEMS

The retrofits of the Front End Processing System and Fuel Delivery System were considered a top priority not only because deficiencies in the systems limited both MSW throughput and influenced electrical generation, but also because they contributed to unstable boiler operation resulting in environmental problems. KTI retained National Ecology Company (NEC), a recognized leader in waste processing, to evaluate the Front End Processing System which is depicted in Figure 1. A description of the original Front End Processing System, which was designed to process 50 tons per hour (TPH) of MSW into 36 TPH of RDF, its operational problems and subsequent modifications follows:

System Description/Problems

After MSW delivery vehicles deposit waste on the tipping floor for inspection where nonprocessable or unacceptable items are removed, the waste was pushed by a front end loader onto a recessed conveyor. To begin the process the waste was then conveyed to the flail mill where the size of the MSW was reduced to a nominal 12 inches. After exiting the flail mill, the waste was conveyed to an electromagnetic ferrous removal system where the ferrous was extracted and conveyed to a transfer trailer situated exterior to the Process Building. The remaining waste passed through a trommel screen where it was split into oversize (>1.25 in.) and undersize (<1.25 in.) fractions. The undersize material then passed over a disc screen where it was split into the fuel fraction (>.625 in.) and the noncombustible or residue fraction (<.625 in.). The residue fraction was in turn conveyed to the secondary shredder where it was shredded to a nominal 4 inch size. The shredded waste discharged from the secondary shredder combined with disc screen overs to constitute the RDF stream which was subsequently conveyed to the Fuel Delivery System.

Oversized Bulky Waste (OBW) that was removed during the initial inspection process was fed into a shear shredder for size reduction. After passing through the shear shredder, the waste entered the core Processing System at a location downstream of the flail mill.

The Fuel Delivery System consisted of redundant drag chain conveyors that deliver fuel to four Detroit Stoker feeders, two per boiler, from the following sources: Process Line RDF, RDF from the fuel storage/inventory area ("Reclaim") or woodchips. Excess fuel delivered to the boilers was conveyed to Reclaim, via a run-around system, for use during periods when the Front End Processing System was off-line.

Some of the major problems encountered with the original Front End Processing System are listed below:

- a. The lack of redundancy required that all processing system components be operational in order to provide fuel to the boilers. If any single component failed, the production of RDF would either cease

or a resultant poor quality RDF was generated.

- b. The shear shredder constantly jammed and as a consequence seldom achieved nameplate capacity thereby inhibiting system throughput.
- c. The metal disc screen and the trommel were constantly plugged with refuse thereby hampering separation efficiency and reducing availability. Depending on the type of failure, either excessive levels of combustible material was bypassed with the residue to the landfill or an inordinate amount of noncombustible, high ash content material was delivered to the boilers.
- d. The ferrous removal system extracted an unacceptably high percentage of tramp combustible material along with the ferrous. The system was also susceptible to failure due to jamming and torn belts.
- e. The secondary shredder was consistently overloaded and susceptible to jamming thereby limiting RDF production as well as affecting availability/reliability.
- f. The outside location of the two residue stream transfer trailers created unacceptable levels of odor and noise in the community.

The problems with the Fuel Delivery System included; a) frequent failure of the drag chain conveyors which deliver fuel to the boiler feeders causing boiler upsets from insufficient fuel; and, b) repeated jamming of the RDF reclaim conveyors which transports RDF inventory/reserve from Reclaim to the boilers at such time as the process line is inactive.

System Modifications

Based on NEC's recommendations, the Maine Energy Recovery Company implemented a Retrofit Program which included the following changes to the Front End Processing System and Fuel Delivery System:

- a. The shear shredder was removed and replaced with a primary shredder (hammermill). With the addition, the primary shredder functionally replaced the flail mill as the first component in the process line and by doing so reduced the nominal size of the shredded MSW to the balance of the system from 12 inches to 6 inches. The reduction in size served to reduce the load on subsequent processing system components thereby improving the overall system reliability and substantially increasing the MSW/RDF throughput. By replacing the shear shredder instead of the flail mill, the retrofit was accomplished without diverting any waste. The revised alignment provided the new system with a degree of redundancy in that waste could be fed to the processing system through either of the new primary shredder or the flail mill.
- b. The original single stage trommel with 1.25 inch holes was replaced with a two stage

- trommel (hole sizes 2.375 and 4.75 inches). The two stage trommel reduces load on the secondary shredder by allowing waste which is properly sized (greater than 2.375 inches but less than 4.75 inches) to bypass the secondary shredder with a resultant increase in material flow to the disc screen.
- c. The metal disc screen was replaced with a larger disc screen configured with rubber discs. The rubber discs are less susceptible to jams because of their flexibility and are spaced closer than the metal discs (i.e. interstitial clearance of 3/8 inches vs 9/16 inches) thereby improving fuel yield.
 - d. A grapple crane was added to the processing line ahead of the primary shredder to remove large nonprocessable items from the infeed conveyor in an efficient manner thereby reducing the potential for damage, or explosions.
 - e. Residue loadout to trailers was reconfigured to allow loadout activity inside of the Process Building to minimize the impact of noise and odor.
 - f. The drag chain conveyors that distribute fuel to each boiler feed system were modified to improve reliability.
 - g. The original pan conveyor in the reclaim conveyor system was replaced with a walking floor-based metering feed system which proved to be more reliable and provided a more constant feed of fuel from Reclaim.

The retrofit was orchestrated such that system changeouts were implemented while the facility was running and accomplished without the diversion of a single ton of MSW.

System Performance

The flow diagram of the modified Front End Processing System, as shown in Figure 2, illustrates the design and equipment changes in the system as well as the revised materials balance. Since the above changes have been incorporated into the facility, RDF production is no longer a limiting factor for power production. The maximum daily throughput capability of the process line has increased from 550 TPD to over 1000 TPD. In addition, the RDF yield from MSW has improved from 64.4% to 85% with only a slight reduction in the heating value of the RDF and a small increase in ash content. The tramp content of the ferrous has been reduced from approximately 28% to 12% thereby improving its marketability in the recycling markets. Most importantly, the consistent supply and feed of RDF to the boilers has permitted a more stable combustion and a dramatic decrease in unburned material in the bottom ash.

Table 1 summarizes key system performance parameters between 1988 and 1995 and illustrates the long-term effectiveness of the Front End Processing System Retrofit Program.

STEAM GENERATION SYSTEM

During the initial phases of commercial operation, many of the problems associated with the boilers were directly linked to an inconsistent supply of fuel to the boilers from the Front End Processing System. However, in early 1988, other problems with the boilers related to the boiler design became apparent. The problems ranged from poor grate reliability to an excessive number of tube failures both in the convective pass and in the waterwall sections of the boilers. To fully appreciate the changes that were incorporated into the boilers, a brief description of the Steam Generation System is provided hereafter:

System Description/Problems

The facility has two multi-fuel waterwall utility boilers manufactured by Babcock and Wilcox. At Maximum Continuous Rating (MCR), these boilers produce a total of 210 KLb/hr of steam at 675 psig and 760°F when fired with 100% RDF or wood. Fossil fuel heat input from either natural gas or oil is limited to 40% MCR. The boilers are balanced draft, with a controlled combustion zone (CCZ) design with staged combustion and a rotogrator spreader stoker system manufactured by Detroit Stoker. Bottom ash drops off the grate into a bifurcated chute where it is directed to one of two Beaumont Birch wet ash drag systems. The bottom ash is mixed with flyash and dewatered on a short incline conveyor before being loaded into trailers for transport to a secure landfill. During 1996 Maine Energy will complete a major renovation of its ash system with a view to maximizing dewaterability and improving environmental conditions in the Ash Loadout Building confines.

The boiler problems, detailed below, can be lumped into two broad categories; grate failures and tube failures.

- a. The grate system constantly failed due to nonferrous metals solidification in the undergrate air holes causing the grates to overheat and warp. The nonferrous metals (primarily aluminum) would also build up around the grate head shaft until a failure situation occurred.
- b. The plugged undergrate air flow made it difficult to control combustion.
- c. The waterwall tubes were subject to accelerated erosion and corrosion and frequently failed. Ultrasonic Testing (UT) of the waterwall tubes indicated excessive wear in the lower levels of the furnace.
- d. The economizer tubes eroded and frequently leaked or failed. UT measurements of the economizer sections showed that the entire banks needed to be replaced.
- e. The superheater and generator tubes suffered sootblower erosion and frequently failed.
- f. The generator bank and economizer lanes frequently plugged which upset air flows through the boiler causing gaseous

pollutant emission exceedances and increased tube erosion.

System Modifications

Through a combination of in-house expertise and support from vendors, KTI Operations began a systematic retrofit of the boilers to correct design problems and to add certain design enhancements to the units. Subject to financial and operational constraints, the most critical areas were targeted and completed first. In parallel, all other problem areas were diligently monitored throughout the retrofitting process, thereby assuring success of the program. The following boiler modifications were made over a three year period:

- a. Grate failures were reduced by increasing the grate airflow hole diameter from .25 inches to .375 inches; installing pans beneath the grate to deflect molten metal away from the shaft; and, by installing improved boiler cameras. The cameras have enabled operators to efficiently maintain a consistent ash bed depth of 6 to 8 inches.
- b. Waterwall tube failures from corrosion/erosion were dramatically reduced by weld overlaying of Inconel over the carbon steel tubes to a height approximately 30 feet above the grate level. Inconel has been added each year as necessary until the entire furnace area was covered to the 30 foot level.
- c. The wall thickness for the economizers increased from .110 inches to .165 inches. An investigation into the original economizers showed that they were designed for a gas fired unit and not for an RDF application. Flow testing in the gas path showed that the inlet flow to the economizers was severely stratified causing increased erosion on the back of the unit. To correct the flow stratification and therefore minimize erosion, turning vanes were installed to maintain a more uniform flow distribution across the face of the economizer.
- d. New generating banks were installed that incorporated an improved design with increased lane spacing 1-1/2 inches to 3-1/2 inches to minimize land pluggage.
- e. New stainless steel superheaters were installed to improve life expectancy.
- f. The amount of shielding in the superheater and generating bank sections of the boiler was more than doubled and the grade of stainless was upgraded from 304 to 310.
- g. As part of a restructured Preventative Maintenance Program, the boilers are closely monitored and brought down for cleaning approximately every three months. Cleaning consists of removing any molten metal that has plugged the grate underfire airflow holes or wrapped around the head shaft. It also encompasses removing any

ash buildup in the convective pass section of the boiler. Cleaning has proven to improve the combustion and control of the boilers and minimizes erosion in the convective pass due to high velocity flue gas passing through a limited area.

System Performance

Forced outages of the boiler due to the tube failures, grate failures, and feeder jams have greatly diminished with the corresponding benefits of less wear and tear on boiler components from cycling of the units (i.e. startups and shutdowns). The favorable impact on power production from the boiler retrofit program is evidenced by Table 1 which shows the improvement in plant capacity factor from 67.9% in 1988 (prior to the retrofits) to 87.6% in 1988 (after completion of the boiler retrofits) and 88.2% in 1995. As used herein, the plant capacity factor is the ratio of actual annual power generation (kwh/yr) to the theoretical maximum power generation of the plant where the theoretical maximum power generation is product of the turbine nameplate (KW) and 8760 hours per year. The retrofit modifications to the boiler have also directly and indirectly benefited the plant's environmental compliance record, as discussed in the following section.

POLLUTION CONTROL SYSTEM

The modifications to the pollution control system coupled with certain operational changes though not as extensive or costly as those made to the Front End Processing System and Steam Generation System, nevertheless have had a dramatic impact on the plant's operation, environmental compliance and community relations. Prior to discussing the problems encountered and the solutions found, a brief description of the pollution control system is provided as follows:

System Description

Each train of the flue gas control system incorporates a Zurn multicyclone particle separator, a General Electric Environmental Services Incorporated (GEESI) spray dryer absorber (SDA) for acid gas control, and a GEESI multicompartement fabric filter baghouse (FF) for particulate matter control. Both trains exit into a common 244 foot stack. Maine Energy was among the first municipal waste combustors in the United States to incorporate an alignment comprising a spray dryer and fabric filter baghouse for pollution control. In 1987, the USEPA contracted with Midwest Research Institute to test the air emissions from Maine Energy in order to evaluate the effectiveness of the SDA/FF on pollutant removal for RDF combustion units. The results helped shape the guidelines for MWC's under 40CFR part 60 E(a), and the Clean Air Act Amendments.

The multicyclone separators are designed to remove larger size particulate matter in order to reduce wear on the downstream control devices. Each SDA utilizes a lime slurry and cooling water mixture which is atomized from a centrifugal wheel into a reaction vessel for acid gas control. The lime slurry is slaked on site from pebble lime. Each fabric filter baghouse is a reverse pulse jet unit with 12 compartments.

Maine Energy was the first large commercial MWC

facility in Maine and was granted an Air Emission License incorporating the emission limits and averaging times specified in Table 2. Maine Energy has continuous emission monitors (CEMs) for opacity, carbon monoxide, carbon dioxide, oxygen, sulfur dioxide, and nitrogen oxides. The facility must perform a stack test for particulate matter, multi-metals including mercury, and PCDD/PCDF every 18 months.

System Problems/Modifications

As delineated earlier, the design deficiencies in the MSW processing system, the steam generation system, and the pollution control system ultimately resulted in a Consent Agreement against Maine Energy along with a substantial fine. Described hereafter are the environmental and public nuisance problems encountered during the start-up and initial years of operations along with a detailing of the subsequent modifications and operational changes implemented to correct such problems.

Air Emissions. Excess emissions of opacity, carbon monoxide, and sulfur dioxide license limits were common for the period 1987 through 1989. Over this period, however, the CEMs and data acquisition system for carbon monoxide and sulfur dioxide operated unpredictably and did not prepare and report data as required by appropriate regulations. The deficiencies in the CEM's and data acquisition system were mostly corrected by 1990. In 1995 the original Lear Seigler insitu CEM was replaced with a state-of-the-art extractive unit manufactured by KVB Analect.

Concerning opacity, the original design of the baghouse included a poppet type bypass damper which allowed flue gas to bypass the baghouse. The bypass was designed to open during cold startup on fuel oil, but would also open when the pressure drop across the baghouse exceeded a preset value. The nature of RDF combustion results in short duration high velocity spikes. The baghouse was not adequately designed to accommodate these spikes which would raise the differential pressure across the baghouse. Depending on the severity of the pressure drop, there could be an exceedance of permitted opacity limits.

On two occasions during 1988 there was a full opening of the bypass damper which caused a release of unfiltered flue gases and flyash out of the stack. This problem was resolved by disabling the bypass damper and reprogramming the control system to ramp down the fuel feed upon an increase in baghouse differential pressure. A unique opacity trip procedure was programmed into the computer system to initiate a main fuel trip during an opacity excursion. Since these changes were implemented, there have been no exceedances of permit limits for opacity. Furthermore, the opacity trip feature has successfully prevented possible additional ash releases resulting from bag failures on at least two occasions.

Most of the excess emissions of carbon monoxide from 1987 through 1990 could be attributed to cycling of the boilers due to fuel supply problems or grate and tube failures. After completion of the modifications to the processing system and boilers, the magnitude and frequency of the excess emissions of carbon monoxide have been substantially reduced.

The excess emissions of sulfur dioxide were addressed by restricting the delivery of sulfur bearing wastes such as tires, tarpaper, and gypsumboard to the facility and by increased inspection of the incoming waste. Operational changes included fuel switching at preset emission levels, and implementation of a program to monitor lime slurry quality. This facility is now in 100% compliance to the license limits for sulfur dioxide emissions.

Stack testing results for particulates, lead, mercury and dioxins, are compared to the license limits detailed in Table 3. An overview of the facility's compliance history is contained in Table 4.

Odor Problems. From the outset, the facility experienced odor releases which would permeate the surrounding downtown area resulting in numerous complaints from local residents, businesses and town officials. Maine Energy commissioned E.C. Jordan of Portland, Maine to identify the sources of odor and noise and to recommend changes to mitigate their impact to the surrounding area. E.C. Jordan determined that the main sources of odor from the facility were:

- a. Exposed shredder explosion chambers,
- b. Ridge vent on Tipping Floor,
- c. Outdoor discharge/loading of ferrous and FEPR,
- d. Undersized process dust collection system.

As was the practice throughout the overall retrofit, the odor problem was dealt with in a systematic manner, with the most severe odor sources addressed first. The shredder explosion chambers were covered, the ridge vent capped, the loading of transfer trailers for ferrous and FEPR was relocated inside, the building penetrations were sealed, Tipping Building airlocks were installed, and the ventilation system was upgraded.

The ventilation system for the Tipping and Process Building was increased in size to supply 100% of the combustion air requirements for both boilers. By increasing the air flow drawn from the Tipping Building, sealing the various building openings and penetrations, and utilizing airlock doors for truck ingress and egress, the 70,000 sq. ft. Tipping Building is maintained under a negative pressure.

The Tipping Building airlock system consists of a vestibule at the entrance and exit of the building. Each vestibule has two doors. The first door opens automatically when a truck approaches to allow the truck to enter the vestibule. The second/inner door opens after the truck is in the vestibule and the outer door is closed. System logic prevents the simultaneous opening of both doors, thereby minimizing the flow area through which air can enter the building. The minimum flow area improves the ventilation system's ability to maintain negative pressure in the facility.

The route that the waste delivery vehicles use on the property is treated daily with a deodorant during the "odor season" which typically lasts from April through October. Additionally, waste delivery vehicles are also fogged twice with a deodorant before exiting the facility thus limiting the migration of uncontrolled odors at the source. As an added

precaution, the indoor air of the Processing and Boiler Buildings is treated with a deodorant.

From an operating perspective, the inventory of MSW and RDF is now managed on a first in, first out basis resulting in an orderly processing and combustion of waste thereby minimizing the aging of putrescibles in the waste. That is, the oldest MSW is processed first, and the oldest RDF is combusted first. In addition, a strict management policy regarding the opening of doors, and the maintenance of doors is enforced.

As a direct result of the above changes, there have been no violations of the odor agreement with the Host Cities even with the institution of a 24 hour hotline through which residents could register complaints.

Noise Problems. Numerous noise complaints were received from local residents, businessmen, and municipal officials. E.C. Jordan systematically pinpointed the sources of noise and recommended solutions. The pumps, fans, and the passage of flue gas through the ductwork resulted in pure tone conditions which served to annoy some nearby residents. The outdoor loading of FEPR and ferrous, and intermittent popping of safety valves were other sources of noise complaints.

Based on the E.C. Jordan findings, sound attenuating equipment consisting of baffles at the induced draft fan outlet, a silencer at the forced draft fan inlet, silencers on the safety valves and acoustic ducts on the Boiler House fans were installed. A structure incorporating acoustic dampening tiles was constructed around the cooling water circulation pumps, and, the FEPR and ferrous loadout was relocated inside the facility.

Following implementation of the changes listed, there have been no violations of the noise agreement with the Host Cities since 1989.

Fugitive Particulate Emissions. Occasionally, fugitive emissions of ash from the periodic cleaning of the multicyclone hoppers, and from the outside loading of ash into transfer trailers prior to disposal were experienced. These problems were resolved by installing a structure around the hoppers and by constructing a building known as the "ash loadout building" to house the ash loading operation.

The ash loadout building has a number of positive environmental effects in addition to controlling fugitive emissions. The trailers are parked in the building for several hours to dewater the ash. The trailers are then washed to prevent trackout of ash from the facility. The ash leachate and washwater is collected for reuse in the ash quench tanks, and the immediate area surrounding the building is graded to capture rainwater for makeup water to the ash quench tanks. Tanks were installed to temporarily store any excess water. A hydronic heating system, which utilizes waste heat from the plant closed cooling water system was installed to keep the Ash Loadout Building floor warm and to melt any snow accumulations in the area in front of the building where trucks maneuver. Reuse of the ash leachate and washwater has been instrumental in Maine Energy reducing wastewater generation by 90% and minimizing reliance on city water.

It is difficult to quantify compliance in the control of fugitive emissions. However, the regulatory agencies have been more than satisfied that the ash loadout building adequately controls fugitive emissions while at the same time capturing ash leachates for reuse as quench water.

ROLE OF RECYCLING/RDF TECHNOLOGY

Unlike mass burn technology, or even shred burn (PRF) technology, RDF technology requires that, prior to combustion, MSW is processed into a homogeneous fuel by removing ferrous and noncombustible materials and shredding the remaining fraction to a consistent nominal size. The RDF process achieves environmental gains over alternative MSW combustion technologies in the areas of materials recycling, pollutant emissions resulting from combustion, ash generation, and the enhanced production of steam and/or electrical power.

Many of the priority pollutants emitted from RDF combustion are generally lower than those for alternative MSW combustion technologies due to the homogeneity of the RDF and because of the nature of the front end process residue removed prior to combustion. Front end process residue consists of the putrescible food fraction, glass, some yard wastes, and dirt.

Under the Clean Air Act Amendments, major sources of potential NOx emissions located in ozone nonattainment areas must apply Reasonably Available Control Technology (RACT) for NOx control. Maine Energy hopes its study will show that the design of RDF facilities represents NOx RACT due to the removal of fuel-bound nitrogen through processing MSW into RDF, and because of the low excess air (LA) requirements.

RDF technology produces a smaller fuel size than alternative combustion technologies. The small fuel size increases the amount burned in suspension resulting in a greater carryover of particulate matter (PM) leaving the furnace. This particulate matter consists of high carbon flyash which has benefits concerning emission of mercury. A 1990 EPA report indicates that RDF units can achieve mercury emission levels less than 120 ug/dscm, while mass burn facilities can range anywhere from 10 to over 1000 ug/dscm even when equipped with the best acid gas/PM control devices.⁽¹⁾ The mercury emissions from Maine Energy measured in 1992 averaged 5.8 ug/dscm, which was the best in the EPA database.⁽²⁾

RDF, by being homogeneous as compared to MSW, produces an ash which has consistent chemical and physical properties. The ash, when measured for the characteristics of toxicity and corrosivity, is consistently below applicable regulatory limits. In addition, the ash is uniform in size, lacking large or bulky objects. These attributes make RDF ash ideal for ash reutilization programs.

(1) White, David M. and Nebel, Kristina L.; Radian Corporation. Summary of Information Related to Mercury Emission Rates and Control Technologies Applied to Municipal Waste Combustors. Prepared for the U.S. Environmental Protection Agency, Industrial Studies Branch, Office of Air Quality

Planning and Standards. Research Triangle Park, N.C., September, 1990.

- (2) Telephone conversation between Mike Mains, Maine Energy, and Walt Stevenson and Mike Johnson, U.S. Environmental Protection Agency, Office of Standards Development, September 4, 1992.

It is worthwhile to note that the materials separation aspect of RDF technology is complemented by community recycling and composting programs. These programs remove glass, aluminum, some ferrous materials, yard waste, and newspaper from the waste stream. With the exception of newspaper, removal of these items reduces wear and tear on the processing line, results in a higher fuel yield and a more uniform fuel. In turn, the more uniform fuel burns cleaner. Maine Energy encourages recycling and elects not to impose put or pay restrictions on its municipal contracts which might restrict or discourage the implementation of recycling programs.

Maine Energy works with the communities and haulers to keep certain unacceptable wastes from this facility. Unacceptable wastes include those that would have a detrimental effect on the environmental performance of the facility. Those wastes include tires, tarpaper, and drywall, or materials which pose a clear danger to the facility and its employees such as medical or hazardous wastes. To further ensure that acceptable wastes are not processed, Maine Energy has an aggressive inspection program whereby the waste is inspected when tipped, then inspected by two employees prior to processing. Rejected materials are staged separately preparatory to removal for proper disposal.

CORPORATE POLICY AND LEADERSHIP

KTI has steadfastly maintained a philosophy that good environmental performance equates to good business. Its practices revolve around a concept which can be characterized as "plan the work – work the plan".

Management has developed well structured, straightforward procedures which emphasize reliable facility operation coupled with code compliant performance. Recognizing that system availability, facility output and environmental performance are linked intrinsically, our procedures basically concentrate on establishing consistent/predictable base-line performance which minimizes upset condition occurrences.

From the outset, corporate policy has been to spare no expense in assuring good environmental performance. The original facility design included an emissions control package which featured a dry scrubber/baghouse combination. The system was installed at a premium and was considerably in advance of what was considered best available control technology (electrostatic precipitator) at the time. When early design and/or operational deficiencies were detected, the company took immediate and decisive steps to rectify the situation. This was evidenced by the fact that; 1)the original operator was dismissed and KTI Operations, Inc. assumed the

role of running the facility; 2)the front end processing system was substantially retrofitted at the Owner's cost during the late 1980's so as to facilitate nameplate throughput and higher reliability; and, 3)the boilers and attendant air emissions control systems were uniformly retooled and/or optimized so as to establish a predictable level of base-line performance.

With the facility stabilized operationally, plant management was able to systematically establish the various procedures by which the facility would function efficiently. As a result, under the current management team, the company has consistently experienced substantial improvements in facility performance. This included increases in its electrical capacity factor to 89.6 percent in 1994 from 67.9 percent in 1988, and in its RDF yield to 85 percent from 64.4 percent over the same period. Then too, facility throughput also improved from annual processing level of 165,857 tons in 1988 to a high of 227, 017 tons in 1994. All of the foregoing suggests that the "plan the work – work the plan" strategy makes good practices turn into the strong performance.

SUMMARY

As the foregoing illustrates, Maine Energy has achieved broad based operational improvements at the Facility. Increasing amounts of MSW have been delivered and processed over the last few years. The higher RDF yield and the greater Electrical Capacity Factor have significantly improved the economics of the Facility. The increase in usable RDF has lowered both the cost of processing and disposal costs. The mix of fuel inputs into the electricity generation process have also improved the Company's financial position with the increased reliance on the cheaper RDF. Unscheduled Outages have declined significantly, resulting in a large increase in the Electrical Capacity Factor.

Furthermore, the corrective measures taken to mitigate noise, odor and fugitive dust impacts to the surrounding area have greatly improved community relations with the host cities of Biddeford and Saco. The combination of source separation by the communities, inspection on the tipping floor, processing of MSW to separate and remove recyclable and noncombustible materials to produce a consistent quality RDF, and the improved availability and reliability of the Front End Processing and Steam Generation Systems have all contributed to Maine Energy Recovery Company having an excellent compliance record over the last 3 years and the lowest mercury emissions and third lowest dioxins emissions in the nation based on stack tests. In recognition of its now consistent performance at a plateau beyond regulatory compliance, Maine Energy will be a recipient of an EPA Environmental Leadership Award during 1996.

**TABLE 1
PERFORMANCE SUMMARY
YEAR ENDED DECEMBER 31**

Operational Statistics	1988 ¹	1989	1990	1991	1992	1993	1994	1995
MSW Processed (tons)	160,602	183,909	208,847	194,503	191,128	219,024	266,044	224,693
RDF Yield	64.4%	72.3%	80.4%	80.6%	83.0%	84.1%	85.0%	85.1%
Ferrous Recovery Yield ²	0.0%	0.7%	2.5%	2.0%	2.0%	2.6%	3.1%	3.04%
FEPR Yield	24.5%	20.5%	14.3%	14.9%	11.9%	10.2%	11.3%	11.2%
RDF Fuel Input	73.0%	77.6%	85.7%	76.0%	82.0%	87.3%	89.2%	92.5%
Woodchips Fuel Input	12.1%	11.0%	4.6%	17.3%	12.9%	7.7%	5.3%	2.9%
Natural Gas/Oil Fuel Input	14.9%	11.4%	9.7%	6.7%	5.1%	5.0%	5.5%	4.6%
Ash Residue Percent ³	15.3%	19.3%	23.5%	24.1%	24.9%	23.1%	24.8%	24.6%
Electrical Capacity Factor	67.9%	73.7%	78.1%	84.3%	87.6%	90.2%	89.6%	88.2%

(1) KTI assumed control of operations at the Facility as of August 18, 1988.

(2) Prior to the completion of the plant retrofit in 1991, ferrous metals were unsuitable for sale.

(3) Includes 40% moisture addition/retention through quenching

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**TABLE 2
AIR EMISSION LICENSE LIMITS**

EMISSION	LIMIT	UNITS	AVERAGING TIME
Opacity	10.00	Percent	6 Minute
Carbon Monoxide	0.400	lb/MMBtu	1 Hour
Sulfur Dioxide	0.067	lb/MMBtu	24 Hour Rolling
Nitrogen Oxides	0.476	lb/MMBtu	Unspecified
Particulates	0.020	lb/MMBtu	Unspecified
Lead	0.016	lb/MMBtu	Unspecified
Mercury	3200	Grains	24 Hour
Hydrogen Chloride	0.038	lb/MMBtu	Unspecified
VOCs	0.040	lb/MMBtu	Unspecified
PCDD	$3.3 \cdot 10^{-6}$	lb/ton RDF	Combusted
PCDF	$1.0 \cdot 10^{-6}$	lb/ton RDF	Combusted

**TABLE 3
STACK TEST RESULTS 1987 - 1992**

PARAMETER	LICENSE LIMIT	UNIT	AVERAGE MEASURED VALUE	% of Limit
Total Dioxins	$3.3 \cdot 10^{-6}$	Lb/Ton RDF	$2.9 \cdot 10^{-8}$	0.88
Total Furans	$1.0 \cdot 10^{-6}$	Lb/Ton RDF	$5.7 \cdot 10^{-8}$	5.70
Mercury	3200	g/24 hrs	47.44	1.48
Lead	0.16	Lb/MMBTU	$6.2 \cdot 10^{-5}$	0.039
Particulate	0.02	Lb/MMBTU	0.010	50.00

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**TABLE 4
COMPLIANCE HISTORY 1990 - 1994**

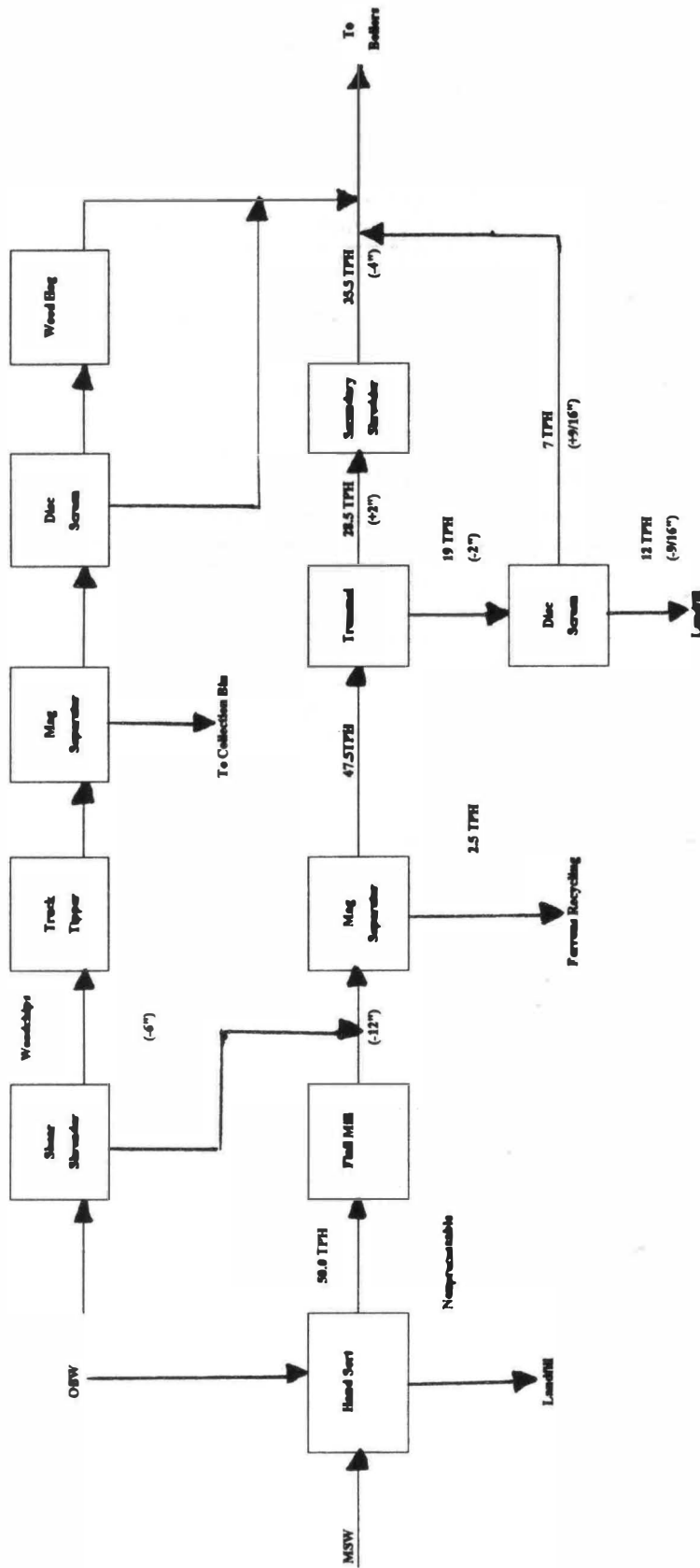
% OF TIME IN COMPLIANCE	1990 ⁽¹⁾	1991	1992	1993	1994
Air Emissions	97.95	99.22	99.39	99.59	99.45
Water Discharge	99.98	99.87	100.0	100.0	99.29 ⁽³⁾
Industrial Pretreatment	(2)	99.98	99.95	99.95	99.99

(1)State of the Art Environmental Testing Equipment installed.

(2)Substantial noncompliance for pH levels. Problem remedied with installation of pH monitor control input to discharge pump.

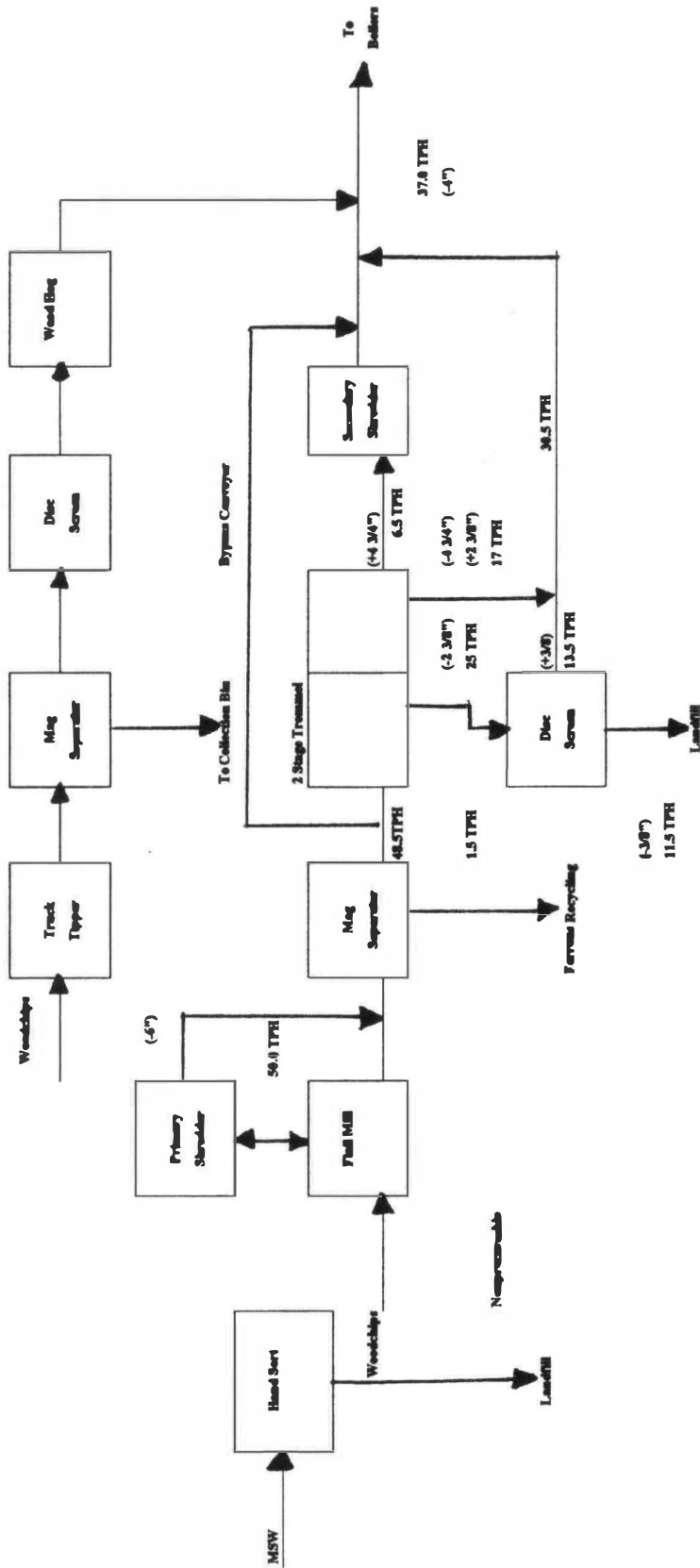
(3)Maine Energy utilizes Saco River water for a once-through cooling water system. Decrease in compliance for 1994 was due to low rainfall, resulting in high river water temperatures in the Saco (dam controlled river).

Figure 1
Original Front End Processing System



- Notes:
- 1) OBW - Overhead Bulky Waste
 - 2) MSW - Municipal Solid Waste
 - 3) TPH - Tons Per Hour
 - 4) Performance is for MSW Processing Only
 - 5) (12%) Indicates Nonmetal Material Size
 - 6) Design Yield = 35.5/56 = 71%

Figure 2
Modified Front End Processing System



Notes

- 1) MSW - Municipal Solid Waste
- 2) TPH - Tons Per Hour
- 3) Performance is for MSW Processing Only
- 4) (12") Indicates Nominal Material Size
- 5) Design Yield = 37.856 = 74%