CONVERTING A MUNICIPAL INCINERATOR PLANT TO AN ENERGY RECOVERY FACILITY

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ABSTRACT

The City of Fall River, Massachusetts Refuse Incineration Facility, although upgraded to meet air pollution control regulations, is not operating at rated capacity, and is an increasing financial burden on the City. Modification of the plant for energy recovery offers opportunities to the City for reducing refuse disposal costs. Building and site constraints, as well as complex institutional considerations, complicated the planning for the plant conversion.

INTRODUCTION

In July 1982, Fall River, Massachusetts contracted with Camp Dresser & McKee Inc. (CDM) to determine the feasibility of converting and modifying its existing incinerator plant to one which recovers heat from combustion and converts it to a useful and/or marketable form of energy.

The feasibility study included an examination and evaluation of the existing incineration plant, the amount of solid waste currently processed at the plant, a survey of solid waste available to Fall River from surrounding communities, an energy market survey concentrating on the local public electric utility, and a technical and economic evaluation of an energy recovery system.

The evaluation of the existing incinerator determined the plant’s solid waste processing capacity. Historical data on plant operation and data on the quantities of solid waste received at the plant were analyzed to determine the average daily throughput.

A survey was conducted to determine the amount of solid waste generated by communities surrounding Fall River. It included current solid waste quantities, city/town population, and method and cost of disposal when available. The survey also determined the amount of solid waste available to supplement Fall River’s supply as needed to operate the incinerator at design capacity.

The proposed utility energy user was contacted during an energy market survey that determined the revenues available for the sale of energy produced by the plant. The study examined the power and steam consumption within the Fall River incineration plant and the sale of surplus electric power to the local utility (Eastern Edison Company).

A technical evaluation and preliminary design of an energy recovery system was made based on the heat available from solid waste incineration at rated capacity. The facility site drawings were examined to determine the best location for necessary new equipment. The technical evaluation also included energy and mass balances through the proposed system.

The final step in the study was the economic analysis of the proposed energy recovery system. The analysis included an estimate of capital and annual operational costs, a review of the major financial and institutional issues associated with the implementation of the proposed system, a description of the available operating alternatives, and the economic analysis of those alternatives.

BACKGROUND

The Fall River Municipal Incinerator Plant, which was designed by Anderson-Nichols & Company, Inc., Boston, Massachusetts, commenced operation in 1972. The plant is equipped with two 300 ton/day (272 tpd) continuous feed, refractory-lined furnace, reciprocating grate, refuse burning systems.
Arrangement of the physical plant is shown in Figs. 1, 2 and 3. As shown in Fig. 2, refuse is delivered over a platform scale (right) to a tipping area (left) where it is directly dumped into an enclosed storage pit (Fig. 3). The pit area is equipped with a traveling bridge crane that delivers refuse to the charging chutes leading to the two furnaces. Each furnace has a nameplate (specified) rating of 300 TPD (272 tpd) and has a multiple-section, reciprocating grate stoker which discharges residue to a wet, dual-conveyor residue removal system. This removal system conveys quenched residue to roll-off containers for transport to landfill. Flue gases exiting the furnace pass through a wet, impingement, tray-type scrubber and induced draft fan. Both induced draft fans discharge to a common manifold which connects the inlets of four packed bed-type parallel ionizing, wet scrubbers (IWS). Another common manifold on the discharge side of the IWS units collects gases for ducting to two steel stacks. Because of existing air pollution control system limitations, the plant is capable of operation only with a single incinerator in service at any time, limiting plant throughput to 300 TPD (272 tpd).

Recorded solid waste receipts (January 1978 – June 1982) at the Fall River incinerator are plotted in Figs. 4 and 5. Figure 4 charts the solid waste disposal by city refuse trucks while Fig. 5 charts the total solid waste received from both city and private collection trucks. Current Massachusetts Air Pollution Control Regulations limit particulate emissions to 0.10 gr/dscf (230 mg/m³) (12 percent CO₂). Stack testing has shown that the plant’s emission rate complies with the regulations if three of the four IWS units are in service on a single incinerator. This limitation was assumed to be valid for analyses made in the study.

Although the plant is located among a group of industrial buildings, industrial activity in the area is low and, therefore, a reliable customer for refuse-derived steam could not be located. Because of this, the sole energy market considered (other than internal heating loads) was the local electric utility. A tie-in to the utility’s lines was considered feasible at the existing plant transformer pad.

**EXISTING PLANT OPERATIONS**

Normal plant operation consists of a single furnace operating on a four-day-per-week, 24 hour per day schedule, Monday through Thursday, with Friday and Saturday burning schedules initiated if needed. Each furnace has continuously demonstrated its ability to process 300 TPD (272 tpd). Since the units are only operated one at a time, there is always a unit off-line for maintenance, thus assuring that the units run at capacity when on-line.

Refractory maintenance is a continuous, but acceptable, expense because of the nature of this type of furnace and scheduled repair of the refractory setting.

No unusual operating problems have been reported in the areas of air supply and distribution, grate operation, temperature control, or residue discharge. A continuing program of equipment maintenance appears to be effective in keeping unscheduled outages to a minimum.

**STUDY DESCRIPTION**

There are two options for retrofitting the existing plant for energy recovery service. One is to upgrade the existing air pollution control equipment to allow operation of both furnaces and install two boiler/turbine generator systems for energy recovery. Another option is to use a single furnace and install a single boiler/turbine generator system to provide energy recovery in the near term. A second boiler/turbine generator could be added if needed, or if the air pollution control system is upgraded.
### Average Solid Waste Quantities in Tons Per Day (7 Days Per Week/5 Days Per Week)

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>74</td>
<td>64</td>
<td>91</td>
<td>90</td>
<td>92</td>
<td>97</td>
<td>81</td>
<td>74</td>
<td>83</td>
<td>84</td>
<td>83</td>
<td>74</td>
</tr>
<tr>
<td>1979</td>
<td>85</td>
<td>73</td>
<td>84</td>
<td>90</td>
<td>92</td>
<td>97</td>
<td>81</td>
<td>74</td>
<td>83</td>
<td>84</td>
<td>83</td>
<td>74</td>
</tr>
<tr>
<td>1980</td>
<td>82</td>
<td>74</td>
<td>77</td>
<td>93</td>
<td>90</td>
<td>95</td>
<td>81</td>
<td>74</td>
<td>83</td>
<td>84</td>
<td>83</td>
<td>74</td>
</tr>
<tr>
<td>1981</td>
<td>80</td>
<td>81</td>
<td>89</td>
<td>87</td>
<td>77</td>
<td>82</td>
<td>77</td>
<td>71</td>
<td>74</td>
<td>76</td>
<td>78</td>
<td>74</td>
</tr>
<tr>
<td>1982</td>
<td>71</td>
<td>71</td>
<td>89</td>
<td>84</td>
<td>84</td>
<td>84</td>
<td>84</td>
<td>78</td>
<td>84</td>
<td>84</td>
<td>84</td>
<td>66</td>
</tr>
</tbody>
</table>

**FIG. 4** City Collection Solid Waste Deliveries (1978-1982)
### Table: Average Solid Waste Quantities in Tons per Day (7 Days per Week/5 Days per Week)

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>123/173</td>
<td>125/175</td>
<td>119/168</td>
<td>120/171</td>
<td>123/173</td>
<td>140/200</td>
<td>77/109</td>
<td>100/141</td>
<td>120/171</td>
<td>115/161</td>
<td>113/162</td>
<td>55/77</td>
</tr>
</tbody>
</table>

#### FIG. 5 CITY AND PRIVATE COLLECTION SOLID WASTE DELIVERIES (1978-1982)
It was beyond the scope of the study to consider the air pollution system upgrade and dual boiler/turbine generator system installation. It was therefore assumed that any energy recovery system for the Fall River Incinerator Plant would be limited to a single boiler coupled to a single turbine generator. However, it was decided that consideration would be given during the study to layouts and space considerations which would allow simplified installation of the second boiler/turbine generator when the need arises.

The study was based on a seven-day-per-week operating schedule to supersede the current four-day-per-week operation. The plant was assumed to be operable 350 days per year with a two-week, total plant shutdown for annual preventive maintenance. Under the operation schedule, the annual plant capacity would be 105,000 tons (95,319 t) per year, i.e. (approximately) 95 percent availability. This availability is higher than usual, but is applicable to the plant when rated at 300 TPD (272 tpd) due to two, identical, redundant systems having a total capacity of 600 TPD (554 tpd).

The current capacity of the Fall River incinerator was determined along with the average solid waste quantity received at the incinerator (as shown in Figs. 4 and 5). To operate the plant at the established 300 TPD (272 tpd) (105,000 tons/year (95,319 t/year)) capacity, approximately 58,200 tpy (52,833 t/y) of solid waste are required from outside communities. Based on the five-day-per-week delivery criterion and allowing for a two-week yearly plant shutdown, it was calculated that an average of 233 TPD (212 tpd) of solid waste needed to be delivered to the plant.

To determine the solid waste available to the Fall River incinerator, a survey was conducted in surrounding communities. The study area was limited to communities in Massachusetts and Rhode Island within a 20 mile (32 km) radius of the Fall River incinerator.

Rhode Island communities west of Narragansett Bay were not included due to travel distance around the Bay. The study area was divided into five zones based on distance from the plant. Figure 6 presents a map and delineation of the study area. The study zones with their respective radial distances are as follows:

- **Zone 1** Communities within 0-5 miles (0-8 km)
- **Zone 2** Communities within 5-10 miles (8-16 km)
- **Zone 3** Communities within 10-15 miles (16-24 km)
- **Zone 4** Communities within 15-20 miles (24-32 km)
- **Zone 5** Communities over 20 miles (32 km)

Only one large community, Brockton, Massachusetts, falls in the Zone 5 division. Brockton was included in the survey due to large solid waste quantities and a relatively high disposal cost.

Each community was requested to provide the amount of solid waste generated, the disposal method used, and the cost of disposal. Populations were obtained from current census figures. In towns where direct contact could not be made, the solid waste quantity was calculated based on a waste generation rate of three pounds (1.36 kg) per day per capita on a five-day-per-week basis.

The survey showed that within the study area, approximately 614 TPD (557 tpd) are generated by Massachusetts cities or towns, and 563 TPD (511 tpd) are generated by Rhode Island cities or towns. The majority of the solid waste is currently collected and hauled to sanitary landfills. Present disposal costs in the individual communities range from a low of "free disposal" for Attleboro, Massachusetts, to a high of $21.00/ton ($23.13/t) for Newport, Rhode Island.

The proposed energy recovery system consists of a waste heat boiler (WHB), turbine generator set, dump condenser, turbine-exhaust condenser, and a deaerator and set of boiler feed pumps. The energy train was designated and sized to operate on a single-incinerator basis rated at 300 TPD (272 tpd) incineration capacity, and would be ducted and dampered so as to be able to serve either incinerator. Figure 7 illustrates a mass/energy balance diagram of the proposed energy train. Electricity produced by the system would be utilized in-plant, with excess sold to the Eastern Edison Company. During the winter months, low pressure steam may also be extracted from the turbine to supplement the heating systems of the incinerator and adjacent maintenance building.

Steam produced from the steam generation equipment would be directed to the turbine-generator set. Steam would be piped into the multi-stage turbine at 450 psig (31 bar), 550°F (288°C), and ultimately exhausted at approximately 5 inches (127 mm) of mercury backpressure to an air-cooled condenser. A portion of the steam is extracted from the turbine to the deaerator and, during the winter months, to the plant heating system. The electric generator is an AC generator which uses the mechanical energy from the turbine to produce electric power.

Based on the 300 TPD (272 tpd) rated capacity of the incinerator, and on the preliminary design data, the turbine-generator set was sized for an optimum energy output of 4.0 MW. The electricity produced would be directed to a distribution switchyard. From the switchyard the electricity produced would be used in the plant with excess power sold to the Eastern Edison Company.

Two types of condensing cooling systems were evaluated in the study:

(a) Dry, ambient air cooling and condensing within finned tubes (air-cooled condenser);
FIG. 6 SOLID WASTE AVAILABILITY SURVEY STUDY ZONES
FROM INCINERATOR OPERATING @ 300 TPD
FLUE GASES
1358°F
408,861 ACFM

WASTE HEAT
BOILER

STEAM 56,100 lb/hr
h: 1270.75 BTU/lb
P: 450 psig
T: 550°F

450°F
204,497 ACFM

TO SCRUBBER

450°F

LOW PRESSURE STEAM
TO BUILDING HEATING SYSTEM WHEN REQUIRED

FEEDWATER 57,800 lb/hr
h: 168.1 BTU/lb

BLOWDOWN
1700 lb/hr
SETTLING BASIN

EXHAUST STEAM 51,650 lb/hr

AIR COOLED
CONDENSER

TURBINE/GENERATOR
4.0 Mw

DEAERATOR STEAM
4,450 lb/hr
h: 1,180 BTU/lb

CONDENSATE 51,650 lb/hr
h: 92 BTU/lb

CONDENSATE PUMPS
2 @ 52 GPM

DEAERATOR

FEEDWATER TREATMENT

BOILER FEED PUMPS
3 @ 28,900 lb/hr
(58 GPM)

POTABLE WATER SUPPLY

BOILER MAKE-UP 1700 lb/hr

FIG. 7 PROPOSED ENERGY TRAIN MASS/ENERGY BALANCE DIAGRAM
### TABLE 1 CAPITAL COSTS (1982 DOLLARS)
AIR-COOLED CONDENSING VS. EVAPORATIVE COOLING SYSTEM

<table>
<thead>
<tr>
<th></th>
<th>Air Cooled Condensers</th>
<th>Evaporative Condensing System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$647,000</td>
<td>$307,000</td>
</tr>
</tbody>
</table>

(b) Water-cooled (shell and tube heat exchanger) condenser with circulation; water-cooled evaporatively in an outside cooling tower.

As shown in Table 1, air-cooled condensers represent a larger capital investment than the evaporative cooling system; however, they were chosen because they do not require large amounts of cooling water, which requires considerable energy for pumping. Also, cooling towers normally require more significant equipment maintenance than air-cooled condensers. Another factor is that no visible steam plume is produced, as in the evaporative system, that can cause environmental concern. This was important because of the close proximity of the plant to Route I-195, where a drift of a visible steam plume could lead to the obscured vision of drivers or to roadway icing in cold weather.

As shown in Fig. 8, 9 and 10, no significant modification to the existing incineration facility would be required for installation of the energy recovery equipment, even in the ultimate capacity, dual boiler/turbine generator configuration shown. A new building addition would be constructed over the access road between the rear of the existing plant and the Route I-195 property line. Approximately 20 ft (6.1 m) of clearance would be maintained below this structure to allow use of the existing access road for transport of residue containers. The new building addition would be enclosed with precast concrete double-tee sections which would match the existing building facade.

The existing APC equipment would remain in place except that the impingement tray scrubbers would be rotated 90 degrees to accept the boiler outlet duct connections. The new turbine generator units would be installed at either side of the existing incinerators at the operating floor level with their associated air cooled steam condensers located on the roof of the new boiler house roof. The space to be occupied by the turbine generator sets is currently unused except for incidental storage.

Table 2 presents the construction cost estimate for the single train energy recovery system.

Table 3 presents the annual operating and maintenance costs associated with operating the new equipment and also operating the plant on a seven day per week schedule. These costs are presented on a first year cost basis and are in December 1982 dollars.

### FINANCIAL AND INSTITUTIONAL ANALYSIS

An analysis was made of the major financial and institutional issues associated with implementation of the proposed project, identifying the available alternatives. Economic analyses of those alternatives were performed.

Seven alternatives, representing the various combinations of technical and/or operating options under consideration, were developed for detailed analysis:

**ALTERNATIVE NO. 1**
Representing the present day operating scenario of the plant, this alternative is without energy recovery, operating on a 5-day, 24-hr basis (4 days of combustion operation and 1 day of maintenance), with an annual throughput of 47,000 tons (42,667 t) of solid waste.

**ALTERNATIVE NO. 2**
Also representative of the present day operating scenario of the plant, except that the 4 days of combustion is to be done at full capacity. This alternative is also without energy recovery, operating on a 5-day, 24-hr basis (4 days of combustion operation and 1 day of maintenance), but with an annual throughput of 60,000 tons (54,468 t) of solid waste.

**ALTERNATIVE NO. 3**
This alternative, representing a more efficient operation of the facility on a 5 day, 24 hr basis, is a no-energy-recovery alternative, with combustion of solid wastes during all five days and the simultaneous performance of maintenance activities, at full capacity. Annual throughput with this alternative is 75,000 (68,085 t) of solid waste.

**ALTERNATIVE NO. 4**
This alternative represents 7 day, 24 hr operation of the facility, at maximum capacity, without energy recovery. Annual throughput with this alternative is 105,000 tons (93,319 t) of solid waste.

**ALTERNATIVE NO. 5**
This is the first of three energy-recovery alternatives, representing 5 day, 24 hr operation with a single boiler/turbine generator installation and an annual throughput of 60,000 tons (54,468 t) of solid waste.
<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste Heat Boiler</td>
<td>$758,000</td>
</tr>
<tr>
<td>Deaerator and Chemical Feeder</td>
<td>35,000</td>
</tr>
<tr>
<td>Breeching and Dampers</td>
<td>322,000</td>
</tr>
<tr>
<td>Ducts and Dampers</td>
<td>328,000</td>
</tr>
<tr>
<td>Boiler Feed Pumps</td>
<td>70,000</td>
</tr>
<tr>
<td>Turbine/Generator Set</td>
<td>1,791,000</td>
</tr>
<tr>
<td>Distribution Board</td>
<td>20,000</td>
</tr>
<tr>
<td>Motor Control Center</td>
<td>8,000</td>
</tr>
<tr>
<td>Air Cooled Condenser with Condensate Pumps</td>
<td>660,000</td>
</tr>
<tr>
<td>Building</td>
<td>1,090,000</td>
</tr>
<tr>
<td>Sitework</td>
<td>50,000</td>
</tr>
<tr>
<td>Eastern Edison Utility Connection</td>
<td>125,000</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>$5,257,000</strong></td>
</tr>
<tr>
<td>Allowance for Engineering, 10%</td>
<td>526,000</td>
</tr>
<tr>
<td>Allowance for Contingencies, 10%</td>
<td>526,000</td>
</tr>
<tr>
<td><strong>Total Construction Cost</strong></td>
<td><strong>$6,309,000</strong></td>
</tr>
</tbody>
</table>
TABLE 3 ANNUAL COST ESTIMATE FOR THE PROPOSED SINGLE TRAIN ENERGY RECOVERY SYSTEM

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>$306,000</td>
</tr>
<tr>
<td>Maintenance</td>
<td>251,000</td>
</tr>
<tr>
<td>Energy ($0.05 kwh)</td>
<td>208,000</td>
</tr>
<tr>
<td>Chemicals</td>
<td>13,000</td>
</tr>
<tr>
<td>Water ($0.50/1000 gal) ($0.13/1000 l)</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Total Annual Cost $779,000

ALTERNATIVE NO. 6

This alternative represents the full capacity usage of the facility on a 5 day, 24 hr basis of operation. This is an energy-recovery alternative, with two boiler/turbine generators installed and an annual throughput of 75,000 tons (68,085 t) of solid waste.

ALTERNATIVE NO. 7

This alternative represents the 7 day, 24 hr full capacity operation of the facility, with energy recovery. Annual throughput with this alternative is 105,000 tons (95,319 t) of solid waste.

It was intended, to the extent possible, to utilize tax-exempt financing for whatever capital improvements were recommended for the facility. However, due to certain requirements and limitations of the Internal Revenue Code, tax exempt financing was judged to be doubtful. Revenue bond financing, lease financing and private ownership, all common methods of financing similar resource recovery projects, were evaluated for their applicability to this project. Initially, private ownership was considered an option for evaluation, particularly due to the tax benefits that accrue to a private entity. City policy pertaining to the facility is such that the city will retain ownership of the plant, and thus, private ownership was dropped from consideration.

Only one capital financing option was investigated in detail, that of the use of insured city General Obligation (G.O.) bonds, i.e. debt service paid from the general fund. Although G.O. bonding was not initially considered to be a viable financing option, since the plant must be able to generate the required revenues to support its operation, other options were eliminated because they were considered impractical, too costly and/or too legally complex.

Table 4 presents a summary of a present worth evaluation of the seven alternatives considered, where the capital and operating costs were weighed against the energy sale credits and a first year tipping fee and present value of net costs were developed. These costs were compared as a basis for the recommendations made to the city.

The results of the analyses presented herein are obscured by the impact of the present tipping fee structure used at the City incinerator. With the present 6/10 (6 charge per ton ($6.60/t) for a private hauler within the City and $10 charge per ton ($11.00/t) for a disposer from outside the City) or a 10/10 structure, it is not cost effective to retrofit the City incinerator for energy recovery. Under the present tipping fee structure, a significant portion of the cost of disposal for those private haulers and outside disposers is being paid by the City.
<table>
<thead>
<tr>
<th>Alternative</th>
<th>Operation</th>
<th>Energy Recovery</th>
<th>First Year Tipping Fee</th>
<th>Total Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5 Day/24 Hour</td>
<td>NO</td>
<td>$38.62 (42.48)</td>
<td>$16,288,000</td>
</tr>
<tr>
<td>2</td>
<td>5 Day/24 Hour</td>
<td>NO</td>
<td>$33.81 (37.19)</td>
<td>$14,701,000</td>
</tr>
<tr>
<td>3</td>
<td>5 Day/24 Hour</td>
<td>NO</td>
<td>$28.27 (31.10)</td>
<td>$12,871,000</td>
</tr>
<tr>
<td>4</td>
<td>7 Day/24 Hour</td>
<td>NO</td>
<td>$35.15 (38.67)</td>
<td>$16,558,000</td>
</tr>
<tr>
<td>5</td>
<td>5 Day/24 Hour</td>
<td>YES</td>
<td>$55.73 (61.30)</td>
<td>$12,804,000</td>
</tr>
<tr>
<td>6</td>
<td>5 Day/24 Hour</td>
<td>YES</td>
<td>$44.01 (48.41)</td>
<td>$8,441,000</td>
</tr>
<tr>
<td>7</td>
<td>7 Day/24 Hour</td>
<td>YES</td>
<td>$52.40 (57.64)</td>
<td>$12,750,000</td>
</tr>
</tbody>
</table>
FIG. 8 CITY OF FALL RIVER ENERGY RECOVERY SYSTEM SITE PLAN

EXISTING FALL RIVER INCINERATOR

NEW ENERGY RECOVERY BUILDING ADDITION

AIR COOLED CONDENSERS (ON ROOF)

ASH DISPOSAL AREA

CHEMICAL STORAGE TANK

EXISTING CONCRETE RETAINING WALL

MAINTENANCE SHOP

TRANSFORMER ENCLOSURE

REINFORCED CONCRETE RETAINING WALL

60'
CONCLUSIONS

Based on this study, the following conclusions were reached:

(a) If a common tipping fee schedule is adopted (where all disposers share equally in the plant costs), then it is advantageous to implement an energy recovery option wherein the plant is retrofitted with a single energy recovery train and provisions made for installation of a second train at a later date if warranted.

(b) If the City of Fall River chooses not to retrofit the plant for energy recovery, the plant could operate on a more cost effective basis by retaining the present operating schedule, but acquiring additional waste for processing. If the plant is operated at full waste processing capacity, the city would enjoy significantly lower unit costs of disposal.

(c) For any retrofitting or modifications to the existing facility, the capital financing should be effected through the sale of insured City General Obligation Bonds. It was recommended that revenues generated from the plant should be isolated in a separate revenue account and should be available exclusively for the payment of debt service and operating costs associated with the plant.

ACKNOWLEDGMENT

The authors wish to acknowledge the efforts of James Fife and Richard Molongoski for their invaluable assistance during preparation of this paper; Joan Trainor, who typed the many edits and rewrites during its preparation; and John Souza, who makes it all happen at the plant.

Key Words: Boiler • Convert • Energy • Incineration • Municipality • Power Generation • Turbine