COMMERCE REFUSE-TO-ENERGY FACILITY, AN ALTERNATE TO LANDFILLING

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ABSTRACT

The development of a refuse-to-energy facility in the Los Angeles urban area is discussed. The Commerce Refuse-to-Energy Facility, under construction since March 1985, represents the application of the most advanced air emission control equipment consistent with "Best Available Control Technology" for control of particulates, acid gases, and NO_x.

INTRODUCTION

Los Angeles County is presently confronted with a mounting solid waste disposal problem similar to what is currently being experienced by many areas of the nation. Faced with existing landfills reaching capacity and increasing difficulties in siting new landfills, a solid waste management plan has been developed which addresses several alternatives. The primary emphasis of the plan is the reduction of landfilling through adoption of alternative solid waste management techniques. Landfilling will, however, continue to be an important aspect of solid waste management as the repository for materials that cannot be recycled or combusted. The combustion of refuse to generate usable energy and electrical power is one alternative which reduces dependence on landfills and converts a waste to a valuable resource, and is considered a major component of the Los Angeles County Solid Waste Management Plan.

The quantity of solid waste generated within Los Angeles County is presently 40,000 tons/day (36,300 t/d) of which 98% is landfilled. By the year 2000 the quantity is expected to increase to 45,000 tons/day (40,800 t/d). Of this, approximately 5000 tons/day (4500 t/d) could be recycled and 27,000 ton/day (24,500 t/d) could be combusted. The remaining 13,000 tons/day (11,800 t/d) of noncombustable refuse plus the 7000 tons/day (6300 t/d) of ash from the combustion process would still require landfilling. The resultant quantity, however, would be less than half the original, thus doubling the remaining landfill life.

The first step in reducing the dependence on landfilling and developing a more balanced approach to refuse disposal in Los Angeles County is the Commerce Refuse to Energy Facility which began construction in March 1985.

This paper presents a description of the Commerce Refuse to Energy Facility, the regulatory structure and applicable emissions standards which apply to the facility implementation, and the air pollution control equipment being employed to meet these regulations.

PROJECT DESCRIPTION

The facility is owned by the Commerce Refuse to Energy Authority, a California joint powers authority created pursuant to the Commerce Refuse to Energy Joint Powers Agreement between the City of Commerce (City) and the County Sanitation Districts of Los Angeles County (Districts). The facility financing included a $1,000,000 grant from the California Waste Management Board, $2,000,000 each from the City and the Districts, and the issuance of $44,175,000 of revenue bonds in November, 1984. Under the terms of the joint powers agreement, the City will provide sufficient refuse from within the City to operate the facility at design capacity and the Districts will provide construction management services and operate the facility. The revenues required to cover debt service and operating costs will be derived from the sale of electrical power to the local utility and tipping fees which are equivalent to the alternative method of disposal (landfill tipping fee plus transportation costs to the nearest landfill).

The facility will employ a conventional mass burn process to combust approximately 300 tons/day (270 t/d) of refuse. The City of Commerce has a large commercial base and a limited residential population. Less than 5% of the refuse generated in Commerce is of residential origin. This is expected to produce refuse with an average heating value of 6250 Btu/lb (14,540 kJ/kg).

Refuse vehicles will be weighed in to establish the disposal charge and then directed to an enclosed tipping area which can accommodate four vehicles. The vehicles will discharge their load into a 1200 ton (1100 t) capacity (3–4 days) storage pit. Two full capacity cranes with 5 cu yd (5.23 m^3) hydraulic grapples are provided to charge the boiler. The cranes are semiautomatic with remote operation from an enclosed pulpit next to the charging hopper. Combustion air for the boiler will be drawn from the top of the refuse storage building to eliminate the escape of odors or dust.

An area at one end of the enclosed tipping area will be used for random inspection of selected loads for hazardous or unacceptable materials. A hopper is provided at the end of the storage pit for disposal of bulky items or transfer of refuse to the landfill. The hopper, located 20 ft above grade, allows the crane operator to load open top transfer vehicles which can drive up to and through the loading area at grade level. A small hydraulic crane is provided to distribute and compact the load in the trailer.

The combustion will occur on a reciprocating grate system provided by Detroit Stoker consisting of a ram feeder and three grate sections. The charging and grate system consist of a water-cooled charging throat with cooling water from a closed loop plant cooling water system, two full capacity hydraulic drive units, and high alloy grade bars.

The single outdoor boiler is of the membrane water wall type. The boiler output is 115,000 lb/hr (52,000 kg/h) of superheated steam at 750°F/650 psig (400°C/45 atm). Design features to minimize high temperature superheater corrosion include a superheated approach temperature which is limited to 1250°F (675°C) plus the use of mechanical rappers, for superheater cleaning.

The superheated steam is used in a turbine to produce 11,400 kW gross, 10,050 kW net electrical power output. The turbine is a full condensing type with two stages of feedwater heating plus a deaerator. Cooling water is provided by a three cell cross flow cooling tower.

The air pollution control equipment consists of ammonia injection for NO_x control plus a spray dryer and fabric filter for acid gas and particulate control. This system will be covered later under a separate section.

DESIGN AND CONSTRUCTION

The facility design, utilizing a standard architectural/engineering (A/E) procurement approach, began in October, 1983, as shown in Fig. 1. The preliminary design consisted of the development of specifications for two major equipment contracts plus the initial design of the balance of the facility.

One of the contracts involved the design and construction of a "chute-to-stack" boiler package which included the furnishing and erection of the boiler, air pollution control equipment, grate system, ash handling system and stack. This specification was issued for competitive, sealed bids in January 1984. The second contract involved the design fabrication and delivery of the steam turbine, generator, condenser, and auxiliary equipment. Bids were received and a contract was awarded to Foster Wheeler for the boiler package and Sumitomo Corporation of America for a Fuji turbine.

These contracts provided for design only with actual fabrication pending completion of facility design. Utilizing the design data and drawings provided under these contracts, the balance of facility design was completed by the firm of Henningson, Durham and Richardson. The resultant plans and specifications were issued for competitive bid and a general contract was awarded to Gust K. Newberg Construction Co. in February 1985. Upon award of the general contract, Foster Wheeler and Fuji were released to begin fabrication.

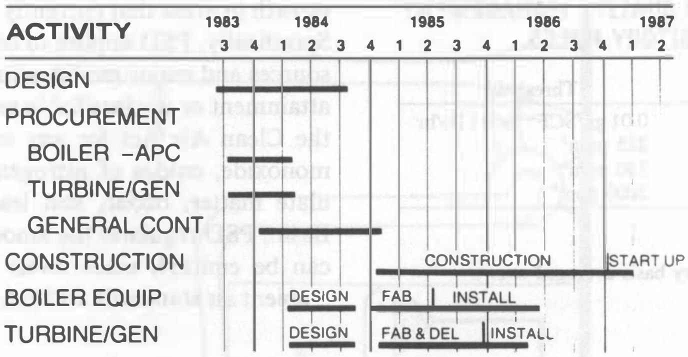

FIG. 1 DESIGN AND CONSTRUCTION SCHEDULE

Actual groundbreaking occurred in the first week of March. Significant construction milestones include the completion of the boiler support steel and start of boiler erection in late September, 1985 and delivery of the turbine in February, 1986. Construction completion is scheduled for early 1987 with full commercial operation by mid-1987.

The Districts, acting as the Authority's agent pursuant to a construction management agreement, will provide field inspection services, general construction management, and will make a determination of completeness of work for acceptance. Start-up and testing will be performed by the Districts on behalf of the Authority.

AIR POLLUTION CONTROL

The South Coast Air Quality Management District (SCAQMD) is the regulatory agency responsible for promulgating rules and issuing permits to construct and operate within the South Coast Air Basin encompassing Los Angeles, Orange, Riverside, and San Bernardino Counties. This regional agency along with the U.S. EPA and the California Air Resources Board (CARB) has regulatory control over implementation of refuse-to-energy facilities in matters related to air emissions.

All refuse-to-energy facilities exceeding approximately 50 tons/day will exceed at least one emission threshold limit and therefore will be subject to New Source Review by the SCAQMD. All facilities are required to obtain a permit for construction followed by a permit to operate from the SCAQMD.

In addition to the SCAQMD requirements, most resource recovery facilities will require a Prevention of Significant Deterioration (PSD) permit from the U.S. EPA. Since the Los Angeles basin is a nonattainment area for all but two criteria pollutants, sulfur dioxide (SO_2) and lead, PSD review is limited to these two plus noncriteria pollutants.

The California Air Resources Board is responsible for implementation and enforcement of national regulations and to insure that local districts adhere to their Air Quality Management Plan. CARB also acts as a reviewing agency in the permitting process.

EMISSION STANDARDS

The emission standards which present the greatest challenge to proponents of resource recovery projects are the requirements of the SCAQMD. These regulations exist in two separate and distinct forms—the Prohibitory Rules and New Source Review Rules.

Prohibitory Rules

The SCAQMD prohibits emissions from incinerators, power plants and other stationary sources in excess of certain limits which are generally expressed as concentrations in the exhaust gas. The more stringent of these rules applicable to most refuse-to-energy facilities are summarized in Table 1. The rules for sulfur dioxide (SO_2) and carbon monoxide (CO) are greater than values normally achieved by resource recovery facilities and, therefore, are not a factor in the permitting process. The requirement for oxides of nitrogen (NO_x) is near the lower boundary of the range of existing facility emissions and, therefore, will require special consideration to insure compliance. The limit for total suspended particulate, 0.01 gr/SCF (0.023 g/Nm^3) or 11 lb/hr (5 kg/h), is a very stringent emission

TABLE 1 SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT PROHIBITORY RULES

Pollutant	Threshold
Total suspended particulate	0.01 gr/SCF[a,b] or 11 lb/hr
Nitrogen oxides	225 ppm[b]
Sulfur dioxide	550 ppm[b]
Carbon monoxide	2000 ppm[b]

[a] Includes condensible fraction.

[b] Calculated at 3% oxygen on a dry basis averaged over a minimum of 15 min.

requirement and will require careful selection of the particulate control equipment.

New Source Review (NSR) as Established by SCAQMD

The NSR requires a preconstruction review of all new air pollution sources and proposed modifications of existing sources for facilities emitting pollutants considered to be nonattainment, and exceeding the following thresholds:

	Net Cumulative Emission (kg/d)	Net Cumulative Emission (lb/day)
Carbon monoxide	249	550
Sulfur dioxide	68	150
Nitrogen oxides	45	100
Particulate matter	63	150
Reactive organic gases (hydrocarbons)	34	75
Lead compounds	1.4	3

Facilities exceeding the NSR thresholds for nonattainment pollutants must provide Best Available Control Technology (BACT), emission offsets, and not cause a violation or make measurably worse an existing violation of any national ambient air quality standard.

Resource recovery facilities, which under State Law, produce a net of 50 MW or less of electricity, will be granted a waiver from providing the emission offsets if the project applicant makes a "good faith effort" to secure all available emission offsets to mitigate the impact of the project.

Prevention of Significant Deterioration (PSD)

The EPA PSD rule is designed to protect from degradation, air that is relatively clean while allowing growth in areas that currently meet national standards. Specifically, PSD applies to construction of new major sources and major modifications in areas designated as attainment or unclassifiable areas under Section 107 of the Clean Air Act for any criteria pollutant (carbon monoxide, oxides of nitrogen, sulfur dioxide, particulate matter, ozone, and lead). In the South Coast Basin, PSD regulates the amount of sulfur dioxide that can be emitted, since levels do not exceed national ambient air standards and are, therefore, in attainment.

AIR EMISSIONS

For the Commerce Refuse to Energy Facility the maximum allowable controlled emissions which were submitted to and accepted by the SCAQMD were based on the following:

Pollution Control Equipment	Pollutant	Removal Efficiency (Percent)
Fabric filter	Particulates	99.7
Spray dryer	Sulfur dioxide	80
	Hydrogen chloride	90
Thermal DeNO$_x$	Oxides of nitrogen	20–50

The resultant emissions were expressed in the form of pounds per hour and incorporated into the SCAQMD permit to construct and upon compliance testing will become conditions of the Permit to Operate.

Because of the project size, the applicable emission rates were less than the significant emission rates as defined for PSD review. This resulted in a request to the EPA for exemption of PSD review which was granted.

AIR POLLUTION CONTROL SYSTEM

The actual choice of control equipment is made by the project proponent in the Permit to Construct application and subject to approval by the SCAQMD. While the exact definition of BACT is still somewhat undefined, the system proposed for the Commerce Refuse to Energy Facility and by several other project proponents in Southern California and which has received acceptance by the SCAQMD is shown in Fig. 2. The system includes a fabric filter for particulate

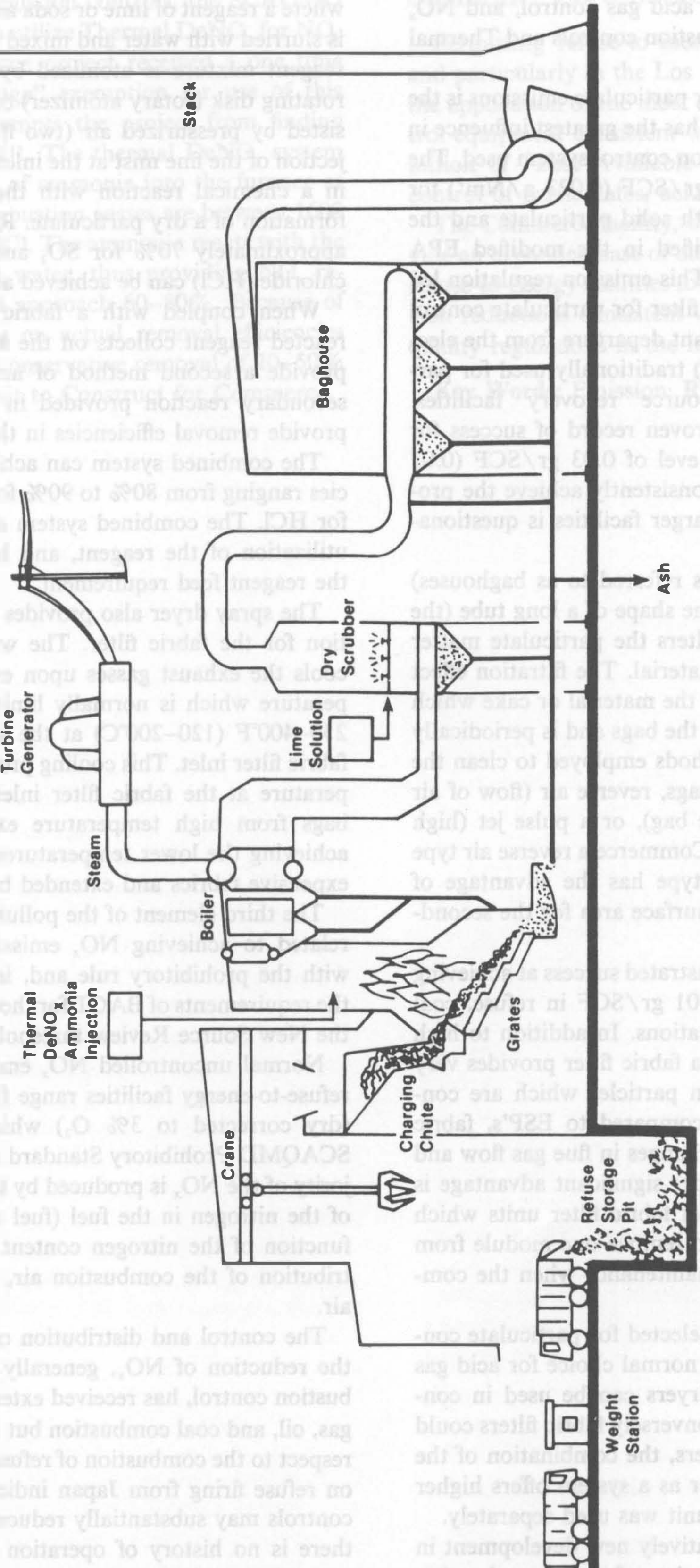

FIG. 2 COMMERCE REFUSE-TO-ENERGY PROJECT SCHEMATIC

control, a spray dryer for acid gas control, and NO_x control provided by combustion controls and Thermal $DeNO_x$.

The Prohibitory Rule for particulate emissions is the emission regulation which has the greatest influence in determining the air pollution control system used. The Prohibitory Rule of 0.01 gr/SCF (0.023 g/Nm^3) for large facilities includes both solid particulate and the condensable fraction specified in the modified EPA Method 5 test procedure. This emission regulation led to the selection of a fabric filter for particulate control which represents a significant departure from the electrostatic precipitator (ESP) traditionally used for particulate control on resource recovery facilities. Although ESP's have a proven record of success for emission reductions to a level of 0.03 gr/SCF (0.07 g/Nm^3), their ability to consistently achieve the prohibitory requirement for larger facilities is questionable.

Fabric filters (sometimes referred to as baghouses) utilize a porous fabric in the shape of a long tube (the bag) which collects and filters the particulate matter as it passes through the material. The filtration effect includes the bag itself plus the material or cake which builds up on the surface of the bags and is periodically removed. The various methods employed to clean the bags include shaking the bags, reverse air (flow of air from the clean side of the bag), or a pulse jet (high pressure pulse of air). For Commerce a reverse air type fabric was selected. This type has the advantage of providing a large filtering surface area for the secondary removal of acid gases.

Fabric filters have demonstrated success at achieving outlet concentrations of 0.01 gr/SCF in refuse, coal firing and industrial applications. In addition to high overall removal efficiency, a fabric filter provides very high removal of submicron particles which are considered respirable. When compared to ESP's, fabric filters are less sensitive to changes in flue gas flow and inlet concentrations. Another significant advantage is the modular construction of fabric filter units which provides the opportunity to remove one module from service for inspection or maintenance when the combustion unit is operating.

Once the fabric filter is selected for particulate control, the spray dryer is the normal choice for acid gas control. Although spray dryers can be used in conjunction with ESP's, and conversely fabric filters could be followed by wet scrubbers, the combination of the spray dryer and fabric filter as a system offers higher performance than if each unit was used separately.

The spray dryer is a relatively new development in acid gas control which consists of a drying chamber where a reagent of lime or soda ash (sodium carbonate) is slurried with water and mixed with the flue gas. The reagent mixture is atomized by either a high speed rotating disk (rotary atomizer) or multiple nozzles assisted by pressurized air (two fluid nozzles). The injection of the fine mist at the inlet of the reactor results in a chemical reaction with the acid gases and the formation of a dry particulate. Removal efficiencies of approximately 70% for SO_2 and 90% for hydrogen chloride (HCl) can be achieved across the spray dryer.

When coupled with a fabric filter, however, unreacted reagent collects on the surface of the bags to provide a second method of acid gas removal. The secondary reaction provided in the fabric filter can provide removal efficiencies in the range of 50–70%.

The combined system can achieve removal efficiencies ranging from 80% to 90% for SO_2 and 90 to 95% for HCl. The combined system also results in greater utilization of the reagent, and hence, a reduction in the reagent feed requirement.

The spray dryer also provides a measure of protection for the fabric filter. The water reagent mixture cools the exhaust gasses upon evaporation to a temperature which is normally limited to approximately 250–400°F (120–200°C) at the spray dryer outlet or fabric filter inlet. This cooling provides a constant temperature at the fabric filter inlet which protects the bags from high temperature excursions as well as achieving the lower temperatures which result in less expensive fabrics and extended bag life.

The third element of the pollution control system is related to achieving NO_x emissions in conformance with the prohibitory rule and, in addition, satisfying the requirements of BACT for those facilities exceeding the New Source Review threshold limits.

Normal uncontrolled NO_x emissions from existing refuse-to-energy facilities range from 150 to 300 ppm (dry corrected to 3% O_2) which compares to the SCAQMD Prohibitory Standard of 225 ppm. The majority of the NO_x is produced by the thermal oxidation of the nitrogen in the fuel (fuel nitrogen), which is a function of the nitrogen content of the fuel, the distribution of the combustion air, and the total excess air.

The control and distribution of combustion air for the reduction of NO_x, generally referred to as combustion control, has received extensive investigation in gas, oil, and coal combustion but data are limited with respect to the combustion of refuse. Test data available on refuse firing from Japan indicate that combustion controls may substantially reduce NO_x emissions, but there is no history of operation under normal commercial operating conditions.

In addition to combustion controls, the SCAQMD is requiring projects to utilize Thermal $DeNO_x$ for NO_x control. The Commerce project received a one time "Innovative Technology" exemption for use of this technology which exempts the project from finding NO_x offsets under NSR. The thermal $DeNO_x$ system involves the injection of ammonia into the furnace at a point where the combustion gasses are between 1600 and 1800°F (870–980°C). The ammonia reacts with the NO_x to form N_2 and water, thus providing NO_x reductions which could approach 60–80%. Because of the limited data base on actual removal efficiencies when firing refuse, a conservative removal of 20–50% was used in the Permit to Construct for Commerce.

SUMMARY CONCLUSION

Permitting refuse-to-energy facilities in California and particularly in the Los Angeles Basin will require the application of the most advanced air emission control equipment consistent with regulatory agency definition of "Best Available Control Technology" for control of particulates, acid gasses, and NO_x.

The Commerce facility, when completed should provide an expanded base of data on the ability of modern refuse-to-energy facilities to achieve high levels of emission reductions consistent with the most stringent air quality regulations in the nation.

Key Words: Emission; Refuse-to-Energy