Retrofitting A Spray Dryer ESP-Equipped Facility

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INTRODUCTION

During the development of the December 19, 1995 United States Environmental Protection Agency's (EPA) Emission Guidelines for Municipal Waste Combustors, much consideration was given to electrostatic precipitator (ESP) equipped facilities. The cost for replacement of well performing ESPs is prohibitive, especially if the facility is already equipped with a spray dryer absorber (SDA). EPA proposed and promulgated Emission Guidelines which were designed to allow facilities with modern well performing ESPs to comply without replacement of existing equipment.

The Essex County Resource Recovery Facility is one example of a facility equipped with a modern, well performing SDA/ESP combination. Due to actions taken by the State of New Jersey Department of Environmental Protection (DEP), the Essex County Facility has already been retrofitted and is in position to comply with the December, 1995 Emission Guidelines. This paper provides further discussion of the actions taken to retrofit the Essex County Facility and presents limited resultant emission data.

FACILITY DESCRIPTION

The Essex County Resource Recovery Facility is located in Newark, New Jersey and is owned and operated by American Ref-Fuel Company. Refer to Figure 1 for a site layout of the retrofitted facility. The facility processes approximately 2,500 tons of municipal solid waste per day. Operation began in November, 1990 with completion of performance and compliance testing in early 1991.

The facility is comprised of three independent mass-burn processing trains and two steam turbine generators. Each of the three processing trains is equipped with a Deutsche Babcock Anlagen (DBA) Roller Grate System and a four-pass boiler. The DBA Roller Grate System was designed and developed in Europe over 50 years ago and is exclusively licensed to American Ref-Fuel Company in North America.

Municipal solid waste is received on the tipping floor, where it is inspected with any unacceptable waste removed before being deposited into the 11,000 ton capacity refuse bunker. In the bunker, the refuse is mixed and usually inspected by one of two overhead refuse crane operators. The waste is stored in the bunker before being charged to one of the three boiler feed hoppers. Maintaining tight control over the waste before incineration and feeding a consistent mixture of refuse aids in good combustion and controlling emissions within state and federal requirements.

Refuse is charged to the furnace by a ram feeder located at the bottom of the feed chute. Waste slowly tumbles down the roller grates, passing through drying, combustion, and burnout zones before the remaining ash residue falls into the water filled quench tank of one of two ash extractors. Wetting the ash minimizes the potential for fugitive dust and facilitates safe handling. Ferrous metal is recovered from the facility residue stream.

Combustion is closely monitored by a Control Room Operator and is controlled by a computerized combustion system which adjusts the combustion parameters to maintain a constant boiler load and control emissions. Combustion air is provided by an under grate primary air fan and a secondary air fan.

Superheated steam is generated in the pendant superheater sections and tube bundles. An economizer section warms feedwater in the fourth pass resulting in a flue gas exit temperature of about 450-520 degrees F. Much of the ash carried with the flue gas from the furnace drops out as the gases turn between the second and third boiler pass. Superheated steam is collected in a common header from the three boilers and is routed to two 35 megawatt turbine generators. Approximately 70 megawatts of electricity are produced with 12 percent used for in-house purposes. The steam is condensed in dual air-cooled condensers.

Facility Emission Control Equipment

The flue gas passes from the furnace section through the four pass boiler. After leaving the boiler and economizer, the flue gas is split and travels through one of two precyclones and spray dryer absorbers (SDA). Part of the remaining fly ash is removed in the precyclones. Lime slurry is injected in the dual fluid nozzle SDAs to facilitate removal of acid gases. Slurry injection rate is controlled by the SDA sulfur dioxide (SO_2) level. More lime slurry is injected as the SDA inlet SO_2 increases. In order to maintain a constant outlet temperature of 300 degrees F, additional temperature control water is atomized in the SDA's.

From the dual SDA's the flue gas passes through an electrostatic precipitator (ESP), induced draft fan and is discharged through a three flue stack. The ESP has three fields which remove remaining particulate and spent lime and salts of reaction from the SDAs. The ESPs have a duct spacing of about 12 inches and a design specific collection area of 575 ft per 1000 acfm. Gas velocity is slightly greater than two feet per second and the aspect ratio is less than 1. The total projected collecting area is almost 100,000 ft.

The fly ash and spent lime are collected and treated with a WES-PHIX® phosphoric acid conditioner and water in a pugmill before being combined with the bottom ash. The combined ash stream is stored in an enclosed bunker. A clam shell overhead crane is used to load trucks within the building. A tarping station completes the ash handling area and allows for controlled fugitive ash emissions.

The facility is equipped with a continuous emission monitoring system and continuous opacity monitoring system. These systems provide the facility feedback on SO_2 concentrations and reduction, carbon monoxide (CO), nitrogen oxide (NOx) and opacity levels. This information allows rapid adjustment of the facility operation by the combustion control system and Control Room Operator to maintain in compliance.

FACILITY HISTORY

American Ref-Fuel Company of Essex County obtained an Air Permit to Construct a Municipal Solid Waste Resource Recovery Facility in December, 1985 from the New Jersey Department of Environmental Protection (NJDEP). The original air pollution control equipment included good combustion control, and a dual SDA/ESP. The dual SDA/ESP was selected based upon the recommendations of the project consulting engineer. At the time this selection was made, SDAs were not in common use. Thus, dual 60 percent capacity SDA's were selected to allow for additional redundancy and reliability. In addition, limited long term performance had been demonstrated for fabric filters (FF) and ESP's were the particulate collection device of choice for most existing waste-to-energy facilities and utility boilers.

NOx CONTROL REQUIREMENTS

The facility permit, as issued, contained numerous emission requirements. For NOx, two requirements were provided: (1) 95 pounds per hour (pph) per unit averaged over three successive test runs using USEPA Method 7; and (2) a one-hour average of not-to-exceed 300 parts per million on a dry basis corrected to seven percent oxygen (ppmdv @ 7% O_2). The 95 pph was derived by the use of an emission factor of three pounds of NOx generated per ton of MSW. Prior to completion of the facility it was confirmed through testing at American Ref-Fuel's Hempstead, New York facility that the commonly used 3 lbs/ton emission factor was in error, based upon incomplete and inaccurate information available at that time, and was not achievable.

A BACT analysis concluded that combustion controls alone were not adequate to bring the facility into compliance with the 95 lb/hr requirement and that Selective Non-Catalytic Reduction (SNCR) was the appropriate add-on control system to be employed by the facility. The evaluation process resulted in the selection of the Thermal deNOx aqueous ammonia technology offered by Exxon Corporation. After reviewing the process designed by Exxon, American Ref-Fuel purchased the technology agreement and modified the system to best fit the facility.

NOx CONTROL RETROFIT

When it was determined that an SNCR system was required, the plant was too close to its startup date to effectively implement a redesign of the boiler to allow for an integrated NOx control system. A retrofit strategy was developed by American Ref-Fuel corporate engineering to implement NOx control according to a schedule imposed by the New Jersey DEP.

Technical grade aqueous ammonia (27.4 wt %) is utilized in the Essex thermal deNOx process. Aqueous ammonia is stored onsite at atmospheric pressure in a 20,000 gallon tank and pumped to three identical vaporizer skids located in the boiler house. Steam is used to evaporate the aqueous ammonia. The ammonia vapor is mixed with steam prior to being injected into the furnace. This carrier steam aids the dispersion of the relatively small quantity of ammonia.

The ammonia vapor/steam mixture can be injected into the boiler through one of three available sets of injection nozzles located on the side walls of the upper first pass of the waterwall boiler. At each level nine nozzles are available on each side of the boiler. The nozzles vary in size and are arranged in a pattern of alternating relatively large and small nozzles at each level.

Because this project was an application of relatively new technology being applied in a retrofit manner on boilers with existing unique emission control technology, as much flexibility as possible was designed into the system to allow for variations in operation such as boiler load and fouling.

Several challenges occurred for this project. First, no provisions were made during the original boiler design for penetration at the required locations. Locating the storage tank, vaporizers and other required equipment was a challenge on the congested site. Routing of feed lines, electrical power supplies, and controls needed to conform to the existing layout. Installation was completed while the facility was operating with tie-in occurring during scheduled boiler outages.

NOx CONTROL SYSTEM OPERATION

There were no comparable systems to use to predict performance, thus questions remained regarding the potential system capability. Testing flexibility was hampered by a requirement to remain within permit limits unless a specific variance was granted by NJDEP. American Ref-Fuel wanted to maintain its clear stack and thus did not want any ammonia slip reacting with HCl to form a visible ammonia chloride (NH_4Cl) plume. Concerns were also raised and addressed concerning public and employee safety due to a potential aqueous ammonia spill. Assurances had to be made that proper programs were in place to prevent spills and control them if necessary.

Several modifications were made to the initial design. Adjustments were made to the control logics, carrier steam supply and the nozzles used for injection. Only two problems were identified during startup. The first was a metallurgy compatibility concern which was quickly addressed. Secondly, the system vaporizers were and are an ongoing concern due to significant fouling. About once a month each system must be taken off-line for cleaning. This cleaning must be carefully prepared for to allow the system to return to service and maintain compliance under NJDEP's permit requirement of a three hour rolling average.

The thermal deNOx system is controlled from the plant's distributed control system (DCS). The function of the control system is to maintain the target outlet NOx concentration by regulating the aqueous ammonia flow rate. Changing of levels or zones is completed manually. Levels are changed infrequently as the boiler conditions change.

The SNCR system was installed in late 1994 and has worked well since. Compliance with the proposed MACT emission limit and averaging time is achievable. The system is routinely achieving an NJDEP requirement of 174 ppmdv @ 7% O_2 on a 3-hour rolling average and 95 lb/hr. The outstanding concern of achieving the NJDEP NOx emission requirement on a 3-hour rolling average basis during a required outage remains as a special challenge for the facility.

MERCURY CONTROL REQUIREMENTS

In addition to the SNCR system, the facility has also been retrofitted with an activated carbon injection (CI) system. The original permit requirement for mercury emissions was 0.053 lb/hr. This value was derived from early test data at other waste-to-energy facilities which later proved to be lower than typical emission rates. Although the Essex County Facility was burdened with an artificially low mercury emission requirement, the facility was fortunate to have had mercury emissions among the lowest of any waste-to-energy facility in New Jersey before activated carbon systems were installed. While mercury had always been an emission of concern under the existing permit, aggressive measures taken by the NJDEP and the facility were successful in minimizing mercury in the waste stream and allow the facility as initially equipped to comply with its permit limits.

The Essex Facility and American Ref-Fuel worked with several efforts to remove mercury from the waste stream. Recycling programs and information were communicated to the various regional hospitals and pharmacies. These sources were assumed to be the largest consumers and dispensers of mercury batteries and hearing aid batteries. American Ref-Fuel also actively participated on a New Jersey DEP task force commissioned to address mercury emissions and establish control requirements.

The revised New Jersey mercury emission requirements for all facilities are presently 65 µg/dscm corrected to 7% O_2 or 80 percent reduction. The concentration requirement is based upon an annual average of four quarters where as the reduction requirement must be demonstrated every quarter. A further requirement will lower the allowable concentration to 28 μg/dscm or 80 percent removal in the year 2000. The new mercury regulations also required that the Essex County Facility install a system to control mercury.

MERCURY CONTROL RETROFIT

Various mercury control technologies were reviewed by all facility operators and the New Jersey DEP to determine which system granted the greatest potential for success. Any system would also need to be capable of increasing control at a future date. It was determined that this objective could best be achieved with a dry activated carbon system and the regulations therefore required that this type of system must be installed at all New Jersey facilities. Norit Americas Inc. was selected by the Essex County Facility as the vendor and design and construction proceeded as expeditiously as possible.

The Norit technology employed utilizes a dry carbon of lignite origin and injects the carbon into the flue gas ahead of the system precyclone and spray dryer absorber. The carbon is handled dry and is pneumatically conveyed to the injection points. Safety concerns of carbon powder were also considered and addressed with the facility design by installation of controls, blowout panels, fugitive dust control and operating procedures.

To provide some additional flexibility, two potential injection points were provided, upstream of the spray dryer atomizer and in the spray dryer vessel. The injection points are shown in the unit cross section in Figure 2. These points were suggested due to concerns about dropping out a significant quantity of carbon in the precyclone and for ease of installation. Early testing determined that the longer residence time and improved distribution of injecting upstream of the precyclones more than compensated for any loss of carbon in the precyclones.

Construction proceeded on a fast track to achieve the required completion date of before December 31, 1995. Several retrofit related modifications were made during this time slowing construction completion. Partially because all the facilities in New Jersey were installing systems, certain critical vendor capabilities were also in short supply.

Difficulties associated with most retrofit projects, including routing of carbon lines, power lines and controls, limited siting options and existing foundations also were incurred and addressed. As previously noted, the Essex site is very congested and locating a carbon silo and blower building was not easy. Penetrations to the existing units only involved penetrating through plate steel, however, access to the chosen injection locations is very restrictive. Work proceeded while the facility was on line.

MERCURY CONTROL SYSTEM OPERATION

Experience with carbon injection on SDA/ESP equipped facilities was very limited, consisting largely of the Warren County EPA carbon injection study. No long term reliable data was available for any similar systems. Concerns were raised over possible reduction in the particulate control performance of the ESPs. Carbon can demonstrate the ability to rapidly lose an electrical charge and thus lose its attraction with an ESP and "skip" through the ESP fields without being captured.

The activated carbon injection system installation was completed in late December, 1995 and the system has been in operation since. The ability of the facility to achieve the December, 1995 Emission Guideline requirements has been demonstrated. The NJDEP emission requirements of 65 μg/dscm corrected to 7%

O_2 or 80 percent reduction, has also been demonstrated to be achievable. Accurate measurement of carbon injection rates are completed by measuring usage on a shift basis and verifying this value on a plant-wide basis by using the truck scales and silo measurements on a monthly basis.

FACILITY PERFORMANCE

Limited emissions data is available for the retrofitted Essex County Facility. The facility has demonstrated exceptional emission results for all testing completed since the retrofits were completed. The emission results are compared to the Emission Guidelines promulgated on December 19, 1995 in Table 1 and show favorable results for all parameters impacted by the retrofit. An added benefit of the mercury control system is the excellent dioxin control achieved. If significant revisions are made to the Emission Guidelines in the process of any legal proceeding or if the interpretation or application of the Guidelines by NJDEP were to significantly revise the Guidelines for the State of New Jersey, meeting the revised requirements may be substantially more difficult. For example, if the NOx emission requirement is applied on a 3-hour rolling average as opposed to a 24-hour block basis, even though the concentration requirement is not adjusted, the emission requirement is substantially more difficult.

CONCLUSION

The Essex County Resource Recovery Facility has been retrofitted and has the emission control configuration of Good Combustion Control/SDA/ESP/SNCR/CI. This configuration is capable of achieving the emission performance requirements of the 1995 EPA Emission Guidelines. This project demonstrates that the emission requirements of the Guidelines as promulgated can be achieved by some facilities equipped with well performing ESPs.

REFERENCES

1. Pohlot, P.D., Armellino, K.E., Zapf, S., et al.; *Retrofit Thermal DeNOx Installation and Operation at a Resource Recovery Facility Equipped with a Spray Dryer/ESP;* Proceedings of 1995 Air and Waste Management Association, Solid Waste Management: Thermal Treatment and Waste-to-Energy Technologies, Washington, D.C., V1P-53; 1995.

Table 1. Essex County Emission Comparison of Selected Parameters Post-Retrofit.

Parameter	Facility Average Corrected to 7% O_2 Unit 1	Unit 2	Unit 3	December 19, 1995 Emission Guideline
Particulate, gr/dscf	0.0025	0.0010	0.0010	0.012
NOx, ppmdv	less than 180	less than 180	less than 180	200
Mercury, μg/dscm percent reduction	27 81%	22 85%	27 80%	80 or 85%
Total Dioxins①, ng/dscm	3.0	1.5	2.0	60

① Total dioxins is reported as tetra-octa polychlorinated dibenzo-p-dioxin and tetra-octa polychlorinated dibenzo furans reported on a total basis.

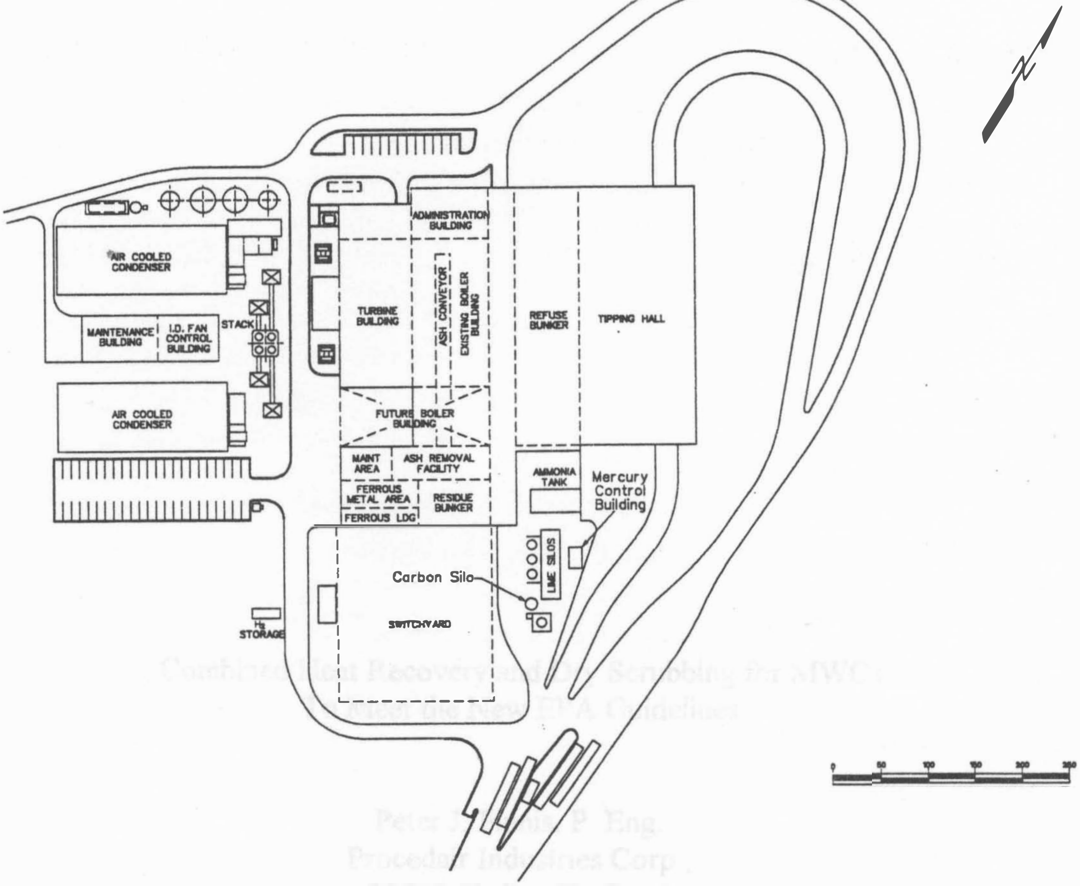

Figure 1 Essex County Resource Recovery Facility Site

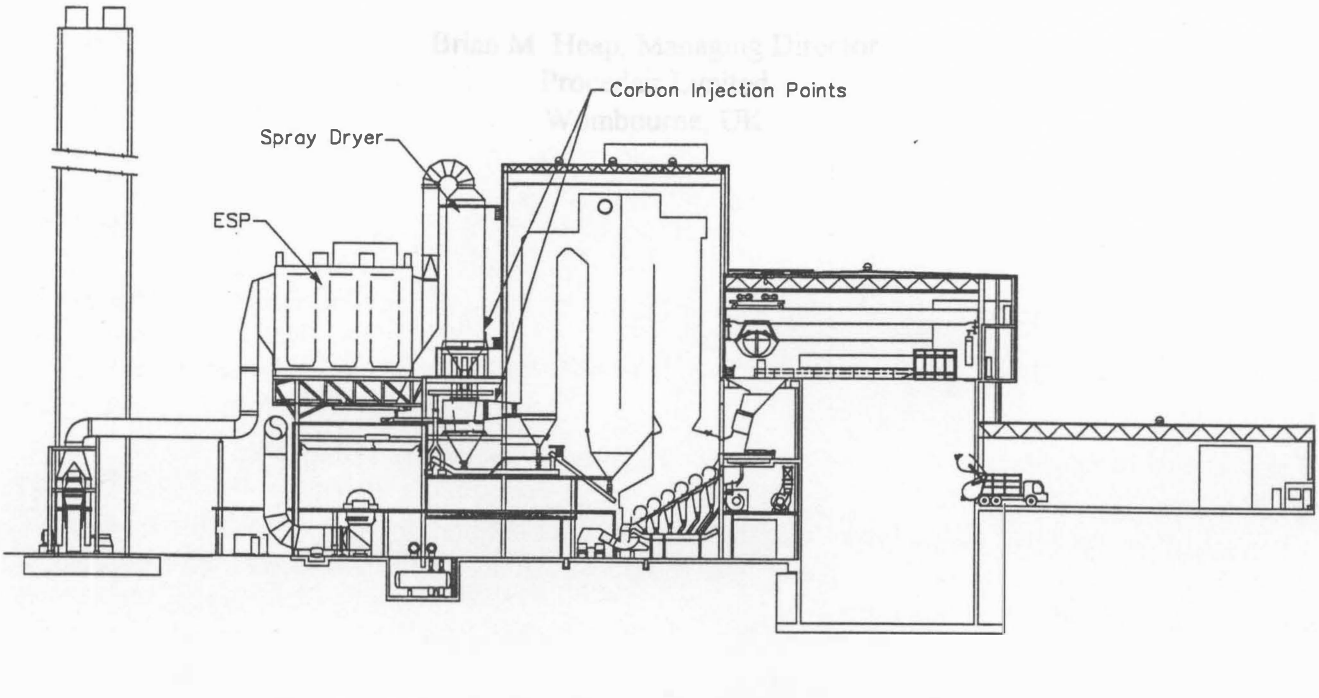

Figure 2. Essex County Resource Recovery Facility Cross-Section showing Carbon Injection Location