ADDENDUM TO
TECHNICAL EVALUATION
AND
PRELIMINARY DETERMINATION

Hillsborough County Resource Recovery Facility Unit 4
Nominal 600 Tons per Day Municipal Waste Combustor
Modification of Nitrogen Oxides Control Equipment

DEP File No. 0570261-009-AC (PSD-FL-369A)

Florida Department of Environmental Protection
Division of Air Resource Management
Bureau of Air Regulation

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(Addendum to Document issued May 24, 2006)

1. BACKGROUND

Hillsborough County (the County) owns and Covanta Energy operates the resource recovery facility (HCRRF), which is located southeast of Tampa, west of I-75, and north of the Crosstown Expressway near Branford. The existing facility consists of three municipal waste combustors (MWCs), each having a nominal design rate capacity of 400 tons per day (TPD) of municipal solid waste (MSW). The location of the Hillsborough County RRF is shown in Figure 1.

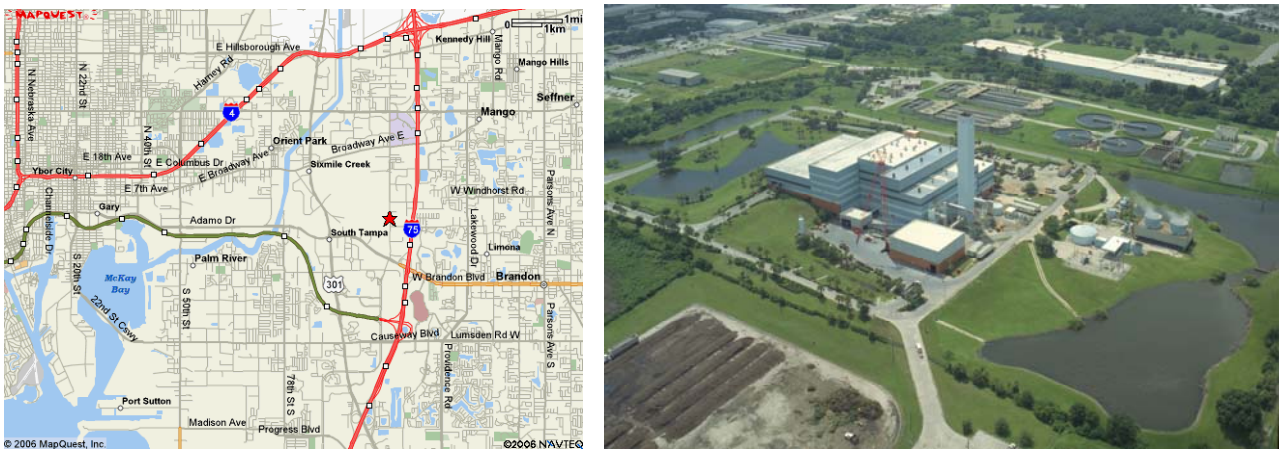

Figure 1. Location and Aerial View from Southeast of the Hillsborough County RRF

On October 3, 2006 the Department issued the Final Permit to the County to construct a nominal 600 tons per day municipal waste combustor (MWC) designated as Unit 4 at HCRRF. The permit and the associated documents including the previous Technical Evaluation and Preliminary Determination are accessible at: www.dep.state.fl.us/Air/permitting/construction/hillsborough.htm

The previously issued Technical Evaluation and Preliminary Determination (TEPD) includes an assessment of the best available control technology (BACT) for key pollutants as well as technology to comply with the requirements of 40 CFR 60, Subpart Eb - Standards of Performance for Large Municipal Waste Combustors.

The permitted emission limitations are given in the table on the following page. The equipment originally proposed by the County and approved by the Department to meet the BACT and Subpart Eb requirements or to avoid triggering a review under the Rules for the Prevention of Significant Deterioration (PSD) consists of:

- A spray dryer (SD) with lime injection to absorb MWC acid gases;
- An activated carbon injection (ACI) system to adsorb MWC organics and mercury (Hg)
- A fabric filter (FF) baghouse to remove particulate matter, including absorption/adsorption reagent
- A flue gas recirculation (FGR) system to limit NO_X formation; and
- A urea-based selective non-catalytic reduction (SNCR) system to further destroy NO_X.

Continuous emissions monitoring systems (CEMS) are required for CO, NO_X, SO_2 and Hg as well as a continuous opacity monitoring system (COMS).

Table 1. Emission Limits Applicable to Hillsborough County RRF Unit 4

Pollutant	Emission Limit	Measurement Basis	Limit Basis
NO_X	110/90 ppmvd	24-hr/12-month CEMS	BACT
CO	100/80 mg/dscm	4-hr/30-day CEMS	BACT/Eb
MWC Acid Gases (SO_2/HCl)	26/25 ppmvd*	24-hr CEMS/Stack Test	BACT/Eb
MWC Metals/PM/PM_{10}	12 mg/dscm	Stack Test	Avoid PSD
Ozone as VOC	NA	NA	NA
Sulfuric Acid Mist	NA	NA	NA
Fluorides (F)	NA	NA	NA
Lead (Pb)	140 µg/dscm	Stack Test	Subpart Eb
Mercury (Hg)	28 µg/dscm*	Quarterly Stack Test	Avoid PSD
Cadmium (Cd)	10 µg/dscm	Stack Test	Subpart Eb
MWC Organics (dioxin/furan)	13.0 ng/dscm	Stack Test	BACT/Eb
Ammonia (NH_3)	15/10 ppmv	260/195 mmBtu/hr Stack Test	PM, Opacity
Opacity	10 percent	6-minute COMS	Subpart Eb

* Alternative 85 percent removal requirement applies.

2. NEW REQUEST

On June 11, 2007 the Department received a request from the County to modify the approved equipment required to meet the BACT limitation for NO_X. The previously approved equipment consists of a FGR system and a urea-based SNCR system. The rationale for the previously selected equipment is given in Section 4.3 of the previously issued TEPD dated May 24, 2006.

The County proposes to replace the FGR requirement with a system called Low NO_X (LN^{TM}) that was recently developed and tested at other facilities by Covanta. The County also proposes to install an <u>ammonia</u> based SNCR system to be supplied by Covanta in lieu of a <u>urea</u> based SNCR system that would have been supplied by Fueltech.

With the changes, Covanta will accept responsibility for meeting the permitted emission limitation to which it did not previously agree. According to Covanta, Fueltech was not willing to guarantee the permitted NO_X limitation of 90 ppmvd on a 12-month basis. The following analysis is an update to Section 4.3 of the previously issued TEPD. Most of the write-up in the first section below was provided by Covanta. A second section includes an update prepared by the Department following further research since issuance of the earlier review.

3. NO_X Formation and Control Update

<u>Combustion Management</u>

The quantity of excess air for combustion and where it is used in a combustion process are both known to have an impact on the amount of fuel NO_X and thermal NO_X. The strategic management of the combustion process is a known method to reduce NO_X emissions.

Conventional mass burn combustion uses between 80 and 100 % excess air with the majority of this excess air being supplied as underfire air (introduced below the grate). Overfire air is typically introduced immediately above the grate to promote combustion of volatile gases. This approach provides good combustion efficiency as indicated by low carbon monoxide levels however NO_X is relatively high due to elevated fuel NO_X and thermal NO_X.

A combustion management system that uses less excess air in strategic locations can reduce both fuel NO_X and thermal NO_X. Less underfire air can promote effective conversion of carbon to volatile gases that are the source of energy for the combustion process while also minimizing the conversion of fuel nitrogen to NO_X. Chemical intermediates such as cyanide and ammonia are formed instead of NO_X. The introduction of overfire air at an elevated location can avoid the direct formation of thermal NO_X while also enabling the potential of these chemical intermediates to either convert to nitrogen or to even promote NO_X reduction.

A combustion management system that uses both mechanical components and an automated combustion control system is recognized as a technically proven NO_X management system that can reduce the amount of NO_X from the combustion process. This approach has an inherent advantage in achieving both low NO_X and NH_3 stack emissions because less reagent (urea or ammonia) is needed.

For reference, similar approaches to those described above are used in other industries such as the power and cement industries. For example, in the power industry systems are available such as reburn and separate overfire air that accomplish the objectives described above. Staged fuel and staged air combustion are practiced by cement kiln operators for the same reasons.

Covanta has developed and tested its own process that is described in Attachment A and which it proposes to install on Unit 4. The Department agrees that given the lower NO_X formation, it will be possible to use less reagent to meet the Department's NO_X BACT limit and it will also be easier to meet the NH_3 emission limits.

<u>Enhanced SNCR</u>

There are further enhancements that can allow additional reduction. These include but are not limited to:

1. Excess reagent injection and tail end scrubbing to remove or recover the excess ammonia;
2. Infrared camera and process controls in conjunction with the many injectors to optimize use of reagent with respect to three dimensional furnace temperature profile;
3. Tunable diode laser (TDL) to identify areas of excess ammonia and adjust the injectors and total reagent usage accordingly and;
4. Installation of a small amount of catalyst downstream of the furnace to further destroy NO_X and excess ammonia.

The first three enhancements were discussed in the previous TEPD. The last one was theorized in the previous document but subsequently observed in practice by Department personnel during a visit at the Brescia facility in Italy.

The Brescia facility has three mass burn units that incorporate Martin GmbH grate technology, FGR and SNCR. The operator, ASM Brescia, installed a single stage "high dust" selective catalytic reduction (SCR) system within an expanded economizer section of Brescia Unit 2 in the

first-of-its-kind demonstration. The three units are operated to achieve 80 milligrams of NO_X per dry cubic meter at 11% oxygen (mg/dscm). With the single stage SCR system in place, Unit 2 exhibits lower ammonia emissions than Units 1 and 3. Further details are given in Attachment B.

Because only a small section of catalyst is used, the Department considers the technology to be a form of enhanced SNCR rather an SCR system of the kind described elsewhere in the previous evaluation. Typically a full SCR system is installed downstream of all the other gas treatment systems following reheat of the cleaned gases. The alternative of a large multi-stage high dust SCR system is possible but has not yet been demonstrated. The Brescia single stage installation is the first step on that path.

3. Changes to Existing Permit

Only minimal changes to the previously issued permit are required. These include specification of the Covanta LN™ system in lieu of the FGR system. Although the County had specified a urea-based SNCR system, the Department had already permitted use of a urea-based or an ammonia-based system.

The County requested an increase in maximum steam capacity from 190,000 to 200,000 pounds per hour with no changes to mass or concentration based emission limits and no changes to the nominal ratings in the permit.

In response to a request for additional information, Covanta explained (by letter dated July 25 2007 to the Hillsborough County Environmental Protection Commission) that they do not expect an increase in emissions for the following reasons:

"Elimination of the FGR system and the decrease in the amount of reagent ammonia and transport water being required result in an overall decrease in the total gas flow through the combustion unit of approximately 12 percent (%). This results in an increase in furnace efficiency of approximately 5%, which in turn generates more steam while combusting the same amount of waste. Since there is no increase in the amount of fuel being consumed there is no increase in emissions being generated."

The plant has not yet been constructed and the potential to emit (PTE) of air pollutants based on the issued permit is unchanged. The explanation by Covanta provides reasonable assurance that the unit will be comply with the same limits while making more steam.

The Department will modify the permit accordingly.

4. Conclusion

The Department will modify the permit as requested by the County. According to the information provided by Covanta, the main effects of the changes in the NO_X control system are: less reagent will be utilized; less ammonia will be emitted; and more steam will be produced.

Both the Covanta LN™ system and the single stage "dusty side" SCR systems are available for consideration by applicants and agencies when conducting BACT determinations.

Overview

The Covanta LN™ process, which is patent pending, involves modifications to the combustion air system of the municipal waste combustor (MWC), combined with modifications to the combustion monitoring and controls systems, to achieve substantial reductions in NO_X formation. The Covanta LN™ process when combined with an SNCR system can achieve the lower NO_X emissions required by the PSD permit issued for Hillsborough County's Expansion Project. The Facility's existing SNCR control system will be integrated with the LN™ combustion air system controls to maximize the NO_X reduction and minimize ammonia slip.

Process Description

MWCs typically employ a moving grate with two major sources of combustion air. Primary air (also called underfire air) is supplied through plenums located under the grate, and is forced through the grate to dry and combust the waste. The quantity of primary air is typically adjusted to minimize excess air during the combustion of the waste on the grate, while maximizing burnout of carbonaceous materials in the waste bed. Secondary air (also called overfire air) is injected through nozzles located in the furnace waterwalls immediately above the grate, and provides turbulent mixing to complete the combustion process. Secondary air provides the majority of the excess air to the combustion process.

Refer to the following figure. With the Covanta LN™ process, the secondary air stream is reduced, and a tertiary air stream is introduced through a new series of nozzles, installed in the MWC furnace waterwalls at a higher elevation in the furnace. The distribution of air between the primary, secondary and tertiary streams is controlled to yield the optimal gas composition and temperature to minimize NO_X and control combustion. The control takes into account the heating value of the waste and the fouling condition of the furnace.

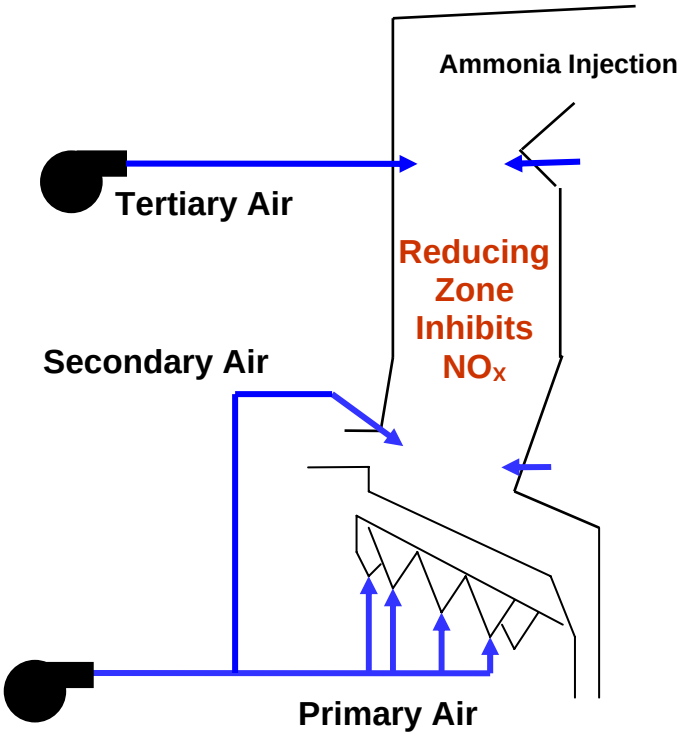

Figure A-1. Principle of Operation of the Covanta LN™ System

The combination of these combustion changes yields a slight increase in furnace efficiency (more steam per ton of MSW fired).

The design of the tertiary air nozzles and their positioning in the furnace is important to the Covanta LN™ process performance. For the Hillsborough expansion unit, the new tertiary air nozzles will be located on the right, left, and front waterwalls of the furnace. The rear waterwall could not be used without substantial modifications to the furnace design. The tertiary air achieves complete coverage of the furnace cross-section to ensure good mixing with the combustion gases. The tertiary air completes the combustion process, and yields uniform flue gas temperature and velocity profiles, which improves the performance and reliability of downstream boiler equipment.

Covanta utilizes computational fluid dynamic (CFD) modeling to determine the size and position of the new nozzles. CFD modeling is an advanced design tool based on fundamental calculations of mass and energy balances, fluid flow, and chemical reactions. Over the last decade CFD modeling has become more widespread in the energy industry, although it has primarily been applied to homogeneous fuel and gas phase systems. The complex, highly heterogeneous nature of waste combustion requires the most advanced, sophisticated modeling techniques. Covanta has been developing CFD models of MWC systems for over five years, and are the world's leader in this area.

The Covanta LN™ process will be combined with the Facility's existing aqueous ammonia SNCR system. Combining SNCR with the Covanta LN™ process yields a number of synergistic effects which enhances the performance of the SNCR system. These enhancements minimize the number of SNCR nozzles required, reduce the amount of carrier water needed with the ammonia, and reduce the amount of unreacted ammonia that exits the boiler, which is commonly called "ammonia slip." The SNCR control system will also be integrated with the LN™ combustion controls to maximize the NO_X reduction and minimize the ammonia slip.

After installation of the Covanta LN™ process equipment, field optimization of the system will be done to set up the new combustion controls and confirm the tertiary air distribution. Advanced instrumentation to measure temperatures in the furnace, view refractory condition on-line, and continuously measure ammonia slip, will be employed during the start-up optimization period.

Commercial Performance Data

The Covanta LN™ process was developed and demonstrated in two commercial installations in the U.S. At the Bristol WTE facility (in Bristol, CT), equipment was installed on one unit in April 2006 to enable testing of the Covanta LN™ technology. The Bristol unit employs a Martin grate, similar to that being designed for Hillsborough. This work was done in collaboration with Covanta's technology partners, Martin GmbH. In November 2006, one unit at the Hempstead WTE facility (in Hempstead, NY) was retrofitted with the Covanta LN™ technology. The Hempstead unit employs a 900 TPD Deutsch Babcock Anlagen (DBA) Roller Grate, which is another mass-burn technology for combusting MSW.

For the Hillsborough Expansion, Covanta proposes to install an aqueous ammonia SNCR system with the LN™ process. This is the same design approach that was tested at Bristol. Between the Bristol and Hempstead facilities, Covanta has accumulated over 1500 hours of operation with the LN™ process. At Bristol the LN™ process was extensively tested. During May, June and July of last year, the Bristol unit the LN™ process was operated for a total of 19 days.

More recently, in May 2007, the unit ran using the LN™ process for 14 days. The results of these operating periods demonstrate the system capabilities, and are summarized in the following table:

Table A-1. Bristol LN™ System Performance Summary (Average Values)

Month	Days	Steam Flow	Aqueous NH_3	NO_X	CO	NH_3 Slip
		(lb/hr)	(gph)	(ppm 7% O_2)	(ppm 7% O_2)	(ppm 7% O_2)
May 2006	4	78,000	9.3	62	24	1.2
June 2006	10	78,000	12.6	62	19	2.4
July 2006	5	74,000	8.6	72	25	1.4
May 2007	14	76,000	13.0	59	30	4.8

At Hempstead, the LN™ unit was tested in December 2006 and January 2007, and is currently operating with this process. The following table presents representative data from the Hempstead LN™ unit with the SNCR system in operation.

Table A-2. Hempstead LN™ System Performance Summary (Average Values)

Test	Steam Flow	Urea	NO_X	NH_3 Slip
	(lb/hr)	(gph)	(ppm 12% CO_2)	(ppm 12% CO_2)
1	235,000	12	90	n/a
2	235,000	15	65	n/a

The SNCR system at Hempstead uses urea as the NO_X reduction reagent. Covanta operates all types of SNCR systems, including those using aqueous ammonia, anhydrous ammonia, and urea. We have found that the type of reagent is not the major factor in the performance of the system to maximize NO_X reduction and minimize ammonia slip. The most important parameters are the location of the injection nozzles in the furnace, the design of the nozzles to ensure good mixing of the reagent with the flue gas, and the design of the control system.

In combination with the LN™ system, Covanta integrates the SNCR system design and controls to maximize mixing of the reagent with the flue gas in the optimum temperature window for NO_X reduction. Covanta is recommending the use of aqueous ammonia because it is safer than anhydrous ammonia, lower cost than a urea system, and the existing Facility already includes an aqueous ammonia system for SNCR that can be extended to the Expansion with supplemental scope.

Compliance with Existing PSD Permit Requirement

The Hillsborough Expansion Project will comply with the NO_X and NH_3 emission limits contained in the PSD permit when using the Covanta LN™ system with the balance of facility operations.

Effect on Other Regulated Pollutants

The Hillsborough Expansion Project will comply with the other emission limits contained in the PSD permit and the Covanta LN™ system will not cause an increase in the emissions of any regulated air pollutant.

The ASM Brescia Waste-to-Energy (WTE) Plant is located in the Lombardia province of Italy as shown in the following map. Brescia lies adjacent to the Venice/Milan Autostrada and is about midway between Milan and Verona as shown in the map on the left hand side of the following figure. The photograph in the middle is of the front of the plant. The one on the right hand side is of a section of the economizer where some catalyst has been installed as discussed below.

Figure B-1. Brescia, Italy. Front of ASM Brescia Plant. Single Stage SCR Section

An off-site survey of the facility was conducted on July 3, 2006. On July 4 a meeting was held with the Director of the ASM Brescia WTE Plant who provided a complete rundown of their operations, brochures, reports, and a tour.

All three units operate with SNCR systems. They have Martin moving grates, flue gas recirculation (FGR), spray dryer/fabric filters, and activated carbon injection systems. They operate each unit at approximately 80 mg NO_X/m^3 and were doing so on the day of the visit.

They have no plume issues under their present operations. The opacity was effectively zero. Any potential plume problems from achieving the relatively low NO_X values are abated by two fairly recent developments at the plant.

Firstly, they are operating at a lower HCl emission limit following Italy's implementation of certain European Union requirements. Their typical emissions are 4 mg HCl/m^3 and the limit is 10 mg/m^3.

Secondly, Unit 2 is equipped with the SNCR system in the furnace plus a thin single stage "dusty side" SCR system within the economizer section. It is only about 60 cm in depth (and ~4x13 meters cross-section). The line was originally designed for that possibility and provided for something like 5 stages of "dusty-side" SCR. They only use one stage. The most obvious benefits of this "trim" SCR system are reduction of reagent consumption and ammonia slip with minimal pressure drop.

They achieve the same 80 mg NO_X/m^3 exhaust value on all three lines. Ammonia emissions are much less for the line with the SCR piece than the ones that rely only upon SNCR to meet the same NO_X emission level.

The Brescia WTE plant demonstrates that it is possible to reduce NO_X emissions to very low values without causing detached plumes while using semi-dry pollution control equipment (spray dryer/fabric filter). Furthermore, the Brescia WTE plant demonstrates the technical feasibility of combining SNCR with a small SCR piece to achieve both low emissions and minimal ammonia slip. The plant director also provided his favorable opinions regarding the benefits of VOC and dioxin/furan destruction.