BOILER MACT REPORT

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Bagasse Boilers Should be Regulated in a Separate Subcategory under the Boiler MACT Rules Because they are a Unique Class of Boilers

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EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) is currently developing revised National Emissions Standards for Hazardous Air Pollutants (NESHAPs) for the source category of Commercial, Industrial, and Institutional Boilers and Process Heaters. The standards must include emission limits that are based on the maximum achievable control technology (MACT) applicable to this source category. These new rules will regulate many types of industrial boilers, including the bagasse boilers operated by the Florida Sugar Industry (FSI)[1]. This paper explains why (a) bagasse boilers constitute a unique class of industrial boilers, and (b) bagasse boilers should be placed in a separate subcategory under the new Boiler MACT rules.

Bagasse boilers exhibit several distinctive design, operating, and emission characteristics. These distinctive features are intrinsically linked to the bagasse fuel, which is a unique type of fuel. The key characteristics of bagasse boilers can be summarized as follows:

(a) Bagasse boilers are uniquely designed and operated to dry and burn bagasse

(b) Bagasse boilers are fully integrated with and tied to the sugar mill, electrical generators, and the other bagasse boilers at the mill

(c) The bagasse is fed directly and continuously from the sugar mill to the boilers

(d) Bagasse is a unique fuel generated by the sugar milling process, and has high moisture content, low density, large range of particle size, and other unique characteristics

When these characteristics are considered together, it is clear that bagasse boilers constitute a unique class and type of industrial boiler. Consequently, bagasse boilers should be regulated in a separate subcategory under the new Boiler MACT rules. This subcategory should not include other types or classes of boilers (e.g., boilers that burn other types of biomass or fossil fuel). The FSI proposes a regulatory definition for "bagasse boiler" as follows:

> *Bagasse boiler* means a hybrid suspension- and grate/floor-fired boiler that is uniquely designed and operated to dry and burn bagasse as its primary fuel. The steam output from the boilers is tied directly to the sugarcane grinding mills, electrical generators, and the raw sugar production process for combined heat and power generation. Bagasse boilers receive bagasse fuel directly and continuously from the sugarcane milling and grinding process. Fuel distributors specially designed for bagasse are used in conjunction with air distributors to spread the fuel material over the boiler width and depth. The drying and much of the combustion of the fuel takes place in suspension, and the combustion is completed on the grate or floor. Bagasse boilers are universally designed to have high heat release rates and high excess air rates.

[1] The Florida Sugar Industry (FSI) is comprised of sugarcane processors located in south Florida. These processors harvest sugarcane to produce raw and/or refined sugar. The FSI operates industrial boilers fired primarily by bagasse, which is a co-product of the sugarcane processing operations. Very limited amounts of fossil fuel may also be burned in the FSI's boilers. The FSI also is coordinating the submittal of this paper with sugarcane processors located in Hawaii and Texas.

Bagasse is the primary fuel that is burned in bagasse boilers at all sugar mills. Bagasse is renewable and carbon neutral. The bagasse boilers are highly integrated into the mill process, they have several unique design and operating features, and they have a characteristic emissions profile, as discussed below.

Why are bagasse boilers uniquely different from other biomass boilers?

Bagasse boilers are different from other biomass boilers because of their design, their operation, and their emissions profile. Bagasse boilers are designed differently because bagasse is a unique fuel that must be handled and combusted differently than other biomass fuels. Key characteristics of bagasse that affect the design of bagasse boilers include:

- Bagasse is a co-product of an industrial process, wherein sugarcane is crushed and washed, and water displaces sucrose within the sugarcane fiber. The industrial process alters the physical and chemical composition of the biomass.
- The bagasse goes directly and continuously from the process (mill) to the boilers for fuel.
- The geographic area in which sugarcane is grown, and the variety of sugarcane being harvested at any time, affect the composition of the bagasse, resulting in a continuously variable fuel.
- Harvesting conditions and harvesting methods affect the composition, including the moisture content of the bagasse.
- Bagasse is about 3 times less dense than wood.
- The particle size range of bagasse is much greater than the range of wood particles fired in boilers.
- Bagasse as produced and burned has a high moisture content (48 to 55 percent).
- It is very low in heavy metals, and typically only 2 percent ash.
- Bagasse is a very clean agricultural material, being composed principally of carbon, hydrogen, and oxygen (typically about 49 percent, 6 percent, and 43 percent, respectively), with 2 to 3 percent mineral ash (mostly oxides of silicon, potassium, calcium, aluminum, phosphorus, manganese, and others).
- The heavy metals content of bagasse is extremely low, as is the chlorine and sulfur content.
- Bagasse has a heating value of about 7,600 to 8,400 British thermal units per pound (Btu/lb) (dry basis) or about 3,800 to 4,200 Btu/lb as produced.

Distinctive design, operating, and emission characteristics of bagasse boilers are summarized below:

1) <u>Design</u>
   a) Dry and burn high moisture fuel while suspended in air and complete combustion of the fuel on grates or floors.
   b) Have significantly higher heat release rate than other biomass-fired boilers.
   c) Require much higher excess air rates than other boilers. The high excess air aids in drying and promotes better turbulence, but reduces residence time in the combustion zone. This drying and burning of the fuel, along with the high moisture content, result in relatively low combustion temperatures in the boilers, in spite of the high heat release rates.

d) Fully integrated with the sugar mill, and they must accommodate highly variable conditions and swings in operations.

e) Continuously fed bagasse by gravity flow into specially designed feeders to prevent clogging. Air distributors are used to spread the bagasse feed throughout the width and depth of the boiler.

2) Operation

a) Since both suspension and grate (or floor) burning occur, the temperature profile within the boiler is highly variable. As a consequence, steam production [and production of carbon monoxide (CO)] varies significantly over even short periods of time due to changing characteristics of the bagasse and the changing conditions within the boiler.

b) The bagasse feed is continuous from the mills directly into the boilers. The bagasse is both dried and burned in the same device. These processes fluctuate with the feed rate and moisture content of the bagasse as it is produced in the mills – there is no intermediate storage (typically) or fuel blending, so weather conditions during the cane harvest and operation of the mill directly and immediately impacts fuel quality and the operation of the boilers.

c) Bagasse boilers operate at relatively low temperatures and high excess air rates, and both directly affect the emissions profile.

3) Emissions

a) The emissions from bagasse boilers are clearly different from other biomass boilers, especially with respect to particulate matter (PM) and CO.

b) Because bagasse is such a clean biomass, it has very low emissions of heavy metals, mercury, hydrogen chloride (HCl), and sulfur dioxide (SO_2).

c) Because bagasse boilers burn a wet biomass at relatively low temperatures and high excess air rates, they produce higher CO and PM emissions compared to other biomass boilers. Additionally, the CO is highly variable due to the operating design and fuel characteristics described above.

d) Because the bagasse boilers operate at relatively low temperatures, they emit very little nitrogen oxides (NO_x).

Bagasse boilers are unique devices by virtue of their design and operation as well as the fuel they burn. Placing bagasse boilers in a category with other boilers with different design, operating, and emission characteristics would not be appropriate, and would result in unachievable MACT emission limits. Therefore, the FSI respectfully requests a separate subcategory for bagasse boilers under the new MACT rules.

2/14/2011

U.S. Sugar Industry Facts

State:	Units	Total	Florida	Hawaii	Louisiana	Texas
Sugarcane Industry						
# of Bagasse Boilers		108	19	3	81	5
Area of Sugarcane Harvested	acres	850,000	384,000	35,000	391,000	40,000
Sugarcane Processed	tons	32,041,197	15,000,000	1,449,197	14,000,000	1,592,000
Raw Sugar Produced	tons	3,571,777	1,766,000	171,777	1,450,000	184,000
No. of Employees		25,985	10,000	800	15,000	185
Direct + Indirect Jobs		87,300	50,000	2,300	27,000	8,000
Economic Impact	$ Billion	5.4	3.1	0.15	2.0	0.17
Sugarbeet Industry						
Raw Sugar Produced	tons	4,225,000	--	--	--	--
Total U.S. Sugar Industry						
Raw Sugar Produced	tons	7,796,777	--	--	--	--

Notes:
2008/09 Gilmore Sugar Manual, Sugar Publications, 2009.
* Unlike other areas, Hawaii sugarcane grows for two years before harvest, with about half the total acres under cultivation being harvested each year.
There are currently 35,000 acres under cultivation for sugarcane in Hawaii. In 2010, 15,488 acres were harvested in Hawaii.
Production data from Hawaii are for year 2010.