

**TO:** Keith Barnett, U.S. EPA

**CC:** Michael Laney, RTI International

**FROM:** Mark Bahner

**DATE:** March 3, 2008

**SUBJECT:** Emission Testing Results

RTI has obtained and analyzed the results of emission testing at cement kilns, to support development of revisions to the cement kiln New Source Performance Standards (NSPS). The goal of this was to obtain criteria pollutant (i.e., carbon monoxide, or CO; nitrogen oxides, or NO<sub>x</sub>; sulfur dioxide, or SO<sub>2</sub>; particulate, or PM; particulate matter under 10 micrometers, or PM<sub>10</sub>) emission test results for kilns that have been installed or significantly modified since 1996. The emission testing results are also compared to permit limits for the kilns. As will be discussed later in this memorandum, the effort to obtain further emission testing and continuous emission monitoring (CEM) data is ongoing. Further memoranda will be generated as additional data are obtained and analyzed.

Emission test results can be reported in many formats, e.g. as a mass emission rate (lb/hr or tpy), as a concentration (ppm or gr/dscf), or as an emission factor (lb/ton of feed, or lb/ton of clinker produced). In order to facilitate comparisons between plants, this memorandum limits emission test report results to those presented in lb/ton of clinker or lb/ton of feed. In fact, the final analysis converts all values to lb/ton of clinker, using the plant-specific conversions, except where noted. (Typically, a value of value of 1.65 tons of feed per ton of clinker can be used to convert between the emission factors. However, the Florida Department of Environmental Protection, or DEP, provided values per ton of feed and per ton of clinker for all plants, based on plant-specific conversions. Therefore, this memorandum has those Florida DEP values for all Florida plants.)

RTI obtained emission test results for criteria pollutants from several states. The most extensive set of emission test results came from the Florida DEP, which provided a spreadsheet containing 567 records of emission test results for criteria and other pollutants (e.g. sulfuric acid mist, and dioxins/furans). These 567 records represented the average result of each emission test (i.e., each emission test typically involves three runs; the average result from the three runs is what was reported in the spreadsheet from the Florida DEP). RTI sorted this list of records according to pollutant, and selected the pollutants of interest (approximately 489 records), removed tests conducted prior to 1997 (leaving approximately 351 records), removed tests conducted at inactive facilities (leaving approximately 304 records), removed tests that were reported in units other than

lb/ton of clinker or lb/ton of feed (leaving 248 records), and removed only single tests. The resulting dataset contained 217 records.

The results of an analysis of the dataset of 217 records are summarized in Table 1. The first column in Table 1 contains the criteria pollutant (e.g., CO, NO<sub>x</sub>, PM, etc.). The next columns contain the plant name and location, state, and kiln number. Note that there has been an important change in ownership of several kilns in Florida. In late 2007, CEMEX purchased Rinker (which had previously purchased Florida Crushed Stone). Table 1 reflects the results of both these purchases, with the old plant names in parenthesis.

The next two columns of Table 1 contain permit values: the first column contains limits from the permit values spreadsheet submitted by the Florida DEP, and the second column contains values that were given as the permit limit in the test results spreadsheet submitted by the Florida DEP. Note that, in some cases, values are different; typically, this means the permit limit was changed over the years of testing. The units for the permit value are given in the next column (i.e., lb/ton of clinker, or lb/ton of feed).

The three columns to the right of the “units” column are the average, minimum, and maximum values from the emission records for that pollutant, plant, and kiln. The column after that contains the number of tests (e.g., 12 tests for CO at Cemex Brooksville, FL, Kiln #1). Again, these values represent tests, not single runs.

The three columns to the right of the “number of tests” column compare the test results to the allowable value given on the permits spreadsheet (i.e., not the testing spreadsheet) sent by the Florida DEP. For example, the permit allowable for CO for the Cemex Brooksville, FL, Kiln #1 is 1.2 lb/ton of feed. The average, minimum, and maximum of the 11 tests were 0.721 lb/ton of feed, 0.360 lb/ton of feed, and 1.14 lb/ton of feed, respectively. Therefore, the average test value was 0.60 (i.e., 0.721/1.2) times the permit allowable. Similar fractions can be calculated for the minimum and maximum test results, and the resulting fractions were 0.30 and 0.95.

In order to compare the results across different plants more easily than in Table 1, it's possible to convert all the test results in units of lb/ton of clinker produced (rather than lb/ton of clinker for some, and lb/ton of feed for others). This step is performed in Table 2, using plant-specific conversion factors from the Florida DEP permit limits spreadsheet. For example, the Cemex Brooksville, FL, Kiln #1 permit allowable value for CO converts from 1.2 lb/ton of feed to 2.0 lb/ton of clinker.

The following comments will address the results presented in Table 2 for each individual pollutant. Note that all values in Table 2 are in lb/ton of clinker produced (from the Florida permit values spreadsheet).

CO – Permit values range from approximately 2.0 to 3.3 lb/ton. Average test values ranged from approximately 50 to 70 percent of permitted values.

NO<sub>x</sub> – The average test values for Cemex Brooksville Kiln 1 and Florida Rock Newberry are 2.05 lb/ton and 2.01 lb/ton, respectively. Note that none of the plants in Table 2 has a permit allowable below 2.0 lb/ton (e.g., 1.95 lb/ton), although the two CEMEX Brooksville (North) kilns are permitted at 2.0 lb/ton. That's because several kilns permitted at 1.95 lb/ton are near completion in Florida, but haven't begun operation. RTI will continue to attempt to obtain and analyze emission testing and CEM data for kilns thought to be operating at less than 2.0 lb/ton for NO<sub>x</sub>. For example, we have obtained extensive NO<sub>x</sub> CEM data for the CEMEX plant in Santa Cruz, CA, and are analyzing and summarizing them. Also, we have NO<sub>x</sub> CEM data for the Suwannee American Cement Company plant in Branford, FL, which is operating with NO<sub>x</sub> emissions at or below 2.0 lb/ton.

PM – The NESHAP value for PM from new kilns is 0.30 lb/ton of feed (i.e., approximately 0.50 lb/ton of clinker). Several of the plants are permitted well below 0.50 lb/ton of clinker (e.g., two at 0.30 lb/ton of clinker, and one at 0.25 lb/ton of clinker). All the kilns easily meet their permit limits for PM, with the average value as a fraction of the permit limit being approximately 0.2 (i.e., the plants are running at approximately a factor of 5 below their PM permit limits).

SO<sub>2</sub> – All of the plants have SO<sub>2</sub> permit values of approximately 0.20 lb/ton, except for Florida Crushed Stone (in Brooksville), which has a permit value of 0.66 lb/ton. All the plants with values of 0.20 lb/ton easily meet their permit limits for SO<sub>2</sub>, with the average values as a fraction of the permit value being below 0.10 (i.e. less than 10 percent of the permit limit). These kilns have very low-sulfur feed materials.

Table 1. Comparison of Permit Values with Emission Test Results for Florida Kilns (lb/ton feed or lb/ton clinker)

Pollutant	Facility <sup>1</sup>	City	State	Kiln	Kiln Type	Permit Value (permit page)	Permit Value (test page)	Units	Test Avg	Test Min	Test Max	Number of Tests	Fraction of Permit Value		
													Test Avg	Test Min	Test Max
CO	Suwannee American Cement	Branford	FL	Kiln 1	C	3.34	3.60	lb/ton clinker	1.71	1.52	2.04	3	0.51	0.46	0.61
CO	CEMEX Miami (Rinker)	Miami	FL	Kiln 1	C	2.81	3.01/2.81	lb/ton clinker	1.74	1.25	1.79	5	0.62	0.44	0.64
CO	Florida Rock Industries	Newberry	FL	Kiln 1 <sup>2</sup>	C	2.50	2.50	lb/ton clinker	1.8	1.14	2.82	12	0.72	0.46	1.13
CO	CEMEX Brooksville-North	Brooksville	FL	Kiln 1	PH	1.2	1.2	lb/ton feed	0.721	0.360	1.14	11	0.60	0.30	0.95
CO	CEMEX Brooksville-North	Brooksville	FL	Kiln 2	PH	1.2	1.2	lb/ton feed	0.81	0.43	1.18	13	0.68	0.36	0.98
NOx	Suwannee American Cement	Branford	FL	Kiln 1	C	2.9 <sup>3</sup>	2.9	lb/ton clinker	2.34	2.07	2.52	3	0.81	0.71	0.87
NOx	Florida Rock Industries	Newberry	FL	Kiln 1 <sup>2</sup>	C	2.45	2.8/2.45	lb/ton clinker	2.01	1.22	2.30	6	0.82	0.50	0.94
NOx	CEMEX Brooksville - South (Rinker/Florida Crushed Stone)	Brooksville	FL	Kiln 1 <sup>2</sup>	PH	2.9	2.9	lb/ton feed	2.16	1.51	2.9	15	0.74	0.52	1.00
NOx	CEMEX Brooksville - North	Brooksville	FL	Kiln 1	PH	1.83 <sup>3</sup>	1.83 <sup>3</sup>	lb/ton feed	1.24	0.86	1.77	11	0.68	0.47	0.97
NOx	CEMEX Brooksville - North	Brooksville	FL	Kiln 2	PH	1.72 <sup>3</sup>	1.72 <sup>3</sup>	lb/ton feed	1.40	0.76	2.21	13	0.81	0.44	1.28
PM	CEMEX Miami (Rinker)	Miami	FL	Kiln 1	C	0.152	0.2/0.142	lb/ton feed	0.027	0.010	0.043	2	0.17	0.07	0.28
PM	Florida Rock Industries	Newberry	FL	Kiln 1 <sup>2</sup>	C	0.22	0.20/0.23	lb/ton feed	0.035	0.009	0.060	11	0.16	0.04	0.27
PM	CEMEX Brooksville - South (Rinker/Florida Crushed Stone)	Brooksville	FL	Kiln 1 <sup>2</sup>	PH	0.40	0.4	lb/ton feed	0.145	0.018	0.319	19	0.36	0.04	0.80
PM	CEMEX Brooksville - North	Brooksville	FL	Kiln 1	PH	0.18	0.18	lb/ton feed	0.054	0.009	0.093	12	0.30	0.05	0.51
PM	CEMEX Brooksville - North	Brooksville	FL	Kiln 2+	PH	0.18	0.18	lb/ton feed	0.054	0.020	0.086	12	0.30	0.11	0.48
SO <sub>2</sub>	Suwannee American Cement	Branford	FL	Kiln 1	C	0.20	0.2/0.27	lb/ton clinker	0.017	0.013	0.020	4	0.08	0.07	0.10
SO <sub>2</sub>	Florida Rock Industries	Newberry	FL	Kiln 1 <sup>2</sup>	C	0.16	0.28/0.16	lb/ton clinker	0.015	0.002	0.030	4	0.09	0.01	0.19
SO <sub>2</sub>	CEMEX Brooksville - North	Brooksville	FL	Kiln 1	PH	0.10	0.10	lb/ton feed	0.009	0.001	0.023	11	0.09	0.01	0.23
SO <sub>2</sub>	CEMEX Brooksville - North	Brooksville	FL	Kiln 2	PH	0.10	0.10	lb/ton feed	0.013	0.004	0.035	13	0.13	0.04	0.35
SO <sub>2</sub>	CEMEX Brooksville - South (Rinker/Florida Crushed Stone)	Brooksville	FL	Kiln 1 <sup>2</sup>	PH	0.60	0.60	lb/ton feed	0.184	0.009	0.599	15	0.31	0.01	1.00
VOC	Suwannee American Cement	Branford	FL	Kiln 1	C	0.12	0.12	lb/ton clinker	0.043	0.040	0.049	3	0.36	0.33	0.41
VOC	CEMEX Miami (Rinker)	Miami	FL	Kiln 1	C	0.12	0.12	lb/ton clinker	0.097	0.080	0.120	9	0.81	0.67	1.00
VOC	Florida Rock Industries	Newberry	FL	Kiln 1	C	0.11	0.12/0.11	lb/ton clinker	0.067	0.001	0.094	8	0.61	0.01	0.85
VOC	CEMEX Brooksville - North	Brooksville	FL	Kiln 2	PH	0.09	0.09	lb/ton feed	0.052	0.018	0.086	2	0.58	0.20	0.96

Table 1 notes: See following page.

Notes for Table 1:

- 1 Facility names reflect the April 2007 purchase of Rinker/Florida Crushed Stone by CEMEX. Former facility names are in parenthesis.
- 2 Includes kiln and clinker cooler emissions (through a common stack).
- 3 Although not reflected in the Florida DEP spreadsheets for permit limits or test results, the NO<sub>x</sub> permit levels for Kiln #1 and #2 at the CEMEX Brooksville - North plant were reduced to 1.21 lb/ton of dry preheater feed (2.0 lb/ton of clinker), in conjunction with installation of SNCR systems on both kilns. See “Indirect Firing/SNCR System Kiln #1 and #2,” at: <http://www.dep.state.fl.us/air/permitting/construction/cemex.htm>. (Specifically at: <http://www.dep.state.fl.us/air/permitting/construction/cemex/026FinalPermit.pdf>.)
- 4 The CEMEX Brooksville – North plant had NO<sub>x</sub> testing conducted in September 2007. The result for Kiln #1 was 0.859 lb/ton of feed (or 1.43 lb/ton of clinker). The result for Kiln #2 was 0.759 lb/ton of feed (or 1.27 lb/ton of clinker). Both these values are reflected in the “Test Min” column of Table 1 (i.e., they were the lowest values in the data set for those kilns).
- 5 Kiln #1 at Suwannee American Cement in Branford, FL, has a NO<sub>x</sub> permit limit of 2.9 lb/ton of clinker on a 24-hr basis, and a limit of 2.4 lb/ton of clinker as a 30-day average.

Table 2. Comparison of Permit Values with Emission Test Results for Florida Kilns (all values in lb/ton clinker)

Pollutant	Facility <sup>1</sup>	City	State	Kiln	Kiln Type	Permit Value (permit page)	Permit Value (test page)	Units	Test Avg	Test Min	Test Max	Number of Tests	Fraction of Permit Value		
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CO	Suwannee American Cement	Branford	FL	Kiln 1	C	3.34	3.60	lb/ton clinker	1.71	1.52	2.04	3	0.51	0.46	0.61
CO	CEMEX Miami (Rinker)	Miami	FL	Kiln 1	C	2.81	3.01/2.81	lb/ton clinker	1.74	1.25	1.79	5	0.62	0.44	0.64
CO	Florida Rock Industries	Newberry	FL	Kiln 1 <sup>2</sup>	C	2.50	2.50	lb/ton clinker	1.80	1.14	2.82	12	0.72	0.46	1.13
CO	CEMEX Brooksville-North	Brooksville	FL	Kiln 1	PH	2.0	2.0	lb/ton clinker	1.20	0.60	1.90	11	0.60	0.30	0.95
CO	CEMEX Brooksville-North	Brooksville	FL	Kiln 2	PH	2.0	2.0	lb/ton clinker	1.35	0.72	1.97	13	0.68	0.36	0.98
NOx	Suwannee American Cement	Branford	FL	Kiln 1	C	2.9 <sup>5</sup>	2.9 <sup>5</sup>	lb/ton clinker	2.34	2.07	2.52	3	0.81	0.71	0.87
NOx	Florida Rock Industries	Newberry	FL	Kiln 1 <sup>2</sup>	C	2.45	2.8/2.45	lb/ton clinker	2.01	1.22	2.30	6	0.82	0.50	0.94
NOx	CEMEX Brooksville - South (Rinker/Florida Crushed Stone)	Brooksville	FL	Kiln 1 <sup>2</sup>	PH	4.32	4.32	lb/ton clinker	3.22	2.25	4.32	15	0.74	0.52	1.00
NOx	CEMEX Brooksville - North	Brooksville	FL	Kiln 1	PH	3.05 <sup>3</sup>	3.05 <sup>3</sup>	lb/ton clinker	2.07	1.43	2.95	11	0.68	0.47	0.97
NOx	CEMEX Brooksville - North	Brooksville	FL	Kiln 2	PH	2.87 <sup>3</sup>	2.87 <sup>3</sup>	lb/ton clinker	2.34	1.27	3.69	13	0.81	0.44	1.28
PM	CEMEX Miami (Rinker)	Miami	FL	Kiln 1	C	0.25	0.33/0.23	lb/ton clinker	0.044	0.016	0.071	2	0.17	0.07	0.28
PM	Florida Rock Industries	Newberry	FL	Kiln 1 <sup>2</sup>	C	0.37	0.34/0.39	lb/ton clinker	0.059	0.015	0.101	11	0.16	0.04	0.27
PM	CEMEX Brooksville - South (Rinker/Florida Crushed Stone)	Brooksville	FL	Kiln 1 <sup>2</sup>	PH	0.60	0.60	lb/ton clinker	0.218	0.026	0.479	19	0.36	0.04	0.80
PM	CEMEX Brooksville - North	Brooksville	FL	Kiln 1	PH	0.30	0.30	lb/ton clinker	0.090	0.015	0.154	12	0.30	0.05	0.51
PM	CEMEX Brooksville - North	Brooksville	FL	Kiln 2+	PH	0.30	0.30	lb/ton clinker	0.091	0.033	0.143	12	0.30	0.11	0.48
SO2	Suwannee American Cement	Branford	FL	Kiln 1	C	0.20	0.2/0.27	lb/ton clinker	0.017	0.013	0.020	4	0.08	0.07	0.10
SO2	Florida Rock Industries	Newberry	FL	Kiln 1 <sup>2</sup>	C	0.16	0.28/0.16	lb/ton clinker	0.015	0.002	0.030	4	0.09	0.01	0.19
SO2	CEMEX Brooksville - North	Brooksville	FL	Kiln 1	PH	0.17	0.17	lb/ton clinker	0.016	0.001	0.040	11	0.09	0.01	0.23
SO2	CEMEX Brooksville - North	Brooksville	FL	Kiln 2	PH	0.17	0.17	lb/ton clinker	0.022	0.007	0.060	13	0.13	0.04	0.35
SO2	CEMEX Brooksville - South (Rinker/Florida Crushed Stone)	Brooksville	FL	Kiln 1 <sup>2</sup>	PH	0.9	0.9	lb/ton clinker	0.275	0.013	0.899	15	0.31	0.01	1.00
VOC	Suwannee American Cement	Branford	FL	Kiln 1	C	0.12	0.12	lb/ton clinker	0.043	0.040	0.049	3	0.36	0.33	0.41
VOC	CEMEX Miami (Rinker)	Miami	FL	Kiln 1	C	0.12	0.12	lb/ton clinker	0.097	0.080	0.120	9	0.81	0.67	1.00
VOC	Florida Rock Industries	Newberry	FL	Kiln 1	C	0.11	0.12/0.11	lb/ton clinker	0.067	0.001	0.094	8	0.61	0.01	0.85
VOC	CEMEX Brooksville - North	Brooksville	FL	Kiln 2	PH	0.15	0.15	lb/ton clinker	0.087	0.030	0.143	2	0.58	0.20	0.96

Table 2 notes: See following page.

Notes for Table 2:

- 1 Facility names reflect the April 2007 purchase of Rinker/Florida Crushed Stone by CEMEX. Former facility names are in parenthesis.
- 2 Includes kiln and clinker cooler emissions (through a common stack).
- 3 Although not reflected in the Florida DEP spreadsheets for permit limits or test results, the NO<sub>x</sub> permit levels for Kiln #1 and #2 at the CEMEX Brooksville - North plant were reduced to 1.21 lb/ton of dry preheater feed (2.0 lb/ton of clinker), in conjunction with installation of SNCR systems on both kilns. See “Indirect Firing/SNCR System Kiln #1 and #2,” at: <http://www.dep.state.fl.us/air/permitting/construction/cemex.htm>. (Specifically at: <http://www.dep.state.fl.us/air/permitting/construction/cemex/026FinalPermit.pdf>.)
- 4 The CEMEX Brooksville – North plant had NO<sub>x</sub> testing conducted in September 2007. The result for Kiln #1 was 0.859 lb/ton of feed (or 1.43 lb/ton of clinker). The result for Kiln #2 was 0.759 lb/ton of feed (or 1.27 lb/ton of clinker). Both these values are reflected in the “Test Min” column of Table 1 (i.e., they were the lowest values in the data set for those kilns).
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