INFORMATION IN SUPPORT OF PERMIT AMENDMENTS

CEMEX USA, INC.
Brooksville Cement Plant
Hernando County, Florida

March 12, 2003
521-02-10

KOOGLER & ASSOCIATES
ENVIRONMENTAL SERVICES
4014 NW THIRTEENTH STREET
GAINESVILLE, FLORIDA 32609
352/377-5822 ▪ FAX/377-7158

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ENVIRONMENTAL SERVICES
4014 NW THIRTEENTH STREET
GAINESVILLE, FLORIDA 32609
352/377-5822 • FAX/377-7158

521-02-10
March 12, 2003

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BUREAU OF AIR REGULATION

Mr. A. A. Linero, P.E. Administrator
New Source Review Section
Florida Department of Environmental Protection
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Subject: ***CEMEX Cement, Inc.***
Brooksville Cement Plant
Hernando County, Florida
Application for Air Construction Permit to Amend Permit Conditions

Dear Al:

This letter is in response to your letter of December 12, 2002, to Mr. Charles E. Walz, Plant and Environmental Manager of the CEMEX Brooksville Cement Plant. Your letter addressed a permit application from CEMEX Cement, Inc. (CEMEX) received by the Department on November 21, 2002, requesting three changes to the No. 1 and No. 2 Kiln Systems. These were:

- Adding waste tires as a supplemental fuel for Kiln No. 2,
- Substituting an annual preheater feed limit in place of the presently permitted 30-day rolling average preheater feed limit on both kilns, and
- Adding petroleum coke (petcoke) as an alternative fuel for Kiln Nos. 1 and 2.

This letter serves two purposes. First, it transmits an Air Construction Permit application addressing only two amendments:

- Adding waste tires as a supplemental fuel for Kiln No. 2, and
- Substituting an annual preheater feed limit in place of the presently permitted 30-day rolling average preheater feed limit on both kilns.

At the present time, CEMEX is withdrawing its request to use petcoke as an alternative fuel in Kiln Nos. 1 and 2. This matter is still a priority to CEMEX, however, it will be addressed as a separate permitting matter.

The second purpose of this letter is to provide the additional information requested in your letter of December 12, 2002 , related to the use of tires as a supplemental fuel and the annual preheater feed limit.

GENERAL INFORMATION

Your letter of December 12, 2002, includes a request for general information not specifically related to the use of Whole Tire Derived Fuel (WTDF) or to the annual preheater feed limit. This general information is provided in this section.

Annual Hours of Operation and Annual Preheater Feed

The annual hours of operation for each kiln and the total annual preheater feed to each kiln for the past five calendar years were requested. While not provided at this time, this information is readily available in Annual Operating Reports (AORs). However, neither the annual operating hours of either kiln nor the total annual preheater feed to either kiln will be affected by the two requested amendments. This being the case, the requested information does not appear to be relevant and is not provided. If this is not the case, CEMEX will gladly provide the information related to annual hours of operation and annual preheater feed.

Fate of Recycled Cement Kiln Dust

Information in Attachment 1 describes the fate of recycled kiln dust and includes a flow diagram showing how this dust is handled.

The kiln dust re-circulation systems are the same for both kilns. The dust is normally returned to the kiln feed bin where it mixes with raw feed from the blend silo. From the kiln feed bin, the raw feed and re-circulated kiln dust enter the POLDOS which pneumatically transfers the material to the preheater.

Alternatively, the recycled dust is returned to the blend silo where it is mixed with raw feed from the raw mill. From the blend silo, the raw feed and recycled dust enter the kiln feed bin, pass through the POLDOS and are introduced to the preheater.

In either case, the recycled kiln dust is a fraction of the total measured preheater feed. The use of WTDF (the ash and steel content thereof) will have no impact on the measured preheater feed.

TIRE DERIVED FUEL IN KILN NO. 2

CEMEX is requesting authorization to use WTDF as a supplemental fuel in the No. 2 Kiln System. It is requesting that up to 20% of the heat input to Kiln No. 2 be in the form of WTDF; the same as presently permitted for Kiln No. 1. This section addresses the effect of WTDF on potential kiln emissions and the handling and feed of WTDF.

Effect of WTDF on Emissions

It is the opinion of CEMEX that the use of up to 20% WTDF in Kiln No. 2 will not effect emissions from the kiln, will not effect kiln operations and will not effect clinker quality. This opinion is based on tests conducted on Kiln No. 1 under baseline (100% coal) and coal/WTDF firing conditions in May and June, 1993, and on approximately nine years of experience in burning WTDF in Kiln No. 1. The 1993 tests were the basis for FDEP authorizing the use of WTDF to replace up to 20% of the heat input to Kiln No. 1. The 1993 Test Reports were provided to the Department, including a report entitled, *Comparison of Particulate Matter, Sulfur Dioxide, Total Hydrocarbons, Carbon Monoxide, Nitrogen Oxides, Hydrogen Chloride, Spaciated Volatile Organics, Metals and Dioxins/Furans Emission Measurements and Opacity of Emissions Under Baseline and Coal/TDF Firing Conditions, Kiln No. 1, May-June, 1993.* A copy of this latter report is included as Attachment 2. The conclusion of this report was:

> *"Based on the comparison of emission data and operating data collected during the baseline period (100 percent coal firing) on May 4-5, 1993 and during the coal/TDF period on June 8-9, 1993, it can be concluded that the use of TDF to provide up to 20 percent of the heat input to Kiln No. 1 has no effect on emissions, operations or clinker quality." [Emphasis added.]*

Prior to the CEMEX (f/k/a Florida Mining and Materials) tests in 1993, baseline (100% coal) and coal/WTDF emission tests were conducted at the Florida Crushed Stone Plant (FCS) located just southeast of the CEMEX Plant. The purpose of the FCS testing was also to support a request to FDEP for the use of WTDF as a supplemental fuel in their cement kiln.

As with the CEMEX tests, the FCS tests demonstrated that the use of WTDF had no impact on emissions from, or operations of, the kiln. Summaries of three FCS Test Reports, previously provided to the Department, are included as Attachment 3.

In addition to the baseline and WTDF emission tests conducted at the CEMEX Plant and at Florida Crushed Stone, similar tests were conducted at the Rinker Cement Plant in Miami, Florida. These tests were conducted in 1993 when Rinker was operating wet-process kilns. The Rinker data, while not summarized herein, were submitted to the Department in support of a request by Rinker to use WTDF as a supplemental fuel in their cement kilns. The Rinker data, like the CEMEX and FCS data, showed that the use of WTDF as a supplemental fuel had no impact on emissions or kiln operations.

The test data generated at CEMEX, and by FCS and Rinker, all resulted in FDEP-issued permit amendments authorizing the use of WTDF as a supplemental fuel. None of the amended permits required changes in permitted emission limits to accommodate the use of WTDF.

In October, 1997, EPA published a document entitled *"Air Emissions from Scrap Tire Combustion,* EPA-600-R-97-115, USEPA Office of Research and Development, Washington, DC. This report summarizes the results of pilot plant testing on a rotary kiln combuster and emission data from 19 utility boilers, two cement kilns and one lime kiln while using TDF as a supplemental fuel. In this report, EPA states:

> *"Based on the results of the (rotary kiln combuster) test program, it can be concluded that, with the exception of zinc emissions, potential emissions from TDF are not expected to be very much different than from other conventional fossil fuel..."*
>
> *"Test data, from (19 boilers, 2 cement kiln and one lime kiln)...indicate that properly designed existing solid fuel combusters can supplement their normal fuels, which typically consist of coal, wood, coke and various combinations thereof, with 10 to 20% TDF and still satisfy environmental compliance emissions limits."*

EPA further states:

> *"Data from the analyses did not indicate that (semi-volatile organic compounds) were present in detectible concentrations. ...concludes that when TDF is combusted in a well-designed and well-operated facility, emissions of (semi-volatile organic compounds) are not significantly different from natural gas.*
>
> *"(dioxins/furans) were collected during two test conditions: 0% TDF and 17% TDF (steady state). No (dioxins/furans) were detected in either test."*

Regarding the data from the two cement plants, EPA states:

> *"The combination of long residence time and high temperature make cement kilns an ideal environment for TDF. Emissions (from cement plants) are not adversely affected (by TDF) compared to baseline fuels and often represent an improvement."*

A copy of sections of the EPA report is included in Attachment 4.

Based on the aforementioned testing and reports, and the operating experience at CEMEX, FCS and Rinker, two new grass roots Portland cement plants (Florida Rock Industries and Suwannee American Cement) and one modernized cement plant (Rinker) were permitted in Florida to burn WTDF as a supplemental fuel with the same emission limiting standards as for

100% coal firing. During the development of these three permits, there was never a discussion of differences in emissions resulting from the use of WTDF.

The Department has previously concluded, and all data (that generated within Florida and that from published EPA and other reports) support the fact that the use of WTDF in a well controlled and operated combustion unit, will have no effect on emissions. This same conclusion should apply to the CEMEX request to use WTDF as a supplemental fuel in Kiln No. 2.

The Effect of WTDF on Mercury and Vanadium Emissions

The use of WTDF to provide up to 20% of the heat input to Kiln No. 2 is not expected to have any impact on potential mercury or vanadium emissions from the kiln.

Data from the 1993 tests at the CEMEX Brooksville Cement Plant previously referenced (Attachment 2) show a typical mercury content for coal of 0.10-0.18 ppm and a typical mercury content for WTDF of 0.04 ppm. This fact alone would suggest that mercury emissions will decrease if WTDF is used as a fuel supplement. (No vanadium analyses were conducted on the coal or WTDF during this test program.)

The emission measurements made at the CEMEX Brooksville Cement Plant in 1993 and measurements made at the FCS Plant in 1990 (Attachment 3) both show a decrease in mercury emissions when WTDF was used as a fuel supplement. The data from the FCS tests further demonstrate that there was no change in vanadium emissions as a result of using WTDF.

Based on these data, CEMEX has concluded that the use of WTDF will have no adverse impact on mercury or vanadium emissions.

WTDF Handling and Feed

CEMEX has received FDEP Permit No. 71066-001-WT for a waste tire facility at their Brooksville Cement Plant. The permit requires that all waste tires be stored and handled in accordance with Rules 62-711.530 and 540, F.A.C. The permit further limits the facility to the storage of 240 tons of waste tires at any one time. A copy of this permit can be provided if necessary.

The waste tires will be received and stored on site in enclosed trailers; each containing approximately 12 tons of tires. At a loading of 12 tons of waste tires per trailer, no more than 20 trailers will be on site at any one time. At the maximum requested feed rate of 60 mmBTU per hour (20 percent of 300 mmBTU per hour), the WTDF feed rate to each kiln will be approximately 2.15 tons of WTDF per hour. The maximum on site storage of waste tires will be sufficient to fire one kiln for approximately 110 hours, or the two kilns for approximately 55 hours, assuming both kilns are firing WTDF at the maximum permitted rate.

The handling and feed of WTDF to Kiln No. 2 will be the same as at the CEMEX Clinchfield, Georgia plant. Photographs and drawings included in Attachment 5 detail this process.

The tires will be received on site in enclosed semi-trailers and stored in these trailers until used. The trailers will be emptied by a tilting truck dump and the tires will discharge in to a receiving bin. The receiving bin has a moving floor which advances the tires to a singulator. The singulator feeds the tires one-at-a-time at a controlled rate, onto a series of ground-level conveyor belts. These belts deliver the tires to a vertical elevator which transfers the tires to the base of the preheater/top of the kiln feed shelf. Here the tires will be dropped onto a short horizontal conveyor which delivers the tires one-at-a-time at a controlled rate to the double airlock feed system.

The double airlock feeder introduces the tires into the kiln system and onto the feed shelf. The tires travel down the feed shelf with the raw feed into the rotary kiln where they are combusted. The point of WTDF feed as just described is identical to where WTDF is fed into the Kiln No. 1 system.

As previously discussed, and documented by test and operating data, the introduction of WTDF as just described to provide up to 20% of the heat input to a preheater kiln has no effect on emissions from the kiln, on kiln operations, or on clinker quality.

The Department requested information on oxygen and carbon monoxide levels at all points in the kiln and preheater tower during the feed of WTDF. The relevant fact is that test data demonstrated that neither carbon monoxide emissions nor any other emissions from the kiln will increase as a result of using WTDF to provide up to 20% of the heat input to the kiln and these data have been provided. The other relevant factors are that the use of WTDF will not adversely effect kiln operations or clinker quality.

Effect of WTDF on Kiln Operations

In your December 12, 2002 letter, information is requested on the fate of steel in waste tires and the ash content of the dry solids fuels (coal and WTDF) with respect to existing and proposed preheater feed limits. These issues will be addressed in this section.

Steel in Tires - A typical analysis of WTDF includes:

Weight	20 pounds per tire (typical)
Ash	8.5 percent (excluding steel)
Steel	10.0 percent
Mercury	0.04 ppm
Heating Value	13,950 BTU/pound (including steel)

At a maximum requested WTDF feed rate of 60 mmBTU per hour (20% of 300 mmBTU per hour), the mass feed rate of WTDF will be approximately 2.15 tons per hour; or approximately 215 tires per hour. This will result in approximately 430 pounds per hour of steel being introduced to the kiln along with the raw feed. The steel will constitute approximately 0.14 percent of the preheater feed at the average preheater feed rate of 150 tons per hour. All of this steel (iron) will be incorporated in the clinker produced in the kiln. The addition of this iron source will require a slight adjustment (reduction) in the amount of iron (mill scale) blended into the raw materials entering the raw mill.

Ash Content of Fuels - The ash content of WTDF is approximately 8.5% while the ash content of coal of approximately 10.6%. If WTDF supplies 20% of the heat input to the kiln system, the difference in the ash contents of coal and WTDF will result in approximately 150 lbs per hour less ash (when WTDF is fired). This difference represents approximately 0.05 % of the preheater feed; and insignificant and immeasurable difference.

PREHEATER FEED LIMIT FOR KILN NO. 1 AND KILN NO. 2

Presently, Kiln No. 1 and Kiln No. 2 are permitted for maximum hourly preheater feed rates of 165 tons per hour and 30-day rolling day average feed rates of 150 tons per hour (rates to each kiln). CEMEX is requesting that the maximum hourly feed rates of 165 tons per hour be retained and that the 30-day rolling average feed rates of 150 tons per hour be replaced by an annual average feed rate of 150 tons per hour or more practically, a total annual preheater feed of 1,314,000 tons (150 tph x 8760 hr/yr).

This requested amendment will have no effect on short term (1-24 hour) or annual emissions from either kiln or on annual production.

The requested total annual preheater feed limit is no different than annualized permit limits in other permits issued by the Department. Examples include, but are not limited to:

- the Suwannee American Cement permit which limits preheater feed to an hour rate (178 tph) and to an annual rate (1,427,880 typ),

- the Florida Rock Cement permit which limits the clinker production to peak hourly and daily rates (115 tph and 110.2 tph) and to an annual rate (800,000 tpy),

- PCS Phosphates permits for X-train, B and D phosphoric acid, C and D superphosphoric acid and acid clarification, all of which contain maximum hourly and annual rates,

- IMC Phosphates South Pierce and New Wales permits for auxiliary boilers, sulfur handling systems and Multifos kiln A, B and C permits, all of which contain maximum hourly and annual rates,

- Louis Dreyfus Citrus and Duda Citrus Belle permits for citrus peel dryers, both of which contain maximum hourly and annual rates for peel processing,
- the 10-25 ton per year emission limits for Hazardous Air Pollutants (HAPs) included in many Department issued air construction and air operating permits, and
- annual limits on fuel use and production in non-Title V facility construction and operating permits for asphalt plants.

It is quite apparent that the Department has established a precedent for establishing maximum hourly and annual permit limits for both processing rates and emission rates. CEMEX is requesting that this same permitting philosophy be applied to the preheater feed rates for Kiln No. 1 and Kiln No. 2.

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Neither of the changes requested by CEMEX are modifications as defined by Rule. Department Rule 62-210.200(169), F.A.C., defines modification as:

> *"Any physical change in, change in the method of operation of, or additions to a facility which would result in an increase in actual emissions..."*

The request to use WTDF in Kiln No. 2 will result in a physical change, but not an increase in emissions. The request to change the preheater feed limits will not result in a physical change, a change in the method of operations (including a change in hours of operation or production), an addition to the facility or an increase in emissions. As a result, I see no reason why the requested change cannot be granted.

I appreciate your review and consideration of these requested changes. If there are questions regarding any of the information provided herein, or if additional information is required, please do not hesitate to contact me at 352-377-5822 or jkoogler@kooglerassociates.com.

Sincerely,

KOOGLER & ASSOCIATES

John B. Koogler, Ph.D., P.E.

JBK/jhm

cc: Dan Heintz, CEMEX, Houston
Roy Schorsch, CEMEX, Houston
Amarjit Gill, CEMEX, Houston
Randy Walser, CEMEX, Brooksville
Charles Walz, CEMEX, Brooksville

KOOGLER & ASSOCIATES
ENVIRONMENTAL SERVICES

Attachment 1

Description of Kiln Dust Return System

CEMEX Cement, Inc.
Brooksville Cement Plant
Hernando County, Florida

KOOGLER & ASSOCIATES
ENVIRONMENTAL SERVICES

Kiln Dust Return System

CEMEX Cement, Inc.
Brooksville Cement Plant
521-02-10

The Brooksville Cement Plant has two dry process preheater kiln systems, each having a large dust collecting baghouse that controls particulate matter from the process air before it leaves the stack. The is dust collected in each baghouse is handled in one of two ways. **Normally** the dust is moved by screw conveyors and bucket elevators to the **kiln feed bin** which receives raw feed from the blending silo. This bin is mounted on weighing devices called load cells that are used in the calculation of the kiln feed rate to the preheater. The material is fed out of the **kiln feed bin** at a determined rate to the **POLDOS** which pneumatically transfers the raw feed and recycled kiln dust to the preheater. This transfer is the measured and reported **preheater feed rate.** [It should be noted that there is a separate feed system for each of the two kiln systems.]

Alternatively, if the kiln feed chemistry is such that the baghouse dust cannot be returned directly to the kiln, or if there's an equipment problem, the baghouse dust is returned and blended with the raw feed just produced by the raw mill. This material is pneumatically conveyed to the kiln blending silo. From the blending silo, the raw feed is transferred to the **kiln feed bin**, to the **POLDOS** and into the **preheater.**

In either case, the kiln dust is returned through the **kiln feed bin** and **POLDOS** to the preheater and is a fraction of the measured **preheater feed rate**.

The attached flow chart shows the flow of the kiln dust.

Attachment 2

Comparative Emissions Report
for Coal Firing and
Coal/WTDF Firing
Scenarios

CEMEX Cement, Inc.
Brooksville Cement Plant
Hernando County, Florida

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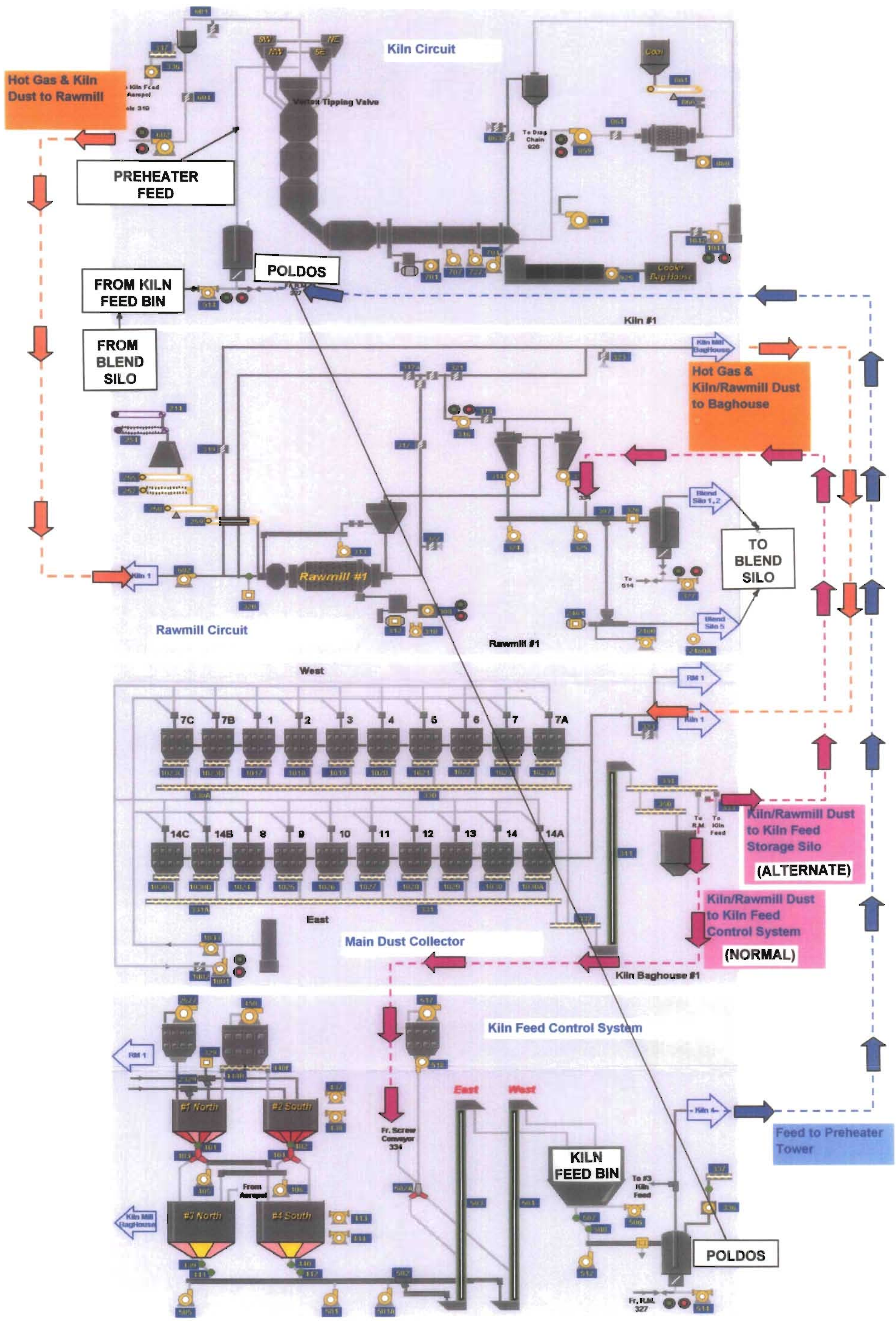
Dust and Hot Gas Flow Path



COMPARISON OF PARTICULATE MATTER, SULFUR DIOXIDE, TOTAL HYDROCARBONS, CARBON MONOXIDE, NITROGEN OXIDES, HYDROGEN CHLORIDE, SPECIATED VOLATILE ORGANICS, METALS AND DIOXINS/FURANS EMISSION MEASUREMENTS AND OPACITIES OF EMISSIONS UNDER BASELINE AND COAL/TDF FIRING CONDITIONS

KILN NO.1

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA

MAY 4-5, 1993
AND
JUNE 8-9,1993

KOOGLER & ASSOCIATES
ENVIRONMENTAL SERVICES
4014 N.W. 13TH STREET
GAINESVILLE, FL 32609
(904) 377-5822

KOOGLER & ASSOCIATES

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KOOGLER & ASSOCIATES

1.0 INTRODUCTION

Southdown, Incorporated, doing business as Florida Mining & Materials (FM&M), operates two dry process cement kilns at the Brooksville facility located south of Highway 98 in Hernando County, Florida. On February 5, 1993, FM&M received approval from the Florida Department of Environmental Protection (FDEP) to conduct tests on the No. 1 cement kiln to evaluate the effect of burning a combination of coal and whole tire derived fuel (TDF).

Kiln No. 1 is presently operating under Permit A027-213207. The permit limits the feed rate to the kiln to 130 tons per hour (corresponding to a preheater feed rate of 145 tons per hour), limits the clinker production rate to 79.6 tons per hour and limits the heat input to the kiln to 300 MMBTU per hour. The permit also limits the emission rate of particulate matter from the kiln to 39.0 pounds per hour and limits the opacity of emissions to 20 percent, maximum six-minute average.

The primary heat input to Kiln No. 1 is pulverized coal. The amendment to Permit A027-213207, issued on February 5, 1993, allows FM&M to test using TDF to provide up to 20 percent of the heat input to the kiln. The TDF is fed through a double air lock feeder at the base of the preheater (near the point where feed material enters the kiln).

The TDF test was scheduled for a 43-day period; an initial 30-day period when TDF would be used to provide up to 20 percent of the heat input to the No. 1 kiln system, a four-day period for the plant to stabilize on coal, a two-day period for baseline testing (100 percent coal), a five-day period for the plant to stabilize on coal/TDF and a two-day test period with coal providing approximately 80 percent of the heat input and TDF providing approximately 20 percent of the heat input. The time periods proposed were operating days as opposed to calendar days.

The 30-day period of TDF firing began on March 29, 1993. The baseline tests were conducted on May 4-5, 1993 and the coal/TDF tests were conducted on June 8-9, 1993. Between the baseline test period (May 4-5, 1993) and the coal/TDF test period (June 8-9, 1993), the No. 1 kiln system was shut down for repair and maintenance. The extent of the repair and maintenance was documented in a separate transmittal to FDEP and Hernando County. The documentation demonstrated that the repairs had no effect on kiln operations.

During both test periods, the test protocol required the monitoring of certain plant operating conditions and the measurement of emission rates of various constituents from the Kiln No. 1 stack. The plant operating conditions included the preheater feed rate, the fuel feed rate (coal and TDF), the temperatures at the feed end of the kiln and at the preheater exit, and the oxygen concentration at the feed end of the kiln. Additionally, the raw material fed into the kiln, the clinker and the fuel were to be analyzed for specified constituents.

Emission measurements were to be made for particulate matter, certain metals, hydrogen chloride, nitrogen oxides, sulfur dioxide, carbon monoxide, total VOCs, speciated VOCs, dioxins and furans. Additionally, the stack gas characteristics were to be measured, including the carbon dioxide and oxygen concentration of the stack gas, and visible emission observations were to be conducted.

In the following sections, the results of the measurements and operating rates under baseline and coal/TDF conditions are compared.

2.0 PLANT OPERATING CONDITIONS

The plant operating conditions that were to be monitored during the two test periods were documented in an FDEP-approved Test Protocol. Plant operating parameters monitored during the baseline and coal/TDF periods are summarized in Tables 1 and 2. A comparison of these data demonstrates that Kiln No. 1 was operating under similar conditions during both test periods. The feed rates to the preheater and other kiln conditions were within the normal range of plant operations during the two test periods and the preheater feed rates were near the maximum permitted rate of 145 tons per hour. During the baseline period, 100 percent of the heat input to Kiln No. 1 (212 MMBTU/hr) was provided with coal. During the coal/TDF test period, coal provided about 78.3 percent of the heat input (182.8 MMBTU/hr) and TDF provided the remaining 21.7 percent (50.8 MMBTU/hr).

Clinker, raw feed and fuel analyses for the baseline and TDF test periods are included in Tables 3, 4, 5 and 6. These data demonstrate that there are no significant differences in the feed, clinker or fuel during the two test periods; other than variations within the normal day-to-day range of these parameters.

TABLE 1
PLANT OPERATING DATA
FLORIDA MINING & MATERIALS
KILN # 1 - BASELINE CONDITIONS

BROOKSVILLE, FLORIDA
MAY 4 AND 5, 1993

May 4, 1993

Time	Kiln Feed (tph)	Coal Feed (tph)	Coal Heat Input (MMBTU/hr)	Kiln Exit Temp. (oF)	Preheater Exit Temp. (oF)	Kiln Exit O2 (%)
0900	144.7	8.66	220.6	1600	750	2.2
1100	142.7	8.43	214.8	1650	760	0.6
1300	147.8	8.55	217.8	1620	750	0.1
1500	139.0	8.45	215.3	NR	NR	NR
1700	139.0	8.19	208.6	1610	750	1.5
1900	139.0	8.65	220.4	1600	740	2.2
2100	139.0	7.92	201.8	1610	750	2.0
Avg	141.6	8.41	214.18	1615	750	1.4

May 5, 1993

Time	Kiln Feed (tph)	Coal Feed (tph)	Coal Heat Input (MMBTU/hr)	Kiln Exit Temp. (oF)	Preheater Exit Temp. (oF)	Kiln Exit O2 (%)
0900	104.8	8.32	208.9	1720	820	1.3
1100	141.5	7.08	177.8	1650	760	1.4
1300	146.7	9.29	233.3	1640	760	0.6
1500	145.7	8.67	217.7	NR	NR	NR
1700	145.7	8.50	213.4	1625	750	1.0
1900	145.7	8.31	208.7	1620	750	0.8
2100	145.7	8.31	208.7	1640	760	0.2
Avg	139.4	8.35	209.8	1649	767	0.9

NR - Not reported in control room log.

TABLE 2
PLANT OPERATING DATA
FLORIDA MINING & MATERIALS
KILN # 1 - COAL/TDF CONDITIONS

BROOKSVILLE, FLORIDA
JUNE 8 AND 9, 1993

June 8, 1993

Time	Kiln Feed (tph)	Coal Feed (tph)	Coal Heat Input MMBTU/hr	TDF Feed (tph)	TDF Heat Input MMBTU/hr	Kiln Exit Temp. (oF)	Preheat. Exit Temp. (oF)	Kiln Exit 02 (%)
0900	138.5	7.07	174.5	1.65	53.46	1610	760	5.0+
1100	101.9	7.07	174.5	1.64	53.14	1800	770	3.2
1300	142.6	7.07	174.5	1.34	43.42	1760	760	3.5
1500	133.3	7.39	182.4	1.60	51.84	NR	NR	NR
1700	133.3	7.39	182.4	1.64	53.14	1740	735	2.8
1900	136.3	7.39	182.4	1.64	53.14	1730	720	4.2
2100	140.3	7.39	182.4	1.72	55.73	1630	750	4.5
Avg	132.3	7.25	179.0	1.60	51.98	1712	749	3.9

June 9, 1993

Time	Kiln Feed (tph)	Coal Feed (tph)	Coal Heat Input MMBTU/hr	TDF Feed (tph)	TDF Heat Input MMBTU/hr	Kiln Exit Temp. (oF)	Preheat. Exit Temp. (oF)	Kiln Exit 02 (%)
0900	142.4	7.70	185.3	1.37	44.39	1720	760	2.3
1100	142.4	7.70	185.3	1.52	49.25	1800	770	2.4
1300	142.4	7.70	185.3	1.56	50.55	1820	760	3.1
1500	140.2	7.80	187.7	1.46	47.31	NR	NR	NR
1700	140.2	7.80	187.7	1.62	52.49	1760	755	2.6
1900	140.2	7.80	187.7	1.61	52.17	1780	765	3.4
2100	140.2	7.80	187.7	1.58	51.20	1740	760	3.2
Avg	141.1	7.76	186.7	1.53	49.62	1770	762	2.8

NR - Not reported in control room log.

TABLE 3
KILN FEED AND CLINKER ANALYSIS
FLORIDA MINING & MATERIALS
KILN # 1 - BASELINE CONDITIONS

BROOKSVILLE, FLORIDA
MAY 4 AND 5, 1993

Element	KILN FEED - 5/4/93 Conc. (%)		CLINKER - 5/4/93 Conc. (%)	
SiO2	20.42	C3S = 81.76	21.64	C3S = 62.24
Al2O3	4.90	C2S = -3.14	5.17	C2S = 15.10
Fe2O3	4.06	C3A = 6.12	4.35	C3A = 6.33
CaO	67.72	C4AF = 12.34	66.12	C4AF = 13.24
MgO	0.70	S/R = 2.28	0.68	S/R = 2.27
SO3	0.01	A/F = 1.21	0.52	A/F = 1.19
Na2O	0.10	LP = 26.49	0.15	LP = 26.50
K2O	0.10	LSF = 101.56	0.62	LSF = 93.58
	------	Na2O Equiv = 0.16	------	Na2O Equiv = 0.56
Total	98.01	Burn.F = 121.68	99.25	Burn.F = 111.96
		Burn.I = 4.43		Burn.I = 3.18
		Factor = 0.9856		Factor = 1.0000

Element	KILN FEED - 5/5/93 Conc. (%)		CLINKER - 5/5/93 Conc. (%)	
SiO2	19.32	C3S = 94.66	21.53	C3S = 64.43
Al2O3	4.86	C2S = -16.02	5.26	C2S = 13.13
Fe2O3	4.09	C3A = 5.96	4.42	C3A = 6.47
CaO	68.79	C4AF = 12.45	66.58	C4AF = 13.44
MgO	0.74	S/R = 2.16	0.73	S/R = 2.23
SO3	0.01	A/F = 1.19	0.45	A/F = 1.19
Na2O	0.10	LP = 26.48	0.15	LP = 26.87
K2O	0.09	LSF = 108.25	0.52	LSF = 94.41
	------	Na2O Equiv = 0.16	------	Na2O Equiv = 0.49
Total	98.00	Burn.F = 127.05	99.64	Burn.F = 112.47
		Burn.I = 5.14		Burn.I = 3.24
		Factor = 0.9837		Factor = 1.0000

TABLE 4
KILN FEED AND CLINKER ANALYSIS
FLORIDA MINING & MATERIALS
KILN # 1 - COAL/TDF CONDITIONS

BROOKSVILLE, FLORIDA
JUNE 8 AND 9, 1993

Element	KILN FEED - 6/8/93 Conc. (%)		CLINKER - 6/8/93 Conc. (%)	
SiO2	20.23	C3S = 81.48	20.88	C3S = 64.64
Al2O3	5.05	C2S = -3.47	5.37	C2S = 11.09
Fe2O3	4.20	C3A = 6.27	4.79	C3A = 6.13
CaO	67.61	C4AF = 12.79	65.70	C4AF = 14.56
MgO	0.71	S/R = 2.19	0.70	S/R = 2.06
SO3	0.03	A/F = 1.20	0.44	A/F = 1.12
Na2O	0.10	LP = 25.24	0.15	LP = 27.94
K2O	0.07	LSF = 101.75	0.49	LSF = 95.24
	------	Na2O Equiv = 0.15	------	Na2O Equiv = 0.47
Total	98.00	Burn.F = 120.97	98.52	Burn.F = 111.79
		Burn.I = 4.28		Burn.I = 3.12
		Factor = 0.9864		Factor = 1.0000

Element	KILN FEED - 6/9/93 Conc. (%)		CLINKER - 6/9/93 Conc. (%)	
SiO2	19.26	C3S = 92.45	20.78	C3S = 66.49
Al2O3	5.08	C2S = -14.52	5.26	C2S = 9.40
Fe2O3	4.23	C3A = 6.30	4.78	C3A = 5.84
CaO	68.53	C4AF = 12.87	65.82	C4AF = 14.56
MgO	0.72	S/R = 2.07	0.69	S/R = 2.07
SO3	0.00	A/F = 1.20	0.50	A/F = 1.10
Na2O	0.10	LP = 24.41	0.15	LP = 27.64
K2O	0.08	LSF = 107.44	0.53	LSF = 96.06
	------	Na2O Equiv = 0.15	------	Na2O Equiv = 0.50
Total	98.00	Burn.F = 125.43	98.51	Burn.F = 112.64
		Burn.I = 4.82		Burn.I = 3.26
		Factor = 0.9892		Factor = 1.0000

TABLE 5
FUEL ULTIMATE ANALYSIS
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILE, FLORIDA

May 4-5, 1993
AND
JUNE 8-9, 1993

Parameter	UNIT	BASELINE COMPOSITE COAL 5/4-5/93	COAL/TDF COMPOSITE COAL 6/8-9/93	COAL/TDF COMPOSITE TDF 6/8-9/93
Moisture	(%)	6.34	7.75	0.47
Carbon	(%)	70.5	67.77	74.35
Hydrogen	(%)	4.69	4.55	7.08
Nitrogen	(%)	1.39	1.24	0.41
Sulfur	(%)	0.83	0.96	1.02
Ash	(%)	9.91	11.28	9.40
Oxygen	(%)	6.36	6.45	0.73
Heating Value	(Btu/lb)	12646	12186	15141

All parameters reported AS RECEIVED

TABLE 6
KILN FEED, COAL AND CLINKER METAL ANALYSES
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIAL
BROOKSVILLE, FLORIDA

MAY 4-5, 1993
AND
JUNE 8-9, 1993

Metal	UNIT	BASELINE COMPOSITE KILN FEED 5/4-5/93	COAL/TDF COMPOSITE KILN FEED 6/8-9/93	BASELINE COMPOSITE COAL 5/4-5/93	COAL/TDF COMPOSITE COAL 6/8-9/93	BASELINE COMPOSITE CLINKER 5/4-5/93	COAL/TDF COMPOSITE CLINKER 6/8-9/93	COAL/TDF COMPOSITE TIRE 6/8-9/93
Arsenic	(ug/g)	16	25	6	16	29	34	<1
Chromium	(ug/g)	35	47	6	6	73	97	5
Lead	(ug/g)	66	66	8	4	83	100	5
Mercury	(ug/g)	0.24	0.24	0.10	0.18	<0.02	<0.02	0.04
Zinc	(ug/g)	38	59	10	6	92	82	4400
Chlorine	(% Wt)	0.12	0.12	0.16	0.16	0.07	0.07	0.07

3.0 PARTICULATE MATTER EMISSION COMPARISON

Particulate matter emission rates were measured during the baseline period on May 4, 1993, and during the coal/TDF firing period on June 8, 1993. Under both sets of operating conditions, the particulate matter emission rates were well below the permitted emission rate of 39 pounds per hour and within the range of particulate matter emissions measured from the kiln on other occasions.

The data presented in Table 7 show an average emission rate of 9.13 pounds per hour during the coal/TDF period and an emission rate of 7.04 pounds per hour during the baseline period. These emission rates are not significantly different. Therefore, it can be concluded that the use of TDF to provide up to 20 percent of the heat input has no significant effect on the particulate matter emission rate of Kiln No. 1.

TABLE 7
COMPARISON OF PARTICULATE MATTER EMISSION RATES
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	6.15	11.33
	2	6.98	7.30
	3	8.00	8.75
Mean		7.04	9.13
S var		0.86	4.17
n		3.00	3.00
Pooled est		1.59	
t stat.		1.61	
t' (95% C.I.)		2.132	

Difference is not significant

4.0 METALS EMISSION RATES

The emission rates of arsenic, total chromium, lead, mercury, and zinc were measured with the EPA multi-metals train (EPA Method 29). The measurements under baseline operating conditions were made on May 4, 1993, and the measurements under coal/TDF conditions were made on June 8, 1993. The emission rates measured under the two sets of conditions are summarized in the following table:

Metal	Baseline Average Emissions (lb/hr)	TDF Average Emissions (lb/hr)
Date	May 4, 1993	June 8, 1993
Arsenic	<0.00174	<0.00143
Chromium	<0.00202	<0.00287
Lead	<0.00781	<0.00201
Mercury	0.01299	<0.00036
Zinc	0.00579	0.01026*

*Significantly greater

Comparisons of these data (Tables 8A-8E) demonstrate that the emission rates of arsenic, chromium and lead are below the detectable limit and are therefore of no concern under either operating condition. The data also show that there is no significant difference in the emission rate of mercury. Statistically however, the emission rate of zinc measured under coal/TDF conditions was greater than the emission rate measured under the baseline firing conditions. The apparent increase in zinc emissions could be due to the zinc content of the TDF.

It can be concluded that the use of TDF to supply up to 20 percent of the heat input to Kiln No. 1 has no effect on metals emissions, with the possible exception of zinc.

TABLE 8A
COMPARISON OF METAL EMISSION RATES
ARSENIC
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run	Baseline lb/hr	TDF lb/hr
1	<0.00176	<0.00143
2	<0.00172	<0.00143
3	<0.00173	<0.00143
Mean	<0.00174	<0.00143

Emissions too close to detection limit.
No meaningful comparison possible.

TABLE 8B
COMPARISON OF METAL EMISSION RATES
CHROMIUM
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	<0.00205	<0.00287
	2	<0.00201	<0.00287
	3	<0.00201	<0.00287
Mean		<0.00202	<0.00287

Emissions too close to detection limit.
No meaningful comparison possible.

TABLE 8C
COMPARISON OF METAL EMISSION RATES
LEAD
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	≤0.00763	<0.00201
	2	<0.00747	<0.00201
	3	0.00834	<0.00201
Mean		<0.00781	<0.00201

Emissions too close to detection limit.
No meaningful comparison possible.

TABLE 8D
COMPARISON OF METAL EMISSION RATES
MERCURY
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	0.02935	<0.00037
	2	0.00233	<0.00035
	3	0.00728	<0.00037
Mean		0.01299	<0.00036
S var		2.07E-04	1.33E-10
n		3.00	3.00
Pooled est		1.02E-02	
t stat.		1.52	
t' (95% C.I.)		2.132	

Difference is not significant

TABLE 8E
COMPARISON OF METAL EMISSION RATES
ZINC
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run	Baseline lb/hr	TDF lb/hr
1	0.00558	0.00832
2	0.00546	0.01392
3	0.00633	0.00853
Mean	0.00579	0.01026
S var	2.22E-07	1.01E-05
n	3.00	3.00
Pooled est	2.27E-03	
t stat.	2.41	
t' (95% C.I.)	2.132	

Difference is significant

5.0 TOTAL HYDROCARBONS

The total hydrocarbon concentration in the stack gas of the plant was measured for two 12-hour periods under baseline conditions and for two 12-hour periods under coal/TDF firing conditions using EPA Method 25A as described in 40CFR60, Appendix A. These data were summarized as 12 two-hour average hourly emission rates for each test condition and were calculated from stack gas flow rates measured during each day of monitoring.

The average emission rate under baseline conditions was 3.36 pounds per hour while the average emission rate under coal/TDF firing conditions was 3.26 pounds per hour. The difference in the emission rates is not statistically significant (Table 9). It can be concluded that the use of TDF to provide up to 20 percent of the heat input does not affect total hydrocarbon emissions from Kiln No. 1.

TABLE 9
COMPARISON OF TOTAL HYDROCARBON EMISSION RATES
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4-5 AND JUNE 8-9, 1993

Run	Baseline lb/hr	TDF lb/hr
1	2.36	2.80
2	3.54	2.62
3	4.06	2.61
4	3.07	3.37
5	3.07	2.6
6	3.44	2.9
7	2.75	4.79
8	4.64	3.69
9	3.92	3.17
10	3.11	3.24
11	3.48	3.65
12	2.88	3.63
Mean	3.36	3.26
S var	0.39	0.40
n	12.00	12.00
Pooled est	0.63	
t stat.	0.40	
t' (95% C.I.)	1.717	

Difference is not significant

6.0 NITROGEN OXIDES

The nitrogen oxides concentration in the stack gas from the plant was measured for two 12-hour periods under baseline conditions and for two 12-hour periods under coal/TDF firing conditions. The method of sampling was EPA Method 7E, 40CFR60, Appendix A. The mass emission rates were calculated using stack gas flow rates measured during each day of monitoring and are reported as 12 two-hour average hourly emission rates.

These data, summarized in Table 10, show an average nitrogen oxides emission rate under baseline conditions of 197 pounds per hour and an average emission rate of 188 pounds per hour under coal/TDF firing conditions. Statistically, there is no difference in these emission rates. It can be concluded that the use of TDF to provide up to 20 percent of the heat input does not affect nitrogen oxides emissions from Kiln No. 1.

TABLE 10
COMPARISON OF NITROGEN OXIDE EMISSION RATES
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4-5 AND JUNE 8-9, 1993

Run	Baseline lb/hr	TDF lb/hr
1	205.95	118.78
2	236.35	92.30
3	205.38	133.55
4	193.97	161.73
5	190.08	227.33
6	166.42	215.70
7	134.01	166.34
8	185.79	189.05
9	200.64	242.46
10	242.86	265.64
11	212.71	243.96
12	194.41	201.78
Mean	197.38	188.22
S var	832.05	2973.08
n	12.00	12.00
Pooled est	43.62	
t stat.	0.51	
t′ (95% C.I.)	1.717	

Difference is not significant

7.0 SULFUR DIOXIDE

The sulfur dioxide concentration in the stack gas from the cement plant was measured for two 12-hour periods under baseline conditions and for two 12-hour periods under coal/TDF firing conditions. The method of sampling was EPA Method 6C, 40CFR60, Appendix A. The mass emission rates were calculated using stack gas flow rates measured each day of monitoring and are reported as 12 two-hour average hourly emission rates. The data are summarized in Table 11 and show an average sulfur dioxide emission rate under baseline conditions of less than 1.9 pounds per hour and an average emission rate under coal/TDF firing conditions of less than 0.8 pounds per hour.

These emission rates were both below the detection limit of Method 6C and no statistical analysis was possible. It can be concluded, however, that the use of TDF in the cement plant does not affect sulfur dioxide emissions from Kiln No. 1.

TABLE 11
COMPARISON OF SULFUR DIOXIDE EMISSION RATES
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4-5 AND JUNE 8-9, 1993

Run	Baseline lb/hr	TDF lb/hr
1	<1.71	<1.05
2	<1.71	<0.35
3	<1.78	<0.84
4	<1.78	<0.5
5	<1.78	<1.42
6	<1.78	<0.71
7	<1.9	<0.9
8	<1.9	<0.18
9	<1.9	<1.25
10	<1.98	<0.71
11	<1.98	<0.7
12	<2.06	<0.7
Mean	<1.86	<0.78

Emissions too close to detection limit
No meaningful comparison posible.

8.0 CARBON MONOXIDE

The carbon monoxide concentration in the stack gas was continuously monitored for two 12-hour periods during the baseline tests and two 12-hour periods during the coal/TDF tests. The measurements were made in accordance with EPA Method 10, 40CFR60, Appendix A. The mass emission rates of carbon monoxide were calculated using stack gas flow rates measured during each day of monitoring and were initially reported as 12 two-hour average hourly emission rates for each of the two test periods. These data are summarized in Table 12.

The carbon monoxide emission data summarized in Table 12 show an average emission rate of 31.5 pounds per hour under baseline conditions and an average emission rate of 49.1 pounds per hour under coal/TDF firing conditions. Statistically, the carbon monoxide emission rate under coal/TDF firing conditions was greater than the emission rate measured under baseline conditions. This matter was further investigated as measurements made at other cement plants under coal and coal/TDF firing conditions have shown that TDF has no effect on carbon monoxide or other emission rates.

The carbon monoxide emission measurements made under baseline conditions (24 hours of monitoring) and under coal/TDF conditions (24 hours of monitoring) were reduced to one-hour average emission rates and carbon monoxide emission data for FM&M Kilns No. 1 and No. 2, measured on other dates, were abstracted from previous reports. These hourly average emission rates are summarized in Table 13.

The carbon monoxide data from the previous tests were analyzed and no difference was found between emission rates from Kiln No. 1 while burning coal (2/28/92) and while burning coal and flolite (2/28/92). Likewise, there was no difference in the emission rates from Kiln No. 2 (a kiln identical to Kiln No. 1) on 3/24/92 and on 2/10/93. It was also determined that there was no difference in the carbon monoxide emission rates from Kiln No. 1 and Kiln No. 2. As a result of these analyses, the data from previous tests were treated as a single set of "baseline" data (i.e. operations without TDF).

When the data from previous tests were compared with carbon monoxide emission data from the current baseline tests (5/4/93, 5/5/93 and 5/4-5/93), it was determined that the previously measured emission rates were significantly greater than the emission rates measured on both 5/4/93 and 5/5/93 and on 5/4-5/93 (all current baseline dates handled collectively). The analysis further showed there was no significant difference between carbon monoxide emission rates measured on 5/4/93 and 5/5/93.

When comparing the previously measured "baseline" data with the coal/TDF carbon monoxide emission measurements, it was statistically determined that:

1. There was no difference between the previous baseline emission rate and the 6/9/93 coal/TDF emission rate;

2. The carbon monoxide emission rates measured on 6/8/93 (coal/TDF) were greater than those measured under previous baseline conditions; and

3. The carbon monoxide emission rate measured on 6/8/93 (coal/TDF) was greater than that measured on 6/9/93 (coal/TDF). In both cases, kiln operating conditions were the same.

In summary:

1. The carbon monoxide emission rate measured under 5/4-5/93 baseline (coal) conditions was less than the emission rates measured under "previous baseline" (coal and coal/flolite) conditions; demonstrating that there can be significant differences in carbon monoxide emission rates with the kiln operating under the same conditions.

2. The carbon monoxide emission rate measured on 6/8/93 with Kiln No. 1 fired with coal/TDF was significantly greater than that measured on 6/9/93 with Kiln No. 1 fired with coal/TDF. This again demonstrates that there can be significant differences in carbon monoxide emission rates with the kiln operating under the same conditions.

3. The carbon monoxide emission rate measured under coal/TDF conditions on 6/9/93 was no different than that measured under "previous baseline" conditions. This demonstrates that the use of coal/TDF does not result in increased carbon monoxide emissions.

4. These data collectively, and data reported from other cement plants, demonstrate that there are significant fluctuations in carbon monoxide emissions from cement plants. These fluctuations results from several factors that vary within the normal range of cement plant operating parameters and not, in this case, from the use of TDF.

TABLE 12
COMPARISON OF CARBON MONOXIDE EMISSION RATES BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4-5 AND JUNE 8-9, 1993

Run	Baseline lb/hr	TDF lb/hr
1	28.10	66.08
2	30.73	39.91
3	31.21	66.63
4	33.56	49.7
5	36.24	47.63
6	31.17	70.04
7	30.9	52
8	33.06	41.16
9	29.9	39.76
10	30.32	37.11
11	30.97	39.13
12	31.56	39.51
Mean	31.48	49.06
S var	4.19	146.81
n	12.00	12.00
Pooled est	8.69	
t stat.	4.96	
t' (95% C.I.)	1.717	

Difference is significant

TABLE 13
CARBON MONOXIDE DATA REVIEW
FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 5 AND JUNE 9, 1993

Baseline Data - (No TDF)					Coal/TDF Data			
Kiln Number	Test Date	Fuel Type	Preheater Feed Rate (tph)	Hourly Average Carbon Monoxide (lb/hr)	Kiln Number	Test Date	Preheater Feed Rate (tph)	Hourly Average Carbon Monoxide (lb/hr)
1	02/28/92	Coal	144	40.1	1	06/08/93	140-142	64.2
				37.5				67.9
				40.7				32.9
1	02/28/92	Coal/Flolite	144	32.6				46.2
				37.5				52.4
				40.7				80.9
2	03/24/92	Coal	139	38.6				55.5
				40.7				43.9
				41.4				44.8
2	02/10/93	Coal	139	41.6				50.5
				47.3				71.3
				41.8				68.8
			Set Average	40.0			Set Average	56.6
1	05/04/93	Coal	139-145	27.0	1	06/09/93	101-143	56.1
				29.2				47.9
				31.5				37.7
				30.0				44.6
				32.0				39.6
				30.4				39.9
				32.8				35.1
				34.3				39.2
				35.1				38.6
				37.4				39.7
				33.5				34.8
				28.8				44.2
			Set Average	31.8			Set Average	41.5
1	05/05/93	Coal	105-146	33.8				
				28.0				
				30.7				
				35.3				
				29.1				
				30.7				
				32.3				
				32.3				
				32.9				
				29.0				
				30.7				
				32.5				
			Set Average	31.4				

9.0 HYDROGEN CHLORIDE

The emission rate of hydrogen chloride was measured under both baseline and coal/TDF firing conditions using EPA Method 26, as described in 40CFR60, Appendix A. The mass emission rates of hydrogen chloride were calculated using stack gas flow rates measured during each day of monitoring.

The hydrogen chloride emission data summarized in Table 14 show an emission rate of 0.44 pounds per hour under baseline conditions and an emission rate of less than 0.35 pounds per hour under coal/TDF firing conditions. Statistically, the hydrogen chloride emission rate under baseline firing conditions is greater than the emission rate measured under coal/TDF conditions.

Under neither condition would the emission rate of hydrogen chloride be of consequence; even if the chlorides present were as hydrogen chloride. The presence of several cations in the Method 26 sampling train (along with chloride) demonstrates that the chlorides are present as salts of the cations (aluminum, ammonia, sodium, etc.) and not as hydrogen chloride.

TABLE 14
COMPARISON OF HYDROGEN CHLORIDE EMISSION RATES
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 5 AND JUNE 9, 1993

Run	Baseline lb/hr	TDF lb/hr
1	0.47	0.36
2	0.44	<0.32
3	0.42	<0.38
Mean	0.44	<0.35
S var	6.33E-04	9.33E-04
n	3.00	3.00
Pooled est	2.80E-02	
t stat.	3.94	
t' (95% C.I.)	2.132	

Difference is significant

10.0 SPECIATED VOLATILE ORGANIC COMPOUNDS

The emission rates of 13 specific volatile organic compounds were measured under both baseline and coal/TDF firing conditions using the VOST system as described in EPA Method M-0300. This method is also an equivalent EPA Method 18, 40CFR60, Appendix A. The mass emission rates of the compounds were calculated using stack gas flow rates measured during each day of monitoring.

The emission data in Tables 15A-15M are summarized below.

VOC	Emission Rate (lb/hr) Baseline	Emission Rate (lb/hr) Coal/TDF
Acetone	<0.0001	0.0210*
Benzene	0.0580*	0.0410
Bromomethane	<0.0003	0.0013*
Carbon Disulfide	0.0039	0.0057
Chlorobenzene	0.0160*	0.0130
Ethylbenzene	0.0058	0.0055
n-Hexane	0.0050*	0.0023
Toluene	0.0490*	0.0340
1,1,1-Trichloroethane	<0.0001	<0.0001
Trichloroethylene	<0.0001	<0.0001
Styrene	0.0270*	0.0120
m-\p-Xylene	0.0170*	0.0110
o-Xylene	0.0069*	0.0044

* Significantly greater

The emission data show greater emission rates of two compounds (acetone and bromomethane) under coal/TDF conditions, greater emission rates of seven compounds under baseline conditions and either no change or concentrations below the detection limits for four compounds. A reasonable conclusion regarding the emission rates of these specific volatile organic compounds is that there is considerable fluctuation at very low emission rates of these organic compounds from cement kilns and that TDF as a fuel supplement has no effect on the magnitude of these emission rates.

TABLE 15A
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
ACETONE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run	Baseline lb/hr	TDF lb/hr
1	<4.3E-05	1.2E-02
2	<4.3E-05	1.2E-02
3	<4.5E-05	4.9E-02
4	<4.5E-05	1.7E-02
5	<4.5E-05	1.7E-02
6	<4.5E-05	1.9E-02
Mean	<4.4E-05	2.1E-02
S var	1.1E-12	2.0E-04
n	6	6
Pooled est	0	
t stat.	3.66	
t' (95% C.I.)	1.812	

Difference is significant

TABLE 15B
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
BENZENE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	Coal/TDF lb/hr
	1	4.5E-02	4.1E-02
	2	4.8E-02	4.2E-02
	3	5.7E-02	3.9E-02
	4	6.3E-02	4.1E-02
	5	6.2E-02	4.1E-02
	6	7.3E-02	4.3E-02
Mean		5.8E-02	4.1E-02
S var		1.1E-04	1.8E-06
n		6	6
Pooled est		0	
t stat.		3.95	
t' (95% C.I.)		1.812	

Difference is significant

TABLE 15C
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
BROMOMETHANE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	<2.1E-05	1.3E-03
	2	1.5E-03	9.4E-04
	3	<2.2E-05	2.4E-03
	4	<2.2E-05	1.3E-03
	5	<2.2E-05	8.5E-04
	6	<2.2E-05	8.2E-04
Mean		<2.7E-04	1.3E-03
S var		3.6E-07	3.5E-07
n		6	6
Pooled est		0	
t stat.		2.89	
t' (95% C.I.)		1.812	

Difference is significant

TABLE 15D
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
CARBON DISULFIDE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	5.5E-03	8.7E-03
	2	4.4E-03	5.8E-03
	3	6.0E-03	5.6E-03
	4	7.3E-03	4.8E-03
	5	<2.2E-05	4.5E-03
	6	<2.2E-05	5.1E-03
Mean		3.9E-03	5.7E-03
S var		9.8E-06	2.3E-06
n		6	6
Pooled est		0	
t stat.		1.32	
t' (95% C.I.)		1.812	

Difference is not significant

TABLE 15E
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
CHLOROBENZENE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	1.4E-02	9.6E-03
	2	1.3E-02	1.4E-02
	3	1.5E-02	1.3E-02
	4	1.6E-02	1.4E-02
	5	1.8E-02	1.2E-02
	6	1.9E-02	1.3E-02
Mean		1.6E-02	1.3E-02
S var		5.4E-06	2.7E-06
n		6	6
Pooled est		0	
t stat.		2.79	
t' (95% C.I.)		1.812	

Difference is significant

TABLE 15F
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
ETHYLBENZENE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	5.0E-03	5.0E-03
	2	5.0E-03	6.1E-03
	3	5.1E-03	5.3E-03
	4	5.8E-03	5.9E-03
	5	6.8E-03	4.9E-03
	6	7.1E-03	6.0E-03
Mean		5.8E-03	5.5E-03
S var		8.9E-07	2.8E-07
n		6	6
Pooled est		0	
t stat.		0.60	
t' (95% C.I.)		1.812	

Difference is not significant

TABLE 15G
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
n-HEXANE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run	Baseline lb/hr	TDF lb/hr
1	3.8E-03	1.3E-03
2	4.7E-03	1.6E-03
3	4.4E-03	2.3E-03
4	5.0E-03	2.8E-03
5	5.3E-03	2.9E-03
6	7.0E-03	2.9E-03
Mean	5.0E-03	2.3E-03
S var	1.2E-06	4.9E-07
n	6	6
Pooled est	0	
t stat.	5.16	
t' (95% C.I.)	1.812	

Difference is significant

TABLE 15H
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
TOLUENE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	3.2E-02	2.9E-02
	2	4.5E-02	3.6E-02
	3	4.7E-02	3.1E-02
	4	5.4E-02	3.3E-02
	5	6.2E-02	4.0E-02
	6	5.5E-02	3.5E-02
Mean		4.9E-02	3.4E-02
S var		1.1E-04	1.5E-05
n		6	6
Pooled est		0	
t stat.		3.35	
t' (95% C.I.)		1.812	

Difference is significant

TABLE 15I
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
1,1,1-TRICHLOROETHANE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	<2.1E-05	<2.2E-05
	2	<2.1E-05	<2.2E-05
	3	<2.2E-05	<2.1E-05
	4	<2.2E-05	<2.1E-05
	5	<2.2E-05	<2.2E-05
	6	<2.2E-05	<2.2E-05
Mean		<2.2E-05	<2.2E-05

Emissions too close to detection limit.
No meaningful comparison possible.

TABLE 15J
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
TRICHLOROETHENE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	<2.1E-05	<2.2E-05
	2	<2.1E-05	<2.2E-05
	3	<2.2E-05	<2.1E-05
	4	<2.2E-05	<2.1E-05
	5	<2.2E-05	<2.2E-05
	6	<2.2E-05	<2.2E-05
Mean		<2.2E-05	<2.2E-05

Emissions too close to detection limit.
No meaningful comparison possible.

TABLE 15K
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
STYRENE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	1.9E-02	1.0E-02
	2	1.8E-02	1.4E-02
	3	2.5E-02	1.3E-02
	4	3.1E-02	1.4E-02
	5	3.4E-02	9.8E-03
	6	3.3E-02	1.3E-02
Mean		2.7E-02	1.2E-02
S var		5.0E-05	3.7E-06
n		6	6
Pooled est		0	
t stat.		4.81	
t' (95% C.I.)		1.812	

Difference is significant

TABLE 15L
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
m-\p-XYLENE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run	Baseline lb/hr	TDF lb/hr
1	1.4E-02	9.1E-03
2	1.5E-02	1.3E-02
3	1.6E-02	1.1E-02
4	1.9E-02	1.2E-02
5	2.1E-02	1.0E-02
6	1.8E-02	1.2E-02
Mean	1.7E-02	1.1E-02
S var	7.0E-06	2.1E-06
n	6	6
Pooled est	0	
t stat.	4.87	
t' (95% C.I.)	1.812	

Difference is significant

TABLE 15M
COMPARISON OF SPECIATED VOLATILE ORGANICS EMISSION RATES
o-XYLENE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4 AND JUNE 8, 1993

Run		Baseline lb/hr	TDF lb/hr
	1	5.7E-03	3.7E-03
	2	5.6E-03	4.9E-03
	3	6.4E-03	4.3E-03
	4	7.6E-03	4.9E-03
	5	8.4E-03	4.0E-03
	6	7.7E-03	4.9E-03
Mean		6.9E-03	4.4E-03
S var		1.4E-06	2.8E-07
n		6	6
Pooled est		0	
t stat.		4.70	
t' (95% C.I.)		1.812	

Difference is significant

11.0 DIOXIN AND FURAN EMISSION COMPARISON

Dioxin and furan emission rates were measured over three two-hour periods during the baseline test on May 5, 1993, and for the same duration during the coal/TDF firing period on June 9, 1993. The measurements were made in accordance with EPA Method 23 (40CFR60, Appendix A). Under both sets of operating conditions, the dioxin and furan concentrations in all samples were below the limit of detection of the analytical method.

It can therefore be concluded that dioxins and furans are not present in the stack gas from Kiln No. 1 under either baseline conditions or coal/TDF conditions.

12.0 OPACITY OF EMISSIONS

The opacity of emissions was observed during four one-hour periods during both the baseline tests and the coal/TDF tests. No visible emissions were observed during any of the observation periods. It can therefore be concluded that the use of TDF has no effect on the opacity of emissions from Kiln No. 1.

13.0 STACK GAS FLOW AND CHARACTERISTICS

The stack gas flow rate, temperature and moisture were measured during six test runs under baseline conditions and six test runs under coal/TDF firing conditions and oxygen and carbon dioxide concentrations were measured during each two-hour period during the 12 hours of monitoring conducted on each of the four test dates.

The stack gas flow rate averaged 187,443 dscfm under baseline conditions and 176,009 dscfm under coal/TDF firing conditions (Table 16). The stack gas temperature averaged 248^{o}F under baseline conditions and 251^{o}F under coal/TDF conditions (Table 17). The stack gas moisture averaged 9.6 percent under baseline conditions and 10.2 percent under coal/TDF firing conditions (Table 18). The oxygen (Table 19) and carbon dioxide (Table 20) concentrations averaged 14.0 and 13.7 percent and 11.6 and 11.6 percent, respectively, under baseline and coal/TDF conditions.

Although there was a slight difference in the stack gas flow rates (as a result of a higher flow rate measured on the second day of baseline testing [5/5/93]), there were no significant differences in the other parameters and all of the stack gas parameters were within ranges normally observed. It can be concluded that the use of TDF as a fuel supplement has no effect on stack gas characteristics.

TABLE 16
COMPARISON OF STACK GAS FLOW RATE BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4-5 AND JUNE 8-9, 1993

Run	Baseline dscfm	TDF dscfm
1	171750	175893
2	178834	167984
3	178597	178353
4	190365	180008
5	198498	178665
6	206616	175148
Mean	187443	176009
S var	179398377	18739215
n	6	6
Pooled est	9953	
t stat.	1.99	
t' (95% C.I.)	1.812	

Difference is significant

TABLE 17
COMPARISON OF STACK TEMPERATURE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4-5 AND JUNE 8-9, 1993

Run	Baseline F	TDF F
1	251.20	258.00
2	249.60	264.00
3	241.30	240.00
4	250.88	242.00
5	247.83	255.00
6	244.54	247.00
Mean	247.56	251.00
S var	15.36	90.40
n	6.00	6.00
Pooled est	7.27	
t stat.	0.82	
t′ (95% C.I.)	1.812	

Difference is not significant

TABLE 18
COMPARISON OF STACK GAS MOISTURE
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4-5 AND JUNE 8-9, 1993

Run	Baseline %	TDF %
1	10.50	9.90
2	10.70	10.20
3	10.70	11.80
4	9.00	10.00
5	8.30	9.50
6	8.30	10.10
Mean	9.58	10.25
S var	1.39	0.64
n	6.00	6.00
Pooled est	1.01	
t stat.	1.15	
t' (95% C.I.)	1.812	

Difference is not significant

TABLE 19
COMPARISON OF STACK GAS OXYGEN CONCENTRATION
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4-5 AND JUNE 8-9, 1993

Run	Baseline %	TDF %
1	13.03	14.20
2	12.50	14.30
3	14.13	13.10
4	14.10	12.30
5	13.13	13.30
6	13.20	13.80
7	14.27	14.50
8	14.57	14.00
9	14.43	13.10
10	15.00	13.90
11	15.00	13.80
12	15.17	13.70
Mean	14.04	13.67
S var	0.78	0.38
n	12.00	12.00
Pooled est	0.76	
t stat.	1.21	
t' (95% C.I.)	1.717	

Difference is not significant

TABLE 20
COMPARISON OF STACK GAS CARBON DIOXIDE CONCENTRATION
BASELINE AND COAL/TDF CONDITIONS

FLORIDA MINING & MATERIALS
BROOKSVILLE, FLORIDA
MAY 4-5 AND JUNE 8-9, 1993

Run		Baseline %	TDF %
	1	12.37	11.80
	2	12.83	9.70
	3	12.20	11.90
	4	12.57	11.70
	5	12.20	11.70
	6	11.47	12.20
	7	10.85	10.50
	8	10.86	12.00
	9	10.57	11.90
	10	11.00	12.10
	11	11.00	12.20
	12	10.83	12.10
Mean		11.56	11.65
S var		0.66	0.58
n		12.00	12.00
Pooled est		0.79	
t stat.		0.27	
t' (95% C.I.)		1.717	

Difference is not significant

14.0 CONCLUSIONS

Based on the comparison of emission data and plant operating data collected during the baseline period (100 percent coal firing) on May 4-5, 1993 and during the coal/TDF period on June 8-9, 1993, it can be concluded that the use of TDF to provide up to 20 percent of the heat input to Kiln No. 1 has no effect on emissions, operations or clinker quality.

Attachment 3

Excerpts from Three Comparative Emissions Reports for Coal Firing and Coal/WTDF Firing Scenarios

CEMEX Cement, Inc.
Brooksville Cement Plant
Hernando County, Florida

KOOGLER & ASSOCIATES
ENVIRONMENTAL SERVICES

SUMMARY OF PARTICULATE MATTER, BENZENE, TOTAL HYDROCARBONS, CARBON MONOXIDE AND NITROGEN OXIDES EMISSION RATES UNDER BASELINE AND WHOLE-TIRE TDF FIRING CONDITIONS

FLORIDA CRUSHED STONE COMPANY
CEMENT/LIME PLANT

BROOKSVILLE, FLORIDA

NOVEMBER 13 - 21, 1991

KOOGLER & ASSOCIATES
ENVIRONMENTAL SERVICES
4014 N.W. 13TH STREET
GAINESVILLE, FL 32609
(904) 377-5822

KOOGLER & ASSOCIATES

To the best of my knowledge, all applicable field and analytical procedures comply with Florida Department of Environmental Regulation requirements and all test data and plant operating data are true and correct.

John B. Koogler, PH.D., P.E.

State of Florida
Registration No. 12925

1/13/92
Date

SEAL

KOOGLER & ASSOCIATES

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KOOGLER & ASSOCIATES

1.0 INTRODUCTION

The Florida Crushed Stone Company (FCS) operates a cement/power/lime (CPL) plant in Hernando County, northwest of Brooksville. The cement plant was permitted under Florida Department of Environmental Regulation (FDER) Air Construction Permit AC27-118674 and the facility was permitted under Permit PSD-FL-091. The CPL plant includes a Portland cement plant having a kiln feed rate of 123.5 tons per hour and a clinker production rate of 75 tons per hour. The plant is normally fired with low-sulfur coal.

In March 1990, FCS applied to FDER requesting approval to burn tire derived fuel (TDF) as a supplemental heat source in the cement kiln of the CPL plant. On June 6, 1990, FDER issued an amendment to the referenced permits authorizing performance tests on the cement plant while using TDF to supply up to 15 percent of the heat input to the kiln. In September 1990, the tests were conducted to measure air pollutant emissions from the CPL plant while the plant was operating under baseline conditions and with shredded TDF supplying up to 15 percent of the heat input to the plant. In September 1991, FCS requested approval from FDER to conduct additional tests with TDF. On October 9, 1991, FDER authorized FCS to conduct tests under baseline conditions and while using whole-tire TDF to provide up to 15 percent of the heat input to the plant. These tests were conducted during the period November 13 - 21, 1991, and the results are reported herein.

The approval granted by FDER on October 9, 1991, authorized two test periods; one representing baseline or normal plant operating conditions and the second representing whole-tire TDF firing conditions. The baseline test was conducted during the period 0942-1412 on November 13, 1991. The whole-tire TDF firing test was conducted during the period 1130-1633 on November 21, 1991. Prior to the test on November 21, 1991, the plant had operated for seven days with whole-tire TDF providing 15 percent of the heat input to the kiln in order to assure equilibrium operating/emissions conditions had been achieved.

During the whole-tire TDF test period, TDF provided 14.6 percent of the heat input to the cement plant; or approximately 39.8 MMBTU per hour heat input. The TDF firing rate corresponding to this heat input averaged 1.2 tons per hour over the three one hour TDF test periods.

During the baseline period, the particulate matter emission rate averaged 11.36 pounds per hour and during the TDF test period, the particulate matter emission rate averaged 9.61 pounds per hour. The allowable particulate matter emission rate is 49.4 pounds per hour.

During the baseline period, the total hydrocarbons emission rate averaged 3.6 pounds per hour and during the TDF test period averaged 1.22 pounds per hour as measured by EPA Method 25A. Emission rates of individual organic compounds generally ranged from 0.001 - 0.0001 pounds per hour under both baseline and TDF test conditions.

The nitrogen oxides emission rate averaged 353 pounds per hour during the baseline period and 199 pounds per hour during the TDF test period. The allowable nitrogen oxides emission rate is 359 pounds per hour.

During the baseline period, the carbon monoxide emission rate averaged 58.5 pounds per hour and during the TDF test period averaged 79.9 pounds per hour.

During the baseline period, benzene emissions averaged ~~0.0013~~ 0.13 pounds per hour, and during the TDF test period, averaged ~~0.0006~~ 0.06 pounds per hour.

The results of the testing demonstrate that the use of TDF has no effect on the emissions from the plant. The small change in carbon monoxide emissions while firing TDF is not significant; i.e., the change would be less than that defined by Rule 17-2.500(2)(e)2, FAC even with the plant operating 8760 hours per year. The change that did occur was, in all probability, the result of normal fluctuations in plant operations. The fact that neither total hydrocarbon emissions nor the emissions of individual hydrocarbons changed during the firing of TDF confirm that the change in carbon monoxide emissions resulted from plant operating fluctuations and not from a reduced combustion efficiency.

2.0 PROCESS DESCRIPTION

The Florida Crushed Stone CPL plant consists of a Portland cement plant, a power and a lime calciner. The Portland cement plant has a permitted kiln feed rate of 123.5 tons per hour and a permitted clinker production rate of 75 tons per hour. The plant is normally fired with coal at a maximum rate of 10.0 tons per hour, resulting in a heat input rate of approximately 240 MMBTU per hour. During the baseline test period, the coal feed rate to the plant averaged 9.1 tons per hour (at 12550 BTU per pound) for an average heat input rate of 228.4 MMBTU per hour. During the TDF test period, the coal feed rate averaged 8.2 tons per hour and the TDF feed averaged 1.2 tons per hour for a total heat input rate of 245.5 MMBTU per hour. During the baseline test period, the kiln feed rate averaged approximately 120 tons per hour and the clinker production rate averaged approximately 78 tons per hour. During the TDF test periods, the kiln feed rate averaged approximately 119 tons per hour and the clinker production rate averaged approximately 77 tons per hour. The cement plant operating data for both test periods are summarized in Tables 1 and 2.

SUMMARY OF EMISSIONS AND STACK GAS PARAMETERS
DURING BASELINE AND TDF TESTS

FLORIDA CRUSHED STONE COMPANY
HERNANDO COUNTY, FLORIDA

TEST	BASELINE	TDF
Date	9/18-20/90	9/20-24/90
PM, mass (lb/hr)	56.80	52.21
conc (gr/dscf)	0.0104	0.0103
O_2 (%)	10.4	11.7
CO_2 (%)	9.3	9.9
CO (ppm)	323	197
SO_2, mass (lb/hr)	595	551
conc (ppm)	94.1	93.5
Organics (lb/hr)*	5.187	1.420
Volatile organics	(0.177)	(0.520)
(Semi-volatile organics)	(5.01)	(0.90)
PCDD/DF (lb/hr)	0.114×10^{-6}	0.008×10^{-6}
<u>Metals (lb/hr - Blank Corrected)</u>		
Al	0.030	0.948
As	<0.004	<0.004
Ba	0.005	0.004
Cd	<0.005	<0.005
Cr	0.010	0.004
Co	0.005	<0.002
Cu	0.003	<0.001
Fe	0.992	0.892
Pb	0.130	0.036
Mg	0.036	0.081
Hg	0.025	0.006
Mo	0.018	0.018
Ni	<0.018	<0.018
Se	<0.004	<0.004
Ag	<0.001	<0.001
Ti	<0.001	0.017
Va	<0.018	<0.018
Zn	3.094	1.643

SUMMARY OF EMISSIONS AND STACK GAS PARAMETERS
DURING BASELINE AND TDF TESTS
(continued)

TEST	BASELINE	TDF
Date	9/18-20/90	9/20-24/90
<u>Stack Gas</u>		
Flow (dscfm)	637,713	599,633
Temp (°F)	385	372
Moisture (%)	7.2	7.4

*See following supplemental table for specific organic compounds.

SUMMARY OF ORGANIC COMPOUND EMISSIONS DURING BASELINE AND TDF TESTS

FLORIDA CRUSHED STONE COMPANY HERNANDO COUNTY, FLORIDA

TEST	BASELINE	TDF
Date	9/18-20/90	9/20-24/90
Volatile Organic Compounds		
Acetone	0.0247	0.0203
Benzene	0.1005	0.1712
Toluene	0.0136	0.2457
Tetrachloroethylene	<0.0025	<0.0022
Chlorobenzene	0.0074	0.0093
Ethylbenzene	<0.0026	0.0041
Xylene	0.0078	0.0151
Chloromethane	<0.0095	0.0425
Bromo methane	<0.0027	<0.0022
Carbon disulfide	<0.0029	<0.0024
Styrene	<0.0024	<0.0046
TOTAL VOCs	<0.1766	<0.5196
Semi-volatile Organic Compounds		
C_{16} - C_{18} aliphatics	5.01	0.90
Total All Organic Compounds	5.187	1.420

SUMMARY OF PLANT AND BAGHOUSE OPERATING CONDITIONS

FLORIDA CRUSHED STONE COMPANY
CEMENT/POWER/LIME PLANT
BROOKSVILLE, FLORIDA

SEPTEMBER 18-24, 1990

	Cement Plant			Power Plant		Lime Plant	
Date	Kiln Feed (tph)	Clinker Prod (tph)	Coal Feed (tph)	Power output (MW/hr)	Boiler Coal Feed (tph)	Calciner Feed (tph)	Coal to Calciner (tph)
Baseline							
9/18/90	127.25	76.35	8.54	114.08	42.1	34.7	10.8
9/19/90	123.64	74.18	8.15	113.92	43.9	30.4	9.3
9/20/90	123.06	73.84	8.23	92.54	42.2	3.29	0 (3)
AVG	124.65	74.79	8.31	106.85	42.7		
TDF							
9/20/90	122.95	73.77	7.82	92.54	42.2	3.29	0 (3)
9/21/90	125.00(1)	75.00(1)	7.20(1)	109.38	46.6	17.41	6.78
9/24/90	113.81	68.29	7.56	115.92	51.8	1.29	0 (3)
AVG	120.59	72.35	7.69	105.95	46.9		

	Baghouse			
Date	Inlet Temp. (°F)	Fan Speed (%)	Fan Current (Amps)	Pressure Drop ("H_2O)
Baseline				
9/18/90	328.5	34.88	479.33	6.5
9/19/90	327.1	34.73	474.09	6.6
9/20/90	357.2	34.90	470.20	6.3
AVG	337.6	34.83	474.54	6.5
TDF				
9/20/90	337.2	34.95	477.40	6.2
9/21/90	(2)	(2)	(2)	(2)
9/24/90	350.4	33.38	448.90	6.3
AVG	343.8	34.16	463.15	6.3

(1) Data obtained from operator's logbook rather than computer printouts.

(2) Baghouse data not available for this day.

(3) Calciner beds reconditioned.

CEMENT PLANT PRODUCTION DATA

Kiln Feed / Coal Feed

BEST AVAILABLE COPY

* Clinker Production = Kiln feed * 0.6

9/18/90

19SEP90 WEDNESDAY DAILY OPERATIONS REPORT TREND LOG 7 DAY END

H1P01 KILN FEED TOTAL K1Q04

S1F01 COAL TOTAL K1F07-S FLOW KILN FUEL OIL

	H1P01	S1F01	K1Q04 SMP	K1F07-S
	TPH	TPH	%	GPM
18SEP90 08:00	127.50	[illegible]	39.500	*
09:00	127.75	8.3750	43.000	*
10:00	127.75	8.5938	29.613	*
11:00	127.50	8.6875	35.750	*
1 12:00	126.00	8.6563	50.375	*
2 13:00	126.75	8.6250	33.500	*
3 14:00	127.50	8.6938	31.500	*
4 15:00	127.75	8.5625	30.000	*
5 16:00	127.75	8.4375	30.875	*
6 17:00	127.75	8.3438	25.813	*
18:00	127.75	8.4063	21.063	*
19:00	127.75	8.3125	26.000	*
20:00	127.75	8.3438	24.563	*
21:00	127.75	8.3750	21.750	*
22:00	126.50	8.3750	52.125	*
23:00	121.25	8.3750	*	*
19SEP90 00:00	119.75	8.3125	*	*
01:00	114.50	8.3438	35.000	*
02:00	114.50	8.4063	32.625	*
03:00	114.75	8.4375	21.938	*
04:00	116.75	8.4375	29.625	*
05:00	119.75	8.4375	33.875	*
06:00	123.25	8.3125	21.938	*
07:00	121.25	8.2813	19.375	*

Average Kiln feed = 127.25 tph

average Clinker production = 127.25 * 0.6 = 76.35 tph

average Coal feed = 8.54 tph

Kiln feed / Coal feed

BEST AVAILABLE COPY

* Clinker Production = Kiln feed * 0.6

9/19/90

20SEP90 THURSDAY DAILY OPERATIONS REPORT TREND LOG 7 DAY END

H1P01 KILN FEED TOTAL — K1J04

S1F01 COAL TOTAL — K1F07-S FLOW KILN FUEL OIL

	H1P01	S1F01	K1J04 SHP	K1F07-S
	TPH	TPH	%	GPM
19SEP90 08:00	120.75	8.1875	27.938	*
2 09:00	120.75	8.0938	33.938	*
3 10:00	121.25	8.1875	40.000	*
4 11:00	121.50	8.1563	15.344	*
5 12:00	122.25	8.4063	34.675	*
6 13:00	123.50	8.3438	47.125	*
7 14:00	124.25	8.3125	34.000	*
8 15:00	125.50	7.8750	30.750	*
9 16:00	125.75	7.8750	23.375	*
10 17:00	125.75	8.0625	27.250	*
11 18:00	125.75	8.1875	29.250	*
19:00	125.50	8.2813	27.813	*
20:00	125.75	8.3125	17.625	*
21:00	125.75	8.3125	29.000	*
22:00	125.75	8.3438	37.250	*
23:00	126.50	8.3438	19.688	*
20SEP90 00:00	127.25	8.2813	26.688	*
01:00	127.75	8.1875	36.125	*
02:00	126.75	8.0938	26.938	*
03:00	124.75	7.7688	36.125	*
04:00	120.75	7.9844	56.000	*
05:00	119.75	8.2813	27.063	*
06:00	119.75	8.2813	38.750	*
1 07:00	122.00	8.2813	41.000	*

average Kiln feed = 123.64 tph
average Clinker production = 74.18 tph
average coal feed = 8.15 tph

Kiln feed / Coal feed

BEST AVAILABLE COPY

Clinker Production = Kiln feed * 0.6

9/20/90

21SEP90 FRIDAY DAILY OPERATIONS REPORT TREND LOG 7

H1P01 KILN K1Q04
FEED TOTAL

S1F01 COAL TOTAL K1F07-S FLOW KILN FUEL OIL

	H1P01	S1F01	K1Q04	K1F07-S
			GMF	
	TPH	TPH	%	GPM
20SEP90 2 08:00	123.25	8.2500	35.375	*
3 09:00	123.75	8.0938	30.625	*
4 10:00	123.75	8.0625	47.625	*
5 11:00	~~123.75~~	~~8.0625~~	42.375	*
6 12:00	123.75	8.2813	55.750	*
7 13:00	122.50	8.4063	35.000	*
8 14:00	121.75	8.40[illegible]	33.625	
15:00	122.50	6.0000 2	75.250	*
16:00	123.25	7.6594 3	26.436	*
17:00	124.50	7.4633 4	23.750	*
18:00	122.50	7.3750	23.000	*
19:00	119.75	7.7032	40.625	*
20:00	118.00	8.0000	13.625	*
21:00	116.25	8.1563	7.1563	*
22:00	114.75	8.2188	29.813	*
23:00	115.25	8.3438	34.125	*
21SEP90 00:00	116.75	8.3438	21.688	*
01:00	117.50	8.2500	23.688	*
02:00	117.75	8.2188	24.000	*
03:00	117.75	8.2188	25.750	*
04:00	115.75	8.2500	50.250	*
05:00	114.75	8.3438	27.938	*
06:00	114.00	8.0313	4.8594	*
07:00	109.75	8.0313	10.594	*

average Kiln feed = 123.06 tph
average Clinker production = 73.84 tph
average coal feed = 8.23 tph

average Kiln feed = 122.95 tph
average Clinker Production = 73.77 tph
average coal feed = 7.82 tph

Baseline average kiln feed = 124.65 tph
Baseline average Clinker Production = 74.79 tph
Baseline average coal feed = 8.31 tph

9/24/90

Kiln feed / Coal feed

Clinker Production = Kilnfeed * 0.6

[illegible] DAILY OPERATIONS REPORT [illegible]

	H1P01 KILN FEED TOTAL / S1F01 COAL TOTAL		K1Q04 / K1F07 FLOW KILN FUEL OIL	
	H1P01	S1F01	K1Q04	[illegible]
	TPH	[illegible]	%	GPM
24SEP90 08:00	[illegible]	[illegible]	38.500	
1 09:00	[illegible]	[illegible]	36.500	
2 10:00	119.75	8.5000	[illegible]	
3 11:00	120.25	8.4375	[illegible]	
4 12:00	121.75	8.2188	[illegible]	
5 13:00	[illegible]	[illegible]	[illegible]	
6 14:00	[illegible]	[illegible]	[illegible]	
7 15:00	13[illegible].50	7.4688	[illegible]	
8 16:00	126.00	7.7657	19.750	
9 17:00	100.00	7.5469	[illegible]	
10 18:00	[illegible]	[illegible]	[illegible]	
19:00	[illegible]	[illegible]	[illegible]	
20:00	4.[illegible]	-.0489	[illegible]	
21:00	4.2344	-.0489	[illegible]	
22:00	3.8[illegible]	-.0489	[illegible]	
23:00	[illegible]	[illegible]	28.250	
25SEP90 00:00	[illegible]	[illegible]	[illegible]	
01:00	[illegible]	[illegible]	[illegible]	
02:00	2.7344	-.0489	[illegible]	
03:00	[illegible]	-.0487	[illegible]	
04:00	[illegible]	[illegible]	89.750	
05:00	[illegible]	[illegible]		
06:00	[illegible]	[illegible]		
07:00	[illegible]	-.0461		

average Kiln feed : 113.81 tph
average Clinker Production = 68.29 tph
average Coal feed = 7.56 tph

TDF Average Kiln feed = 120.59 tph

TDF Average Clinker Production = 72.35 tph

TDF Average Coal feed rate = 7.69 tph

NITROGEN OXIDES EMISSION RATES UNDER BASELINE AND SHREDDED TDF FIRING CONDITIONS

FLORIDA CRUSHED STONE COMPANY
CEMENT/POWER/LIME PLANT

BROOKSVILLE, FLORIDA

OCTOBER 14-16, 1991

KOOGLER & ASSOCIATES
ENVIRONMENTAL SERVICES
4014 N.W. 13TH STREET
GAINESVILLE, FL 32609
(904) 377-5822

KOOGLER & ASSOCIATES

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KOOGLER & ASSOCIATES

1.0 INTRODUCTION

The Florida Crushed Stone Company (FCS) operates a cement/power/lime (CPL) plant in Hernando County, northwest of Brooksville. The cement plant was permitted under Florida Department of Environmental Regulation (FDER) Air Construction Permit AC27-118674 and the facility was permitted under Permit PSD-FL-091.

In March 1990, FCS applied to FDER requesting approval to burn tire derived fuel (TDF) as a supplemental heat source in the cement kiln of the CPL plant. On June 6, 1990, FDER issued an amendment to the referenced permits authorizing performance tests on the cement plant while using TDF to supply up to 15 percent of the heat input to the kiln. In September 1990, the tests were conducted to measure air pollutant emissions from the CPL plant while the plant was operating under baseline conditions and with shredded TDF supplying up to 15 percent of the heat input to the plant. During this test period, the nitrogen oxides emission measurements were flawed by laboratory analyses. In September 1991, FCS requested approval from FDER to conduct additional tests with shredded TDF so that nitrogen oxides emissions could be measured. On October 9, 1991, FDER authorized FCS to conduct tests for nitrogen oxides under baseline conditions and while using shredded TDF to provide up to 15 percent of the heat input to the plant. These tests were conducted during the period October 14-16, 1991, and the results are reported herein.

The CPL plant consists of a Portland cement plant having a kiln feed rate of 123.5 tons per hour and a clinker production rate of 75 tons per hour, a power plant with a maximum permitted generating rate of 125 megawatts, and a lime calciner with a nominal production rate of 20 tons per hour. All three of the plants are normally fired with low-sulfur coal.

The approval granted by FDER on October 9, 1991, authorized two 24-hour test periods; one representing baseline or normal plant operating conditions and the second representing shredded TDF firing conditions. The baseline test was conducted during the period 0830 on October 14, 1991, through 0800 on October 15, 1991. The shredded TDF firing test was conducted during the period 0940 on October 15, 1991, through 0940 on October 16, 1991.

During the TDF test period, shredded TDF was used to provide 14.5 percent of the heat input to the cement plant; or approximately 33 MMBTU per hour heat input. The shredded TDF firing rate corresponding to this heat input averaged 1.0 tons per hour over the 24-hour TDF test period.

During the baseline period, the nitrogen oxides emission rate averaged 678.1 pounds per hour and during the shredded TDF test period, the nitrogen oxides emission rate averaged 654.0 pounds per hour. The results of the testing demonstrate that the use of shredded TDF has no effect on nitrogen oxides emissions from the CPL plant.

2.0 PROCESS DESCRIPTION

The Florida Crushed Stone CPL plant consists of a Portland cement plant, a power and a lime calciner. The Portland cement plant has a permitted kiln feed rate of 123.5 tons per hour and a clinker production rate of 75 tons per hour. The plant is normally fired with coal at a maximum rate of 10.0 tons per hour, resulting in a heat input rate of approximately 240 MMBTU per hour. During the baseline test period, the coal feed rate to the plant averaged 8.5 tons per hour (at 12550 BTU per pound) for an average heat input rate of 213.4 MMBTU per hour. During the shredded TDF test period, the coal feed rate averaged 8.1 tons per hour and the shredded TDF feed averaged 1.0 tons per hour for a total heat input rate of 236.4 MMBTU per hour. During both test periods, the kiln feed rate averaged approximately 120 tons per hour and the clinker production rate averaged approximately 78 tons per hour. The cement plant operating data for both test periods are summarized in Tables 1 and 2.

The CPL power plant has a maximum permitted generating capacity of 125 megawatts and a maximum permitted heat input of 1234 MMBTU per hour. During the baseline test period, the generating rate of the power plant averaged 100 megawatts and the coal feed rate averaged 37.1 tons per hour (a heat input rate of 931.2 MMBTU per hour). During the shredded TDF tests, the generating rate of the plant averaged 96 megawatts and the coal feed rate averaged 35.8 tons per hour (898.6 MMBTU per hour).

The lime calciner is an integral part of the power plant. During the baseline test period, the feed rate to the calciner averaged 25.9 tons per hour and the lime production rate 9.2 tons per hour. The coal feed rate to the calciner averaged 11.4 tons per hour for a heat input rate of 286.1 MMBTU per hour. During the shredded TDF test period, the feed rate to the calciner averaged 23.6 tons per hour and the lime production rate averaged 5.2 tons per hour. The coal feed rate to the lime plant averaged 8.2 tons per hour, or 205.8 MMBTU per hour.

The operating parameters of the power plant and lime plant during the two test periods are summarized in Tables 1 and 2.

521-02-10

Memorandum

Via Fax: 713-653-8567
Via Email: Jgill@CemexUSA.com

TO: Jeet Gill, CEMEX
FROM: John B. Koogler, Ph.D., P.E.
DATE: January 30, 2003
SUBJECT: CEMEX Brooksville Cement Plant
Response to FDEP Letter

The Florida Department of Environmental Protection (FDEP) letter of December 12, 2002 to Charlie Walz regarding changes to the Permit Conditions for Kiln No. 1 and Kiln No. 2, anticipates a PSD Review to effect the changes. In my opinion, the changes requested by CEMEX are not *modifications* as defined by Department Rule 62-210.200(169), F.A.C., and are therefore not subject to the PSD Review process. My suggested response to FDEP is to provide some of the basic information requested by their letter of December 12, 2002, and to incorporate in the response our rationale for determining that the requested changes do not require a PSD Review.

The three changes requested by CEMEX are:

- Adding whole tire derived fuel (TDF) as a supplemental fuel for Kiln No. 2,
- Substituting an annual preheater feed limit in place of the presently permitted 30-day rolling average preheater feed rate limit on both kilns, and
- Adding petroleum coke (petcoke) as an alternative fuel for both kilns.

To support these requests, the Department requires that the request be submitted on appropriate FDEP forms (in other words, as a permit application) and sets forth four areas of information that are to be provided. The information requested includes:

1) **Information on the TDF Feed Mechanism**
2) **Operational Information**
   a) operating records for each kiln for the past five years
   b) information on the introduction of kiln baghouse dust back into the preheater feed system
   c) information on the ash content of the presently permitted coal
3) **Information on the use of petcoke as a fuel**
4) **Information on the Effects of TDF and Petcoke on Mercury and Vanadium Emissions.**

I've talked with Greg DeAngelo, the author of the Department letter and the information required by the Department is not as onerous as what appeared in the letter. My suggested response is to provide pertinent information in the form of a construction permit application and include:

- Information on the tire feed mechanism
- Information on the annual hours of operation and annual preheater feed for each kiln for the past five years
- A description of where kiln baghouse dust is reintroduced back into the preheater feed system
- Information on the ash content of coal and the fate of steel in TDF
- Analyses of coal petcoke
- Information on experience with burning TDF in Kiln No. 1 and with burning petcoke in Knoxville

In submitting this information, we should stress the opinion that there will be no change in the emission rates of any regulated pollutant resulting from the use of TDF or petcoke. DeAngelo stated that all we needed to do was support this position with data. As the use of these two fuels would result in no increase in emissions, a PSD Review will not be triggered. Similarly, we should state the opinion that changing from a 30-day rolling average preheater feed rate to a 12-month rolling average preheater feed rate will not result in any production increase and hence, no increase in emissions. In both cases, the annual preheater feed would be 1,314,000 tons per year (150 tph x 8760 hr/year).

To demonstrate there will be no change in emissions as a result of burning TDF and petcoke, we can use previously reported TDF data from Kiln No. 1 and petcoke emission data from your Knoxville plant and/or elsewhere. DeAngelo stated the previously reported TDF data would be acceptable. If similar comparative data are available from petcoke, we need to provide it. Alternatively we can propose a "before" and "after" test with petcoke and do a statistical comparison of emission rates in accordance with 40 CFR 60, Appendix C.

To provide the response I have outlined, the following information is required:

1. TDF Feed
   - Details on the TDF management system if different from that for Kiln No. 1
   - Details on the TDF feed system. If a manufactured system is proposed, we need to provide manufacturer drawings, or if a fabricated system will be used, we can provide a conceptual drawing.
   - The fate of steel in TDF-will this replace iron previously added in the raw mill and is all of the steel consumed in the clinker?
   - A drawing showing the location of the TDF feed. DeAngelo suggested we note any differences between the location of the proposed TDF feeder for Kiln No. 2 and the location of the feeder on Kiln No. 1.
   - The oxygen and CO levels within the pyroprocessing system requested by the Department are not necessary; we need only address changes in CO *emissions*.

2. Information on Kiln Systems
   - The annual operating hours and annual preheater feed for each kiln for the past five years. In my opinion, this is not relative as we are claiming there is no annual change in preheater feed as a result of changing from a 30-day rolling average to a 12-month rolling average. But, to avoid the perception of providing the Department little of what they requested, I suggest we provide this information. Let me have your thoughts.
   - A diagram showing where the preheater feed is measured and where kiln baghouse dust is reintroduced into the feed system. This matter came up recently while the Department was reviewing a permit change requested by Florida Rock. It has to do with whether or not the baghouse duct is double counted as preheater feed; once as raw meal and again as baghouse dust. DeAngelo stated that this request was for informational purposes only.

3. Petcoke Information
   - A typical analysis of petcoke and coal
   - Experience and emission data from burning petcoke in Knoxville and/or elsewhere

Once I have this information, a response can be prepared to the Department's December 12, 2002 letter in a matter of days. If you have any questions regarding matters discussed herein, please call me at 352-377-5822.

JBK/jhm
cc: Charles E. Walz, CEMEX Brooksville

Attachment 4

Excerpts from EPA Report

Air Emissions From Scrap Tire Combustion

CEMEX Cement, Inc.
Brooksville Cement Plant
Hernando County, Florida

KOOGLER & ASSOCIATES
ENVIRONMENTAL SERVICES

United States Environmental Protection Agency
Office of Research and Development Washington, DC 20460
EPA-600/R-97-115
October 1997

CLEAN AIR TECHNOLOGY CENTER

EPA

AIR EMISSIONS FROM SCRAP TIRE COMBUSTION

Prepared for:

Office of Air Quality Planning and Standards
and
U.S. - Mexico Border Information Center on Air Pollution
Centro Información sobre Contaminación de Aire

C I C A

FOREWORD

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory is the Agency's center for investigation of technological and management approaches for reducing risks from threats to human health and the environment. The focus of the Laboratory's research program is on methods for the prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites and groundwater; and prevention and control of indoor air pollution. The goal of this research effort is to catalyze development and implementation of innovative, cost-effective environmental technologies; develop scientific and engineering information needed by EPA to support regulatory and policy decisions; and provide technical support and information transfer to ensure effective implementation of environmental regulations and strategies.

This publication has been produced as part of the Laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

E. Timothy Oppelt, Director
National Risk Management Research Laboratory

EPA REVIEW NOTICE

EPA-600/R-97-115
October 1997

AIR EMISSIONS FROM SCRAP TIRE COMBUSTION

Prepared by:

Joel I. Reisman
E.H. Pechan & Associates, Inc.
2880 Sunrise Boulevard, Suite 220
Rancho Cordova, CA 95742

EPA Contract No. 68-D30035
Work Assignment No. III-111

EPA Project Manager:

Paul M. Lemieux
Air Pollution Technology Branch
Air Pollution Prevention and Control Division
National Risk Management Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

Prepared for:

U.S.-Mexico Border Information Center on Air Pollution
Centro Informacion sobre Contaminacion de Aire/CICA
and
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711
and
Office of Research and Development
U.S. Environmental Protection Agency
Washington, DC 20460

ABSTRACT

Two to three billion (2-3 x10^9) scrap tires are in landfills and stockpiles across the United States, and approximately one scrap tire per person is generated every year. Scrap tires represent both a disposal problem and a resource opportunity (e.g., as a fuel and in other applications). Of the many potential negative environmental and health impacts normally associated with scrap tire piles, the present study focuses on (1) examining air emissions related to open tire fires and their potential health impacts, and (2) reporting on emissions data from well designed combustors that have used tires as a fuel.

Air emissions from two types of scrap tire combustion are addressed: uncontrolled and controlled. Uncontrolled sources are open tire fires, which produce many unhealthful products of incomplete combustion and release them directly into the atmosphere. Controlled combustion sources (combustors) include boilers and kilns specifically designed for efficient combustion of solid fuel.

Very little data exist for devices that are not well-designed and use scrap tires for fuel. These sources include fireplaces, wood stoves, small kilns, small incinerators, or any device with poor combustion characteristics. Air emissions from these types of devices are likely between that of open burning and a combustor. However, there is serious concern that the emissions are much more similar to those of an open tire fire than a combustor.

Open tire fires are discussed. Data from a laboratory test program on uncontrolled burning of tire pieces and ambient monitoring at open tire fires are presented and the emissions are characterized. Mutagenic emission data from open burning of scrap tires are compared to mutagenic data for other fuels from both controlled and uncontrolled combustion.

A list of 34 target compounds representing the highest potential for health impacts from open tire fires is presented. The list can be used to design an air monitoring plan in order to evaluate the potential for health risks in future events.

Methods for preventing and managing tire fires are reviewed. Recommendations are presented for storage site design, civilian evacuation, and fire suppression tactics.

Air emissions data from the use of tires as fuel are discussed. The results of a laboratory test program on controlled burning of tire-derived fuel (TDF) in a Rotary Kiln Incinerator Simulator (RKIS) are presented. Based on the results of the RKIS test program, it was concluded that, with the exception of zinc emissions, potential emissions from TDF are not expected to be very much different than from other conventional fossil fuels, as long as combustion occurs in a well-designed, well-operated, and well-maintained combustion device.

Source test data from 22 industrial facilities that have used TDF are presented: 3 kilns (2 cement and 1 lime) and 19 boilers (utility, pulp and paper, and general industrial applications). In general, the results indicate that properly designed existing solid fuel combustors can supplement their normal fuels (coal, wood, and various combinations of coal, wood, oil, coke, and sludge) with 10 to 20% TDF and still satisfy environmental compliance emissions limits. Furthermore, results from a dedicated tires-to-energy (100% TDF) facility indicate that it is possible to have emissions much lower than produced by existing solid-fuel-fired boilers (on a heat input basis), when properly designed and the facility is controlled.

ACKNOWLEDGMENTS

This document was prepared for Paul M. Lemieux of EPA's National Risk Management Research Laboratory (NRMRL) by Joel I. Reisman of E. H. Pechan and Associates, Inc., Sacramento, CA. The author would like to thank Michael Blumenthal of the Scrap Tire Management Council for his assistance in collecting source test data and his valuable referrals and insightful thoughts on the utilization of scrap tires for productive purposes. Thanks are also extended to Paul Ruesch, EPA Region 5, for his assistance in providing contacts and other useful information. Others who provided valuable assistance are Rich Nickle, Agency for Toxic Substances and Disease Registry; Paul Koziar, Wisconsin Department of Natural Resources; Bruce Peirano, EPA ORD; Alan Justice, Illinois Department of Commerce and Community Affairs; Jim Daloia, EPA Response and Prevention Branch, Edison, NJ; and Gary Foureman, EPA National Center for Environmental Assessment.

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ABBREVIATIONS AND ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
AWMA	Air and Waste Management Association
BaP	benzo(a)pyrene
BTU	British thermal unit
CTPV	coal tar pitch volatiles
EPA	U.S. Environmental Protection Agency
ERT	EPA's Emergency Response Team
ESP	electrostatic precipitator
GC/MS	gas chromatography/mass spectroscopy
HAP	hazardous air pollutant
HPLC	high-pressure liquid chromatography
IAFC	International Association of Fire Chiefs
IDLH	Immediately Dangerous to Life and Health
NAAQS	National Ambient Air Quality Standard
NIOSH	National Institute for Occupational Safety and Health
NSP	Northern States Power
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCDD	polychlorinated p-dibenzodioxins
PCDF	polychlorinated dibenzofurans
PIC	product of incomplete combustion
PM	particulate matter
PM_{10}	particulate matter less than 10 µm in aerodynamic diameter
PNA	polynuclear aromatic hydrocarbon
RfC	inhalation reference concentration
RKIS	rotary kiln incinerator simulator
STMC	Scrap Tire Management Council
TDF	tire-derived fuel
TLV	threshold limit value
TPCHD	Tacoma-Pierce County Health Department
TSP	total suspended particulate
TWA	time-weighted average
UPA	United Power Association
VOC	volatile organic compound
VOST	Volatile Organic Sampling Train
WDNR	Wisconsin Department of Natural Resources
WP&L	Wisconsin Power and Light

EXECUTIVE SUMMARY

Two to three billion (2-3 x10^9) scrap tires are in landfills and stockpiles across the United States, and approximately one scrap tire per person is generated every year. Scrap tires represent both a disposal problem and a resource opportunity (e.g., as a fuel and in other applications). Of the many potential negative environmental and health impacts normally associated with scrap tire piles, the present study focuses on (1) examining air emissions related to open tire fires and their potential health impacts, and (2) reporting on emissions data from well designed combustors that have used tires as a fuel.

Air emissions from two types of scrap tire combustion are addressed: uncontrolled and controlled. Uncontrolled sources are open tire fires, which produce many unhealthful products of incomplete combustion and release them directly into the atmosphere. Controlled combustion sources (combustors) are, for example, boilers and kilns specifically designed for efficient combustion of solid fuel. Combustor emissions are much lower and more often than not, these sources also have appropriate add-on air pollution control equipment for the control of particulate emissions.

Very little data exist for devices that are not well-designed and use scrap tires for fuel. These sources include fireplaces, wood stoves, small kilns, small incinerators, or any device with poor combustion characteristics. Air emissions from these types of devices are likely between that of open burning and a combustor. There is serious concern that emissions would be more like those of an open tire fire than a well-designed combustor; however, emissions testing would have to be conducted to confirm this.

Open Tire Fires

Air emissions from open tire fires have been shown to be more toxic (e.g., mutagenic) than those of a combustor, regardless of the fuel. Open tire fire emissions include "criteria" pollutants, such as particulates, carbon monoxide (CO), sulfur oxides (SO_x), oxides of nitrogen (NO_x), and volatile organic compounds (VOCs). They also include "non-criteria" hazardous air pollutants (HAPs), such as polynuclear aromatic hydrocarbons (PAHs), dioxins, furans, hydrogen chloride, benzene, polychlorinated biphenyls (PCBs); and metals such as arsenic, cadmium, nickel, zinc, mercury, chromium, and vanadium. Both criteria and HAP emissions from an open tire fire can represent significant acute (short-term) and chronic (long-term) health hazards to firefighters and nearby residents. Depending on the length and degree of exposure, these health effects could include irritation of the skin, eyes, and mucous membranes, respiratory effects, central nervous system depression, and cancer. Firefighters and others working near a large tire fire should be equipped with respirators and dermal protection. Unprotected exposure to the visible smoke plume should be avoided.

Data from a laboratory test program on uncontrolled burning of tire pieces and ambient monitoring at open tire fires are presented and the emissions are characterized. Mutagenic emission data from open burning of scrap tires are compared to other types of fuel combustion. Open tire fire emissions are estimated to be 16 times more mutagenic than residential wood combustion in a fireplace, and 13,000 times more mutagenic than coal-fired utility emissions with good combustion efficiency and add-on controls.

A list of 34 target compounds representing the highest potential for inhalation health impacts from open tire fires was developed by analyzing laboratory test data and open tire fire data collected at nine tire fires. The list can be used to design an air monitoring plan in order to evaluate the potential for health risks in future events.

Methods for preventing and managing tire fires are presented. Recommendations are presented for storage site design, civilian evacuation, and fire suppression tactics. For example, tire piles should not exceed 6 m (20 ft) in height; maximum outside dimensions should be limited to 76 m (250 ft) by 6 m (20 ft). Interior fire breaks should be at least 18 m (60 ft) wide. Civilians should be evacuated when they may be subject to exposure by the smoke plume. Fire suppression tactics are site and incident-specific and firefighters should have specialized training to deal effectively with them.

Other Impacts from Open Tire Burning

The scope of this report is limited to airborne emissions. However, significant amounts of liquids and solids containing dangerous chemicals can be generated by melting tires. These products can pollute soil, surface water, and ground water and care must be taken to properly manage these impacts as well.

Controlled Combustion

The results of a laboratory test program on controlled burning of tire-derived fuel (TDF) in a Rotary Kiln Incinerator Simulator (RKIS) are presented. In all, 30 test conditions were run, with the TDF feed rate varying from 0 to 21.4% of heat input. The test conditions were achieved by varying kiln firing rate, combustion air flow rate, and tire feed rate. The majority of the tests were conducted with a steady-state feed of TDF. However, variations in the mode of TDF feeding were simulated in two tests to evaluate the impact of transient operation on air emissions.

Based on the results of the RKIS test program, it can be concluded that, with the exception of zinc emissions, potential emissions from TDF are not expected to be very much different than from other conventional fossil fuels, as long as combustion occurs in a well-designed, well-operated and well-maintained combustion device. However, as with most solid fuel combustors, an appropriate particulate control device would likely be needed in order to obtain an operating permit in most jurisdictions in the United States.

Test data, from 22 industrial facilities that have used TDF are presented: 3 kilns (2 cement and 1 lime) and 19 boilers (utility, pulp and paper, and general industrial applications). All sources had some type of particulate control. In general, the results indicate that properly designed existing solid fuel combustors can supplement their normal fuels, which typically consist of coal, wood, coke and various combinations thereof, with 10 to 20% TDF and still satisfy environmental compliance emissions limits. Furthermore, results from a dedicated tires-to-energy (100% TDF) facility indicate that it is possible to have emissions much lower than produced by existing solid-fuel-fired boilers (on a heat input basis) with a specially designed combustor and add-on controls.

Depending on the design of the combustion device, some tire processing is usually necessary before it is ready to be used as a fuel. Processing includes dewiring and shredding and/or other sizing techniques. Some specially designed boilers and cement kilns have had their feed systems designed to accept whole tires.

TDF has been used successfully in properly designed combustors with good combustion control and appropriate add-on controls, particularly particulate controls, such as electrostatic precipitators or fabric filters. The resultant air emissions can usually satisfy environmental compliance limits even with TDF representing up to 10 to 20% of the fuel requirements. Twenty percent supplemental TDF is perceived as an upper limit in most existing boilers because of boiler limitations on fuel or performance. However, dedicated tire-to-energy facilities specifically designed to burn TDF as their only fuel have been demonstrated to achieve emission rates much lower than most solid fuel combustors.

Conclusiòn

Air emissions have been documented from open burning of scrap tires and from TDF in well-designed combustors. Laboratory and field studies have confirmed that open burning produces toxic gases that can represent significant acute and chronic health hazards. However, field studies have also confirmed that TDF can be used successfully as a 10 - 20% supplementary fuel in properly designed solid-fuel combustors with good combustion control and add-on particulate controls, such as electrostatic precipitators or fabric filters. Furthermore, a dedicated tire-to-energy facility specifically designed to burn TDF as its only fuel has been demonstrated to achieve emission rates much lower than most solid fuel combustors.

No field data were available for well-designed combustors with no add-on particulate controls. Laboratory testing of an RKIS indicated that efficient combustion of supplementary TDF can destroy many volatile and semi-volatile air contaminants. However, it is not likely that a solid fuel combustor without add-on particulate controls could satisfy air emission regulatory requirements in the U.S.

No data were available for poorly designed or primitive combustion devices with no add-on controls. Air emissions from these types of devices would depend on design, fuel type, method of feeding, and other parameters. There is serious concern that emissions would be more like those of an open tire fire than a well-designed combustor. Stack emissions test data would need to be collected and analyzed to confirm this.

3.0 TIRES AS FUEL

Tire-derived fuel (TDF) has been successfully utilized as a source of energy in cement and lime manufacturing, steam generation for electricity, and other industrial processes. Results of source test reports have been collected and are summarized by source type. Typical sources that have been successful in integrating TDF with other fuels are:

- Cement Kilns;
- Pulp and Paper Mills;
- Utilities (including dedicated Tire-to-Energy facilities); and
- General Industrial Boilers.

TDF has long been recognized as a potential fuel. It compares favorably to coal, as presented in Table 16. It has a higher heating value than coal, and less moisture content. TDF contains more carbon, about as much sulfur as medium-sulfur coal, but much less fuel-bound nitrogen.

Whether burning TDF in a new facility or as a modification to an existing facility, several issues must be considered. One consideration is the need convert scrap tires into a useable fuel. This requires a system to dewire, and shred, or otherwise size the tires so they can accommodated by a combustor. In addition to aiding in feeding, the sized fuel generally allows for more efficient combustion. However, some large combustor configurations, such as cement kilns, wet-bottom boilers, and stoker-grate boilers can be modified to accept whole tires. Modifications to hardware, combustion practices and/or other operating practices may also be necessary in order to burn TDF. These modifications are case-specific, and must be addressed by engineering staff when considering using TDF.

3.1 Laboratory Simulation of TDF Emissions

Pilot-scale emissions testing of TDF was conducted in a 73 kW (250,000 BTU/hr) rotary kiln incinerator simulator (RKIS) in EPA's Environmental Research Center in Research Triangle Park, NC (Lemieux, 1994). This size simulator has been established as exhibiting the salient features of full-scale units with ratings 20 to 40 times larger.

The test program was undertaken to provide assistance to state and local pollution agencies in establishing permitting guidelines and evaluating permit applications for facilities seeking to supplement its fuel with tires or TDF. A list of analytes would defer some of the expenses of stack sampling.

The purposes of the test program were to (1) generate a profile of target analytes for guidance in preparing a full-scale stack sampling program and (2) provide insight into the technical issues related to controlled combustion of scrap tires. Because of the differences in scaling, such as gas-phase mixing phenomena and other equipment-specific factors, Lemieux specifically states that emission factors from the RKIS cannot be directly

TABLE 16. COMPARATIVE FUEL ANALYSIS BY WEIGHT (JONES, 1990)

Fuel	Composition (percent)							Heating Value	
	Carbon	Hydrogen	Oxygen	Nitrogen	Sulfur	Ash	Moisture	kJ/kg	Btu/lb
TDF	83.87	7.09	2.17	0.24	1.23	4.78	0.62	36,023	15,500
Coal	73.92	4.85	6.41	1.76	1.59	6.23	5.24	31,017	13,346

extrapolated to full-scale units. Furthermore, there are significant differences between kilns and other combustion devices, such as boilers, and the study does not address these issues. Nevertheless, the simulator is useful in examining the fundamental phenomena of TDF combustion and to gain an understanding of the qualitative trends that would be found in a full-scale rotary kiln.

The TDF tested was wire-free crumb rubber sized to <0.64 cm (<1/4 in.). It was combusted at several combinations of feed rate, temperature, and kiln oxygen concentration. The TDF was combusted with natural gas as the primary fuel. Samples were taken to examine volatile and semi-volatile organics, PCDD/PCDF, and metal aerosols. Data were collected to determine the effects of feed rates, type of feeding, i.e., continuous versus batch, and combustion controls on emissions. The data were taken in the exhaust stream prior to any add-on air pollution control devices.

The study addressed two issues: (1) the influence of the mode of tire feeding, for example, whole tires versus shredded tires, on the PICs, and (2) the potential for air toxic emissions not normally found when burning conventional fuels.

The TDF material used in the test program was analyzed and the proximate and ultimate analyses and metals analysis results are presented in Table 17. TDF contains significant amounts of zinc, since zinc is used extensively in the tire manufacturing process.

In all, thirty test conditions were run, with the TDF feed rate varying from 0% to 21.4% of heat input. The test conditions were achieved by varying kiln firing rate, combustion air flow rate, and tire feed rate. The majority of the tests were conducted with a steady-state feed of TDF. Variations in the mode of TDF feeding were evaluated in two tests. In one test, the kiln air flow rate was ramped up and down every 10 minutes ("ramp") to change the kiln oxygen concentration to simulate transient operation. In the other, TDF was introduced in 300 g batches spaced ten minutes apart ("batch") to simulate transient operation, such as feeding whole tires at periodic intervals.

VOCs were collected by a Volatile Organic Sampling Train (VOST) and analyzed with a gas chromatograph/mass spectrometer (GC/MS). The majority of the VOCs were very near to or below the detection limits of the equipment. Estimated emissions of VOCs for five representative test runs are presented in Table 18.

PAHs were analyzed with a Continuous Emission Monitor (CEM) PAH analyzer. PAH emissions were fairly insensitive to temperature and oxygen for the range of conditions studied, however, increasing TDF feed rates tended to increase PAH emissions for all oxygen levels. Overall, it was observed that supplementing natural gas with TDF tended to increase PAH emissions, but not dramatically, provided that steady-state operation is maintained.

Semi-volatile organic compounds (SVOC) and bulk particulate were collected by isokinetic sampling protocols with a Modified Method 5 (MM5) train. Data from the analyses did not indicate that SVOC were present in detectable concentrations. Lemieux

TABLE 17. PROXIMATE AND ULTIMATE ANALYSIS OF RKIS TEST TDF

Proximate Analysis	
Moisture	0.84%
Volatile Matter	65.52%%
Ash	7.20%
Fixed Carbon	26.44%
Ultimate Analysis	
Moisture	0.84%
Carbon	76.02%
Hydrogen	7.23%
Kjeldahl Nitrogen l Nitrogen Nitro	0.34%
Sulfur	1.75%
Total Halogens (calculated as chlorine)	0.31%
Ash	7.20%
Metals	
Cadmium	<5 ppm
Chromium	<5 ppm
Iron	295 ppm
Lead	51 ppm
Zinc	2.14%
Heating Value	37,177 kJ/kg

TABLE 18. ESTIMATED EMISSIONS OF VOCS - RKIS TEST RESULTS (BASE FUEL - NATURAL GAS)

Compound	0% TDF (Natural Gas Only)		7% TDF (steady-state)		17% TDF (steady-state)		19% TDF (ramp)		15% TDF (batch)	
	ng/J	lb/MMBtu	ng/J	lb/MMBtu	ng/J	lb/MMBtu	ng/J	lb/MMBtu	ng/J	lb/MMBtu
1,1,1 Trichloroethane	2.24E-04	5.21E-07	3.75E-04	8.72E-07	4.41E-04	1.03E-06	2.24E-04	5.21E-07	2.17E-04	5.05E-07
2-Methyl propene	9.60E-04	2.23E-06	2.30E-03	5.35E-06	1.94E-03	4.51E-06	7.37E-04	1.71E-06	2.33E-04	5.42E-07
2-Methyl-2-propanol benzene	2.13E-04	4.95E-07	2.15E-04	5.00E-07	1.81E-03	4.21E-06	2.24E-04	5.21E-07	2.33E-04	5.42E-07
Benzene	6.71E-04	1.56E-06	1.25E-04	2.91E-07	1.25E-04	2.91E-07	7.36E-03	1.71E-05	2.19E-02	5.09E-05
Bromomethane	2.00E-04	4.65E-07	2.15E-04	5.00E-07	2.58E-04	6.00E-07	1.22E-03	2.84E-06	3.82E-04	8.88E-07
Carbon disulfide	2.13E-04	4.95E-07	3.43E-04	7.98E-07	2.30E-04	5.35E-07	2.24E-04	5.21E-07	9.43E-04	2.19E-06
Chlorobenzene	2.13E-04	4.95E-07	2.15E-04	5.00E-07	2.30E-04	5.35E-07	2.24E-04	5.21E-07	2.20E-04	5.12E-07
Chloromethane	2.40E-04	5.58E-07	7.15E-04	1.66E-06	3.90E-03	9.07E-06	2.38E-02	5.53E-05	5.16E-02	1.20E-4
Ethylbenzene	2.13E-04	4.95E-07	2.15E-04	5.00E-07	2.70E-04	6.28E-07	2.24E-04	5.21E-07	4.96E-04	1.15E-06
Heptane	2.13E-04	4.95E-07	2.83E-04	6.58E-07	2.48E-04	5.77E-07	2.24E-04	5.21E-07	2.33E-04	5.42E-07
Hexane	2.01E-04	4.67E-07	2.45E-04	5.70E-07	2.45E-04	5.70E-07	2.24E-04	5.21E-07	2.36E-04	5.49E-07
Iodomethane	2.13E-04	4.95E-07	2.15E-04	5.00E-07	2.30E-04	5.35E-07	2.35E-04	5.47E-07	2.33E-04	5.42E-07
m,p-Xylene	6.21E-04	1.56E-06	4.17E-04	9.70E-07	1.06E-03	2.47E-06	2.64E-04	6.14E-07	1.78E-03	4.14E-06
Nonane	2.77E-04	6.44E-07	7.29E-04	1.70E-06	4.25E-04	9.88E-07	2.24E-04	5.21E-07	2.71E-04	6.30E-07
o-Xylene	1.85E-04	4.30E-07	2.15E-04	5.00E-07	3.18E-04	7.40E-07	2.24E-04	5.21E-07	5.24E-04	1.22E-06
Styrene	2.63E-04	6.12E-07	7.85E-04	1.83E-06	7.16E-04	1.67E-06	7.03E-04	1.63E-06	7.80E-04	1.81E-06
Toluene	3.97E-04	9.23E-07	5.02E-04	1.17E-06	4.64E-04	1.08E-06	3.48E-04	8.09E-07	1.29E-03	3.00E-06

(1994) concludes that when TDF is combusted in a well-designed and well-operated facility, emissions of SVOCs are not significantly different from natural gas.

PCDD and PCDF were collected during two test conditions: 0% TDF and 17% TDF (steady-state). No PCDD/PCDF were detected in either test.

Metal aerosol samples were collected during two test conditions; 0% TDF and 17% TDF (steady-state). Estimated metals emissions from these tests are presented in Table 19. The TDF-only column is a linear extrapolation and was calculated by dividing the values in the TDF+natural gas column by 17% (0.17). Elevated emissions of arsenic, lead, and zinc were found in the stack gas. Zinc was present in significant concentrations.

Total particulate matter (PM) measurements were made from the MM5 and MultiMetals trains. The PM results are presented in Table 20. The PM emissions represent uncontrolled emissions, such as found prior to any installed PM control device. As expected, the PM emissions during TDF combustion are higher than those from natural gas combustion alone.

The PM results from the batch feed run are significantly higher than for any of the others. This may suggest that burning TDF in batches, which roughly approximates feeding of whole tires, has the potential to form significant transient emissions. This phenomenon could be exacerbated in a system that exhibits significant vertical gas-phase stratification, or operates at low excess air levels, such as cement kilns. However, Lemieux (1994) believes that the size of the facility will serve to mitigate the intensity of transient emissions resulting from batch charging of tires of TDF, because for an extremely large facility, a constant stream of whole tires may roughly approximate steady-state operation. Even so, Lemieux (1994) cautions that the potential for generation of large transients should not be ignored, especially in smaller facilities.

Based on this test program, it is concluded that, with the exception of zinc emissions, potential emissions from TDF are not expected to be very much different than from other conventional fossil fuels, as long as combustion occurs in a well-designed, well-operated and well-maintained combustion device. If unacceptable particulate loading occurs as a result of zinc emissions, an appropriate particulate control device would need to be installed.

3.2 Source Test Data - Utility and Industrial Facilities

Source test data from a variety of source types have been collected and are presented in Table 21 and Appendix Tables A-1 through A-22. Test data of criteria pollutant emissions from seven utility boilers are summarized in Table 21. In general, particulates and NO_x decreased as the percent TDF increased. Emissions of SO_x did not follow a pattern. There are insufficient data on CO emissions from utilities to draw a conclusion.

Data summaries from field source tests are presented in the Appendix. Beginning with Table A-1, each table is divided into two parts. Part "a" presents a summary of

TABLE 19. ESTIMATED EMISSIONS OF METALS - RKIS TEST RESULTS (BASE FUEL - NATURAL GAS)

Metal	0% TDF (Natural Gas Only)		17% TDF (steady-state)		TDF Only (estimated)	
	ng/J	lb/MMBTU	ng/J	lb/MMBTU	ng/J	lb/MMBTU
Antimony	7.72E-05	1.80E-07	9.05E-04	2.10E-06	5.32E-03	1.24E-05
Arsenic	4.80E-04	1.12E-06	1.59E-02	3.70E-05	9.35E-02	2.17E-04
Beryllium	nd	nd	2.14E-05	4.98E-08	1.26E-04	2.93E-07
Cadmium	1.76E-04	4.09E-07	4.54E-04	1.06E-06	2.67E-03	6.21E-06
Chromium	2.78E-04	6.46E-07	1.66E-03	3.86E-06	9.76E-03	2.27E-05
Lead	3.45E-03	8.02E-06	2.83E-02	6.58E-05	1.66E-01	3.86E-4
Manganese	1.21E-03	2.81E-06	2.48E-03	5.77E-06	1.46E-02	3.40E-05
Nickel	3.00E-04	6.98E-07	1.50E-03	3.29E-06	8.82E-03	2.05E-05
Selenium	3.56E-04	8.28E-07	1.93E-03	4.49E-06	1.14E-02	2.65E-05
Zinc	1.23E-01	2.86E-04	15.21	3.54E-02	89.47	2.08E-01

TABLE 20. PARTICULATE MATTER (PM) LOADING - RKIS TEST PROGRAM

% TDF	Feed Type	Particulate Loading (mg/Nm³)[1]
0.00	Steady-state	4.14
0.00	Steady-state	17.37
14.97	Batch	285.46
15.50	Steady-state	95.28
16.95	Steady-state	43.67
17.14	Steady-state	137.24
17.30	Steady-state	101.01
19.18	Ramp	132.95

[1] Nm^3 is a normal cubic meter of gas at 0° C and 1 atmosphere pressure.

TABLE 21. CRITERIA POLLUTANT EMISSIONS AT UTILITIES USING TDF

Power Plant	Particulates (Total)		Sulfur Oxides		Nitrogen Oxides		Carbon Monoxide	
	g/MJ	lb/MMBTU	g/MJ	lb/MMBTU	g/MJ	lb/MMBTU	g/MJ	lb/MMBTU
Facility A								
100% Tires	9.5×10^{-7}	2.2×10^{-6}	6.0×10^{-6}	1.4×10^{-5}	4.2×10^{-5}	9.8×10^{-5}	3.1×10^{-5}	7.2×10^{-5}
Facility B								
0% TDF	0.090	0.21	0.606	1.41	0.34	0.78	NT	NT
5% TDF	0.0064	0.015	0.774	1.80	0.25	0.58	NT	NT
10% TDF	0.004	0.009	0.658	1.53	0.13	0.30	NT	NT
Facility C								
0% TDF	0.22	0.52	0.490	1.14	0.34	0.79	0.654	1.52
7% TDF	0.060	0.14	0.37	0.87	0.39	0.91	3.12	7.26
Facility D								
0% TDF	0.027	0.063	2.28	5.30	0.258	0.601	NT	NT
5% TDF	0.0308	0.0717	2.46	5.73	0.219	0.510	NT	NT
10% TDF	0.0242	0.0564	2.46	5.71	0.188	0.436	NT	NT
15% TDF	0.0350	0.0815	2.35	5.47	0.190	0.443	NT	NT
20% TDF	0.0195	0.0453	2.30	5.34	0.166	0.387	NT	NT
Facility E								
0% TDF	0.036	0.083	0.0090	0.021	0.082	0.19	NT	NT
7% TDF	0.133	0.310	0.032	0.074	0.0537	0.125	NT	NT
Facility F								
2% TDF	0.073	0.17	2.49	5.78	NT	NT	NT	NT

NT = Not tested or data not available.

Note: Above data taken directly from reference; no adjustment was made to significant digits.

information on the facility, source type, baseline fuels, air pollution controls, test conditions, test methods, and fuel handling/feed data, as available. Part "b" of the table presents the source test data.

Individual power plant test data are presented in Tables A-1 through A-8. Table A-1 presents emissions data from utility "A", the only dedicated tires-to-energy facility examined in this report. Data for utilities B through H are given in Tables A-2 through A-8, respectively. All plants are coal-fired, except for plant E, which burns wood, plant G, which burns coal and wood, and plant H, which burns coal and/or petroleum coke.

Data from two cement kilns and one lime kiln are presented in Tables A-9 through A-11. Cement kilns burn a variety of fuels. Facility I burns natural gas and coal, while facility J burns a mixture of coal and coke. Facility K, a lime kiln, burns natural gas. The combination of long residence time and high temperatures make cement kilns an ideal environment for TDF. Emissions are not adversely affected compared to baseline fuels and often represent an improvement (Clark, et al., 1991).

Emissions data from pulp and paper mills are presented in Tables A-12 through A-17 for facilities L through Q, respectively. Pulp and paper mills burn various mixtures of wood, coal, oil, and sludge from onsite wastewater treatment facilities. For the pulp and paper boilers reported here, particulate, zinc, and SO_x emissions tended to increase with percent TDF added. Emissions of PAHs from facility M decreased, while those from facility L varied. Zinc is used in the tire manufacturing process, and is expected to increase with increasing TDF supplementation. Furthermore, zinc oxide has a small particle size and may not be controlled efficiently by venturi scrubbers.

Emissions from general industrial boiler applications are presented in Tables A-18 through A-22 for facilities R through V, respectively. These facilities are coal-fired, except for facility V which burns wood. They cover cogeneration and process heat for manufacturing and food processing.

The data presented in the appendix tables are taken from many data sources and are presented in various formats. Some source data are expressed in an emission factor format, i.e., mass of pollutant per unit of heat input [e.g., grams per megajoule (g/MJ) or pounds per million British Thermal Units (lb/MMBTU)]. The emission factor format is the most useful, because these results can be compared to a similar combustion/control system. However, these data should not be considered as recognized emission factors, because they have not undergone all the rigors of quality assurance and statistical analysis that are necessary before EPA will consider them valid emission factors.

Because many of the source tests were conducted in response to an environmental compliance requirement, they are reported in the source test as an emission limit on a mass per unit time basis (e.g., kg/hr or lb/hr). This type of data is less useful for comparison between facilities. In these cases, often the best information that can be inferred is how the TDF emission rate compares with the baseline (no TDF) emission rate for any given pollutant.

In the summary, or "a" section of the tables, the "Test Methods" entry may indicate "Unknown." While the details may be unavailable, all facilities with the reference "Clark, et al., (1991)," refer to the EPA report *Burning Tires for Fuel and Tire Pyrolysis: Air Implications,* and have had their methods procedures evaluated and accepted as creditable by EPA as a condition of being included in that report.

It is extremely difficult to establish a universal emission factor, or even a range of emission factors as a function of TDF added, because of the limited amount of emissions data when compared to all the other variables influencing the emission rate of any pollutant, such as:

- Baseline fuel type and variability, such as sulfur, nitrogen, ash, metals, chlorine, moisture content, etc. Furthermore, many sources were tested with multiple fuels (e.g., coal and wood), making it even more difficult to identify the impact of TDF.

- Air pollution control device efficiency varies with the type of fuel. For example, the efficiency of a venturi scrubber typically falls when handling the smaller particulate common to TDF. Fabric filters and electrostatic precipitators (ESPs) are preferable for particulate control for TDF exhaust streams.

- Combustor design. There are several boiler design types; suspension (fluidized bed and cyclone types) and grate firing (traveling, reciprocating, and chain stokers; stokers may be either spreader, underfeed, or overfeed). TDF combustion efficiency varies for each design type. For example, TDF is typically difficult to burn in suspension (e.g., in fluidized bed and cyclone-type boilers), because of its size and weight. However, this problem may be remedied with further research and development. To date, the spreader stoker is the most successful and widely used boiler configuration with TDF. However, with consistent and well-controlled processing of TDF (i.e., sizing and de-wiring), most well-maintained solid fuel combustors can successfully accommodate TDF as a supplemental fuel.

- The amount and type of processing/sizing that is used to convert a scrap tire to TDF. Size of TDF (whole tires, chunk, shredded, or crumb rubber) and type (wire-included or de-wired) influences the rate and type of air emissions.

Table A-9a. Facility I - Cement Kiln

Source Description

Facility Name, Location:	Ash Grove Cement Durkee, OR
Facility Type:	Cement Plant
Source Type:	Cement Kiln
Test Dates:	October 18 - 20, 1989
Other fuel(s):	Natural gas and coal
Air pollution control device(s) used:	ESP
Test Conditions:	Unknown
Test Methods:	Unknown
Fuel Handling/Feeding:	Unknown
Testing Company:	Unknown
Environmental Agency:	Oregon DEQ
Reference:	Clark, et al (1991)

Source Test Data Evaluation

	Yes	**No**	**Unknown**

Test Witnessed by or Prepared for

Table A-9a. Facility I - Cement Kiln

Source Description

Facility Name, Location:	Ash Grove Cement Durkee, OR
Facility Type:	Cement Plant
Source Type:	Cement Kiln
Test Dates:	October 18 - 20, 1989
Other fuel(s):	Natural gas and coal
Air pollution control device(s) used:	ESP
Test Conditions:	Unknown
Test Methods:	Unknown
Fuel Handling/Feeding:	Unknown
Testing Company:	Unknown
Environmental Agency:	Oregon DEQ
Reference:	Clark, et al (1991)

Source Test Data Evaluation

	Yes	No	Unknown
Data Expressed in Emission Factor Form	some		
Baseline Fuel Test Data Available	X		
Accurate Fuel Feed Rates		X	
Multiple Baseline Fuels	X		
Test Witnessed by or Prepared for Governmental Agency	X		

Table A-9b. Facility I - Cement Kiln

Pollutant		Baseline, 0% TDF	9-10% TDF	% Change
Particulate	g/MJ	0.417	0.382	-8
	lb/MMBtu	0.969	0.888	-8
SO_2	g/MJ	0.119	0.0950	-20
	lb/MMBtu	0.276	0.221	-20
CO	ppm	0.046	0.036	-27
Aliphatic compounds	g/MJ	0.00047	0.0004	-18
	lb/MMBtu	0.0011	0.0009	-18
Nickel	ug	30	ND	NA
Cadmium	ug	3.0	2.0	-33
Chromium	ug	30	ND	NA
Lead	ug	ND	ND	NA
Zinc	ug	35	35	0
Arsenic	ug	0.2	0.2	0
Chloride	kg/hr	0.122	0.0895	-26
	lb/hr	0.268	0.197	-26
Copper	ug	37	13	-65
Iron	ug	400	200	-50

ND = Not detected.
NA = Not applicable.

Table A-10a. Facility J - Cement Kiln

Source Description

Facility Name, Location:	Holnam Incorporated Industries Seattle, WA
Facility Type:	Cement Plant
Source Type:	Cement Kiln
Test Dates:	October 15 - 19 1990
Other fuel(s):	Coal/coke
Air pollution control device(s) used:	ESP
Test Conditions:	0%, 11%, 14% TDF (as heat input)
Test Methods:	EPA Methods 1, 2, 3A, 4, 5 (front and backhalf extraction), 6C, 7E, 10, 12, 0010 (Semi-Volatile Organic Sampling Train), TO-14 .
Fuel Handling/Feeding:	Tire chips
Testing Company:	Am Test, Inc.
Environmental Agency:	Washington DOE
Reference:	Am Test (1991), Clark, et al (1991)

Source Test Data Evaluation

	Yes	No	Unknown
Data Expressed in Emission Factor Form	X		
Baseline Fuel Test Data Available	X		
Accurate Fuel Feed Rates			X
Multiple Baseline Fuels		X	
Test Witnessed by or Prepared for Governmental Agency	X		

Table A-10b. Facility J - Cement Kiln

Pollutant	Baseline, 100% Coal, 0% TDF		11% TDF			14% TDF		
	10^{-6} g/MJ	10^{-6} lb /MMBtu	10^{-6} g/MJ	10^{-6} lb /MMBtu	% Change	10^{-6} g/MJ	10^{-6} lb /MMBtu	% Change
Acenaphthalene	1.19	2.76	0.864	2.01	-27	0.886	2.06	-26
Acenaphthylene	0.095	0.22	ND	ND	-100	ND	ND	-100
Anthracene	1.06	2.46	ND	ND	-100	ND	ND	-100
Benzo(b)anthracene	4.25	9.88	ND	ND	-100	ND	ND	-100
Benzoic Acid	4.498	10.46	ND	ND	-100	ND	ND	-100
Benzo(a)pyrene	0.877	2.04	ND	ND	-100	ND	ND	-100
Benzo(g,h,i)perylene	ND	ND	1.34	3.11	NA	4.442	10.33	NA
Bis(2-chloroethoxy)methane	95.641	222.42	74.583	173.45	-22	118.57	275.75	+24
Butyl Benzyl Phthalate	2.57	5.98	ND	ND	-100	ND	ND	-100
Dibenz(g,h)phthracene	45.877	106.69	20.50	47.67	-55	28.88	67.17	-37
Di-N-Butylphthalate	0.959	2.23	ND	ND	-100	ND	ND	-100
1,2-Dichlorobenzene	1.38	3.21	ND	ND	-100	ND	ND	-100
2,4-Dinitrotoluene	5.749	13.37	4.29	9.97	-25	3.87	9.00	-33
Fluorene	3.29	7.65	3.02	7.03	-8	3.06	7.12	-7

(Continued)

Table A-10b. Facility J - Cement Kiln (Cont.)

Pollutant	Baseline, 100% Coal, 0% TDF		11% TDF			14% TDF		
	10^{-6} g/MJ	10^{-6} lb /MMBtu	10^{-6} g/MJ	10^{-6} lb /MMBtu	% Change	10^{-6} g/MJ	10^{-6} lb /MMBtu	% Change
Hexachlorobenzene	31.60	73.49	17.38	40.42	-45	22.99	53.46	-27
Naphthalene	146.20	340.00	76.944	178.94	-47	68.456	159.20	-53
2-Nitroanaline	2.01	4.67	ND	ND	-100	2.16	5.02	+7
N-Nitrosodiphenyl-amine	39.05	90.81	20.47	47.60	-48	21.47	49.92	-45
Pyrene	2.14	4.97	1.02	2.38	-52	0.959	2.23	-55
1,2,4-Tricholrobenzene	7.504	17.45	1.11	2.57	-85	ND	ND	-100
4,6-Dinitro-2-methylphenol	2.38	5.53	ND	ND	-100	ND	ND	-100
4-Methyl Phenol	8.407	19.55	3.93	9.13	-53	6.570	15.28	-22
2-Nitrophenol	83.846	194.99	72.747	169.18	-13	74.012	172.12	-12
4-Nitrophenol	ND	ND	21.34	49.62	NA	12.80	29.77	NA
Pentachlorophenol	ND	ND	ND	ND	NA	ND	ND	NA
Phenol	140	32	69.247	161.04	-50	131.89	306.71	-4
2,4,5-Trichlorophenol	ND	ND	ND	ND	NA	ND	ND	NA

NA = Not applicable.
ND = Not detected.

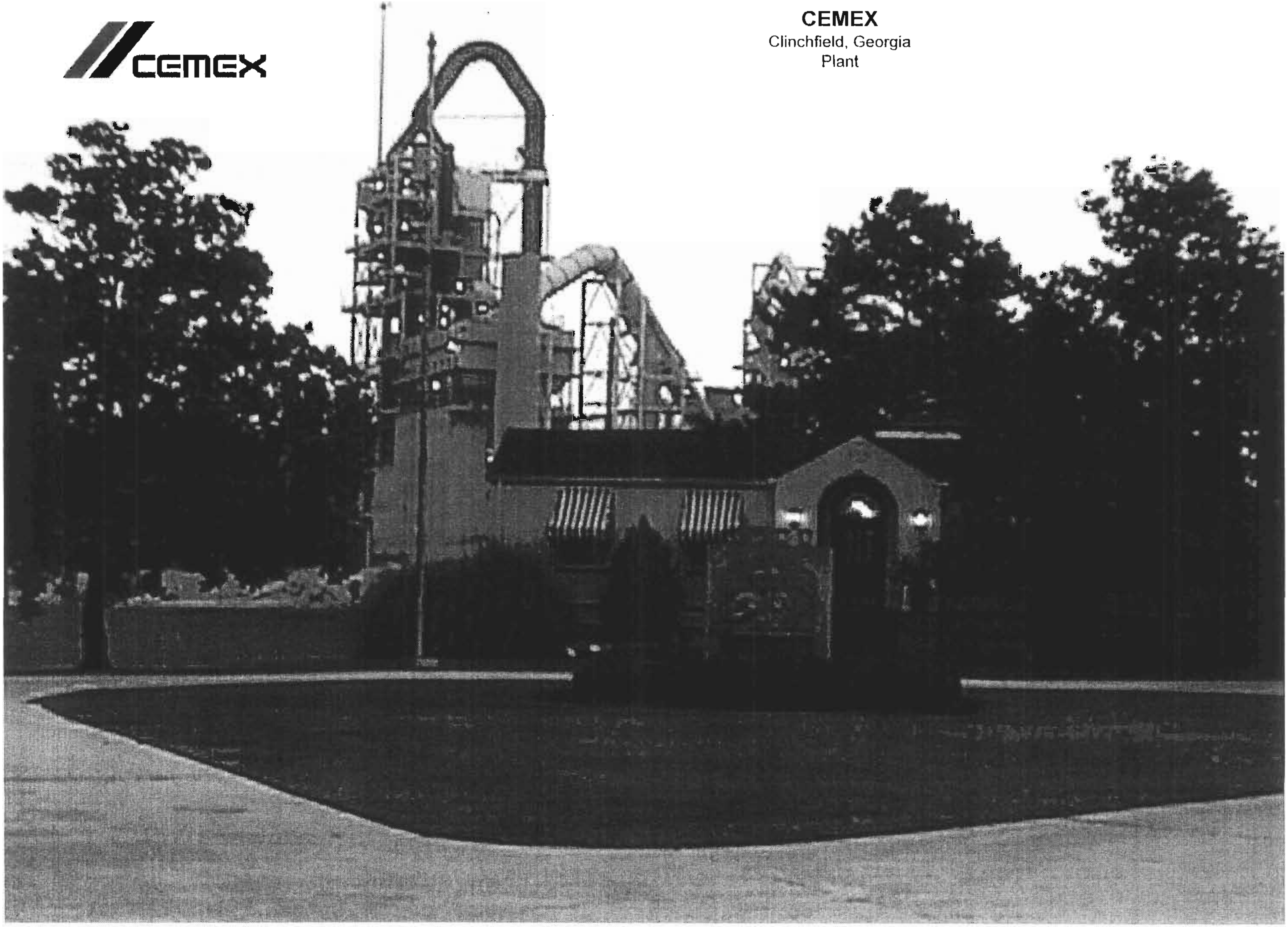
Attachment 5

Description of WTDF Feed System

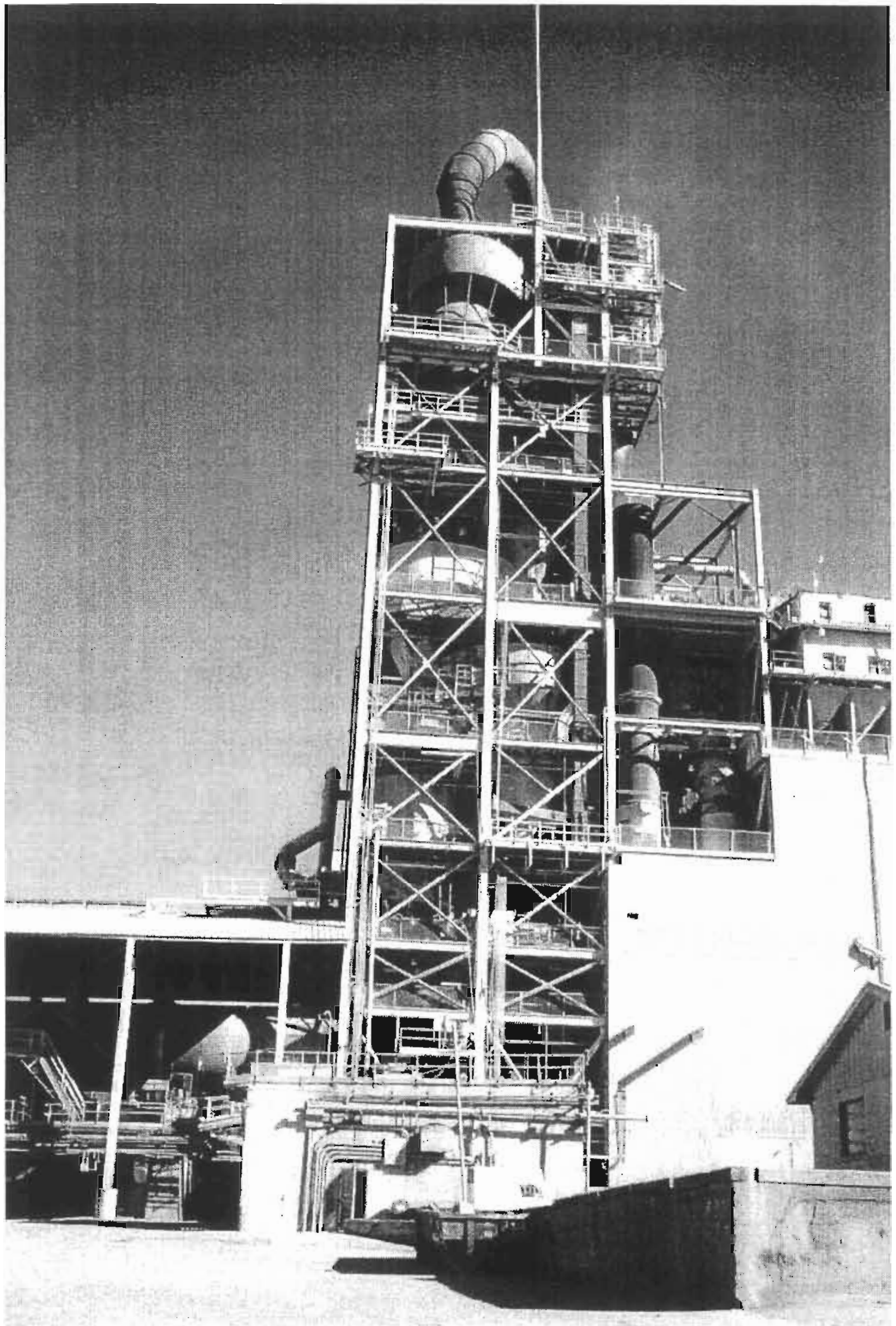
CEMEX Cement, Inc.
Brooksville Cement Plant
Hernando County, Florida

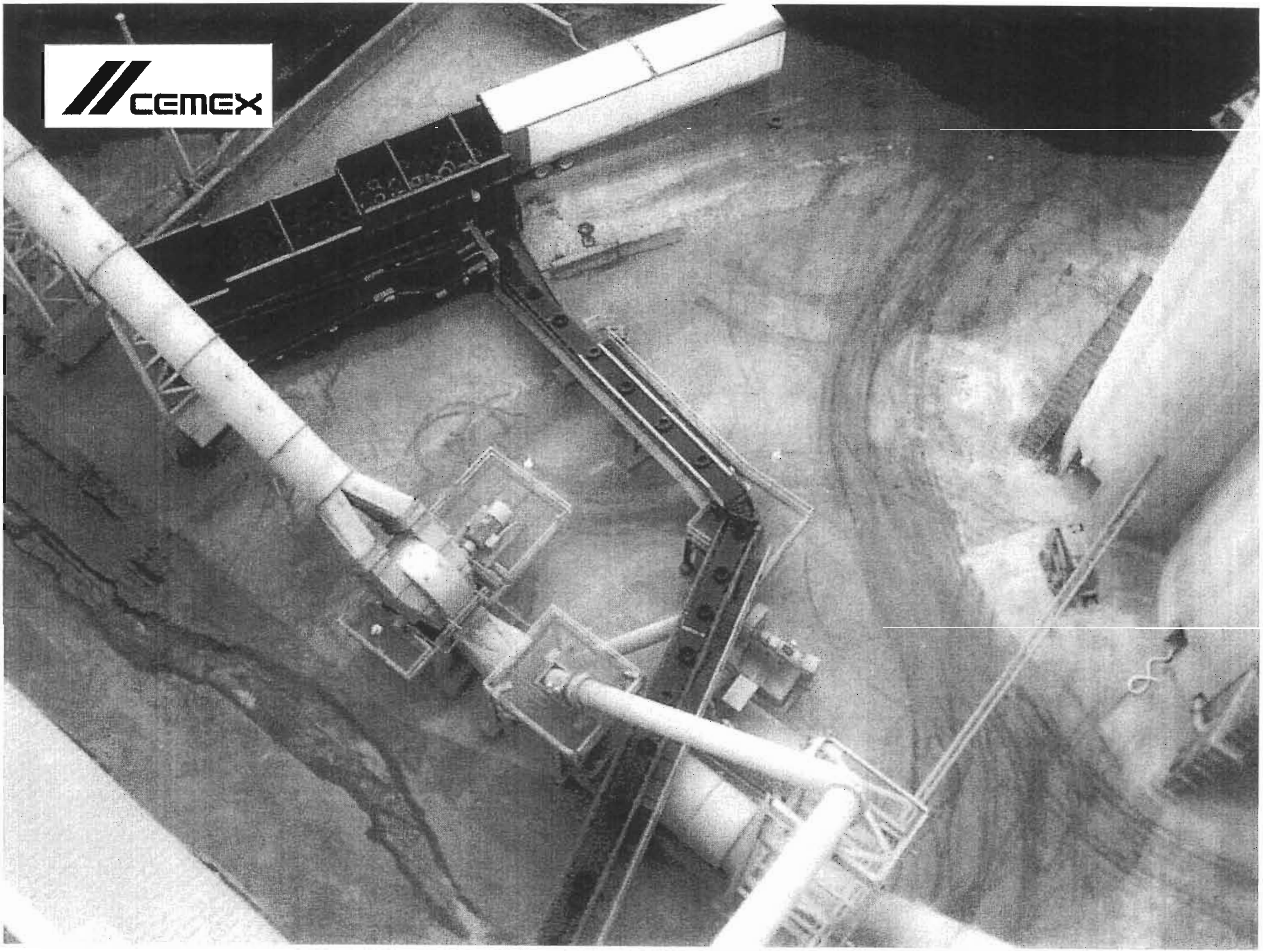
KOOGLER & ASSOCIATES
ENVIRONMENTAL SERVICES

CEMEX
Clinchfield, Georgia
Plant



CEMEX

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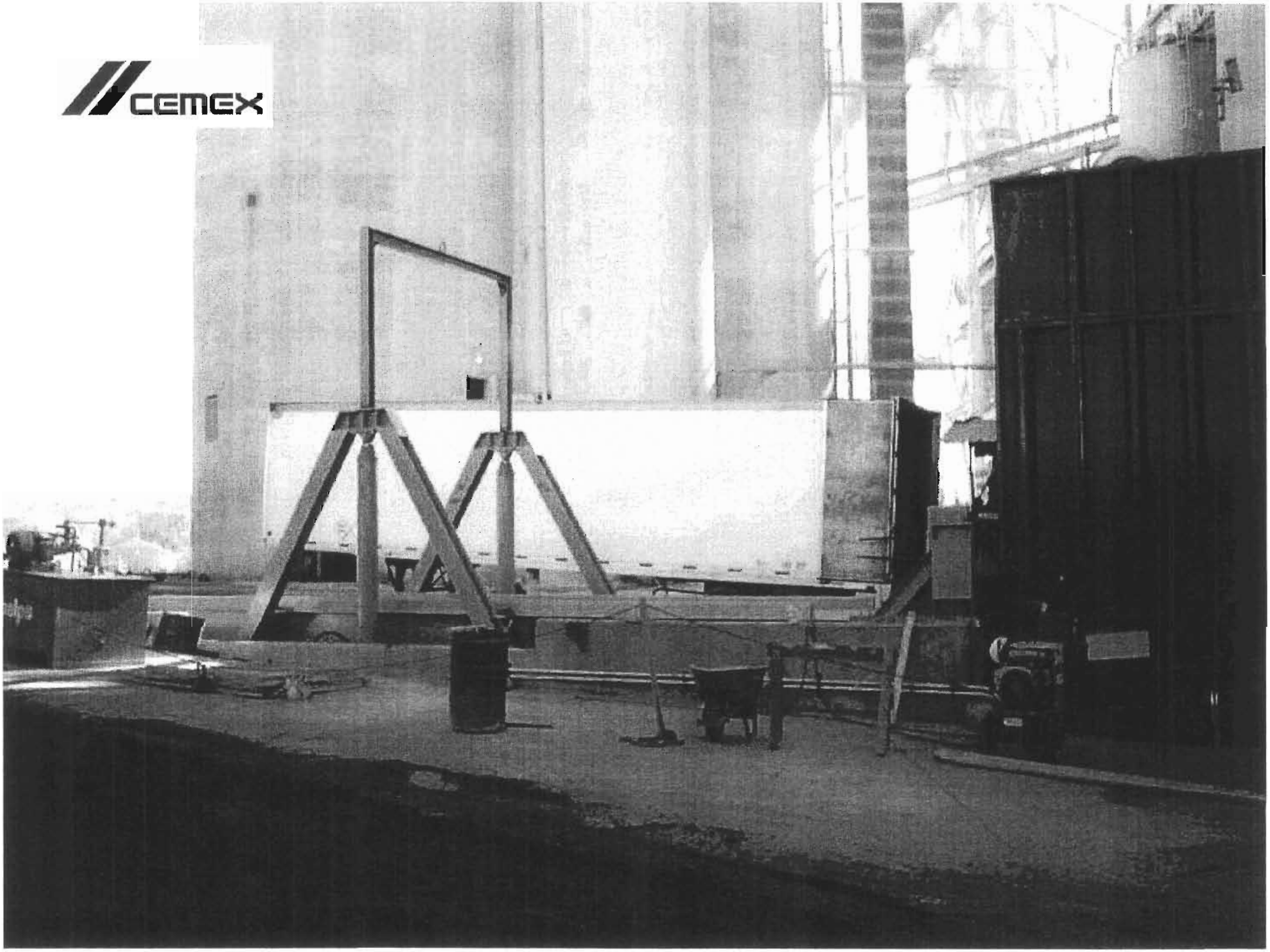
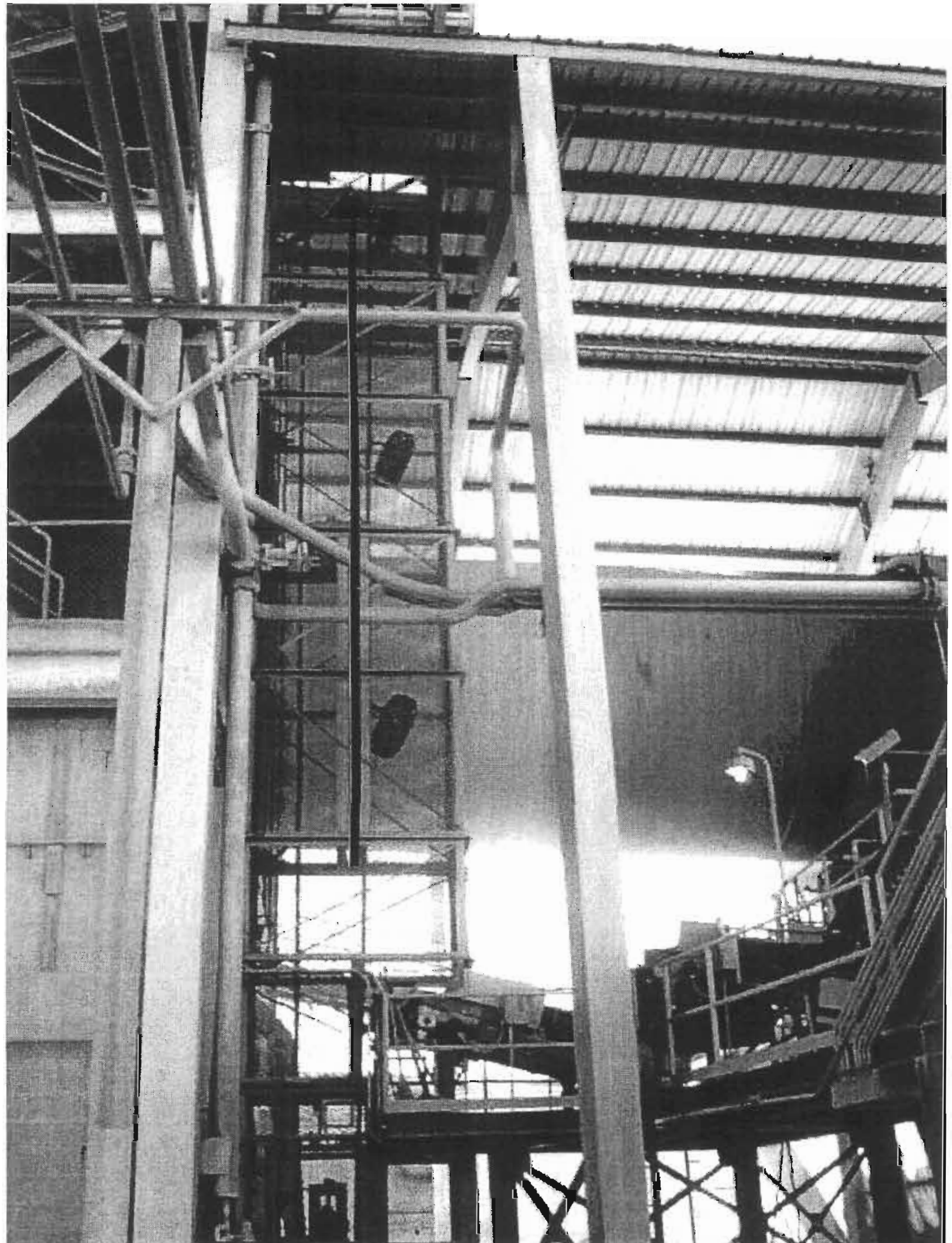


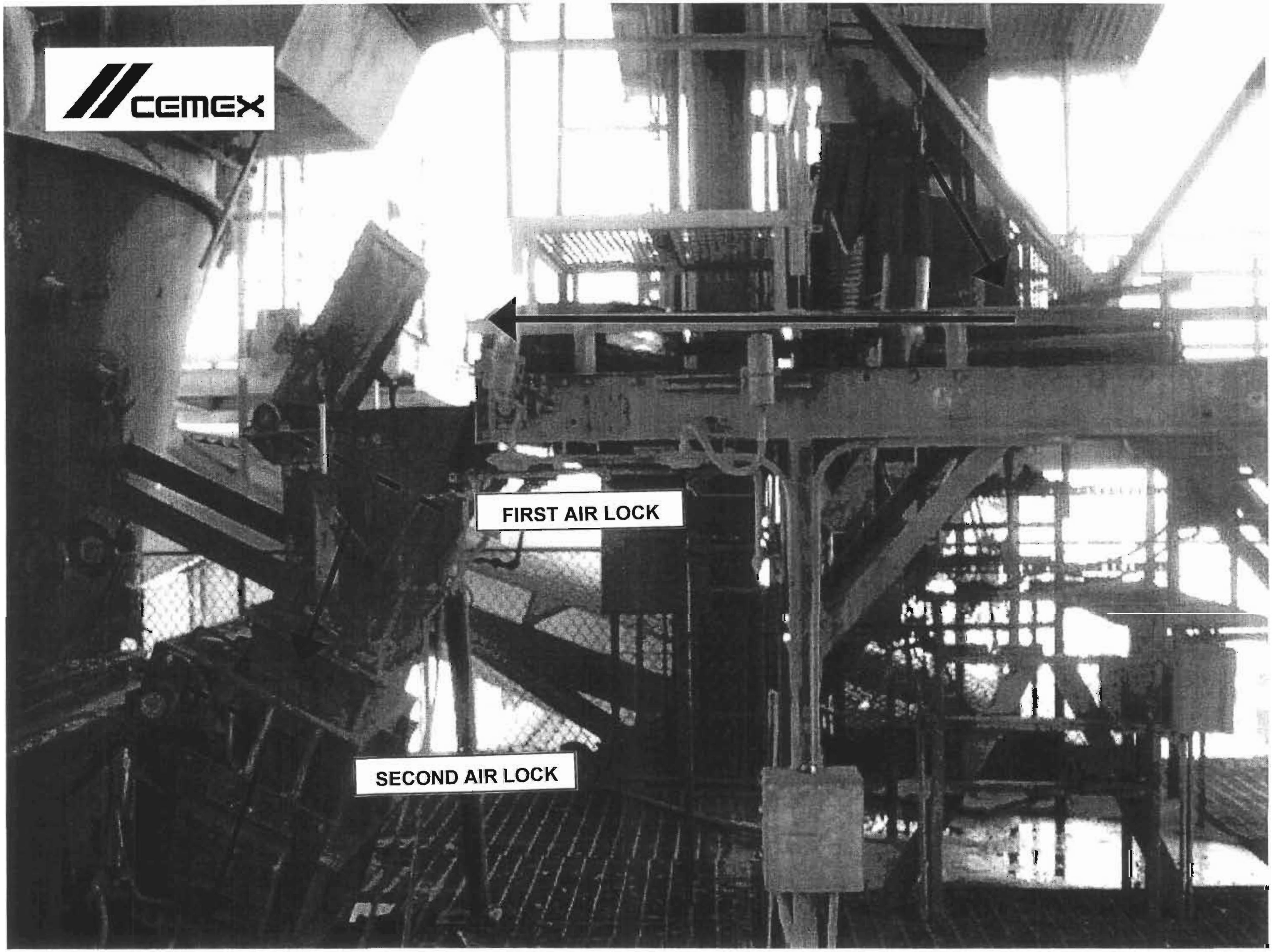

CEMEX

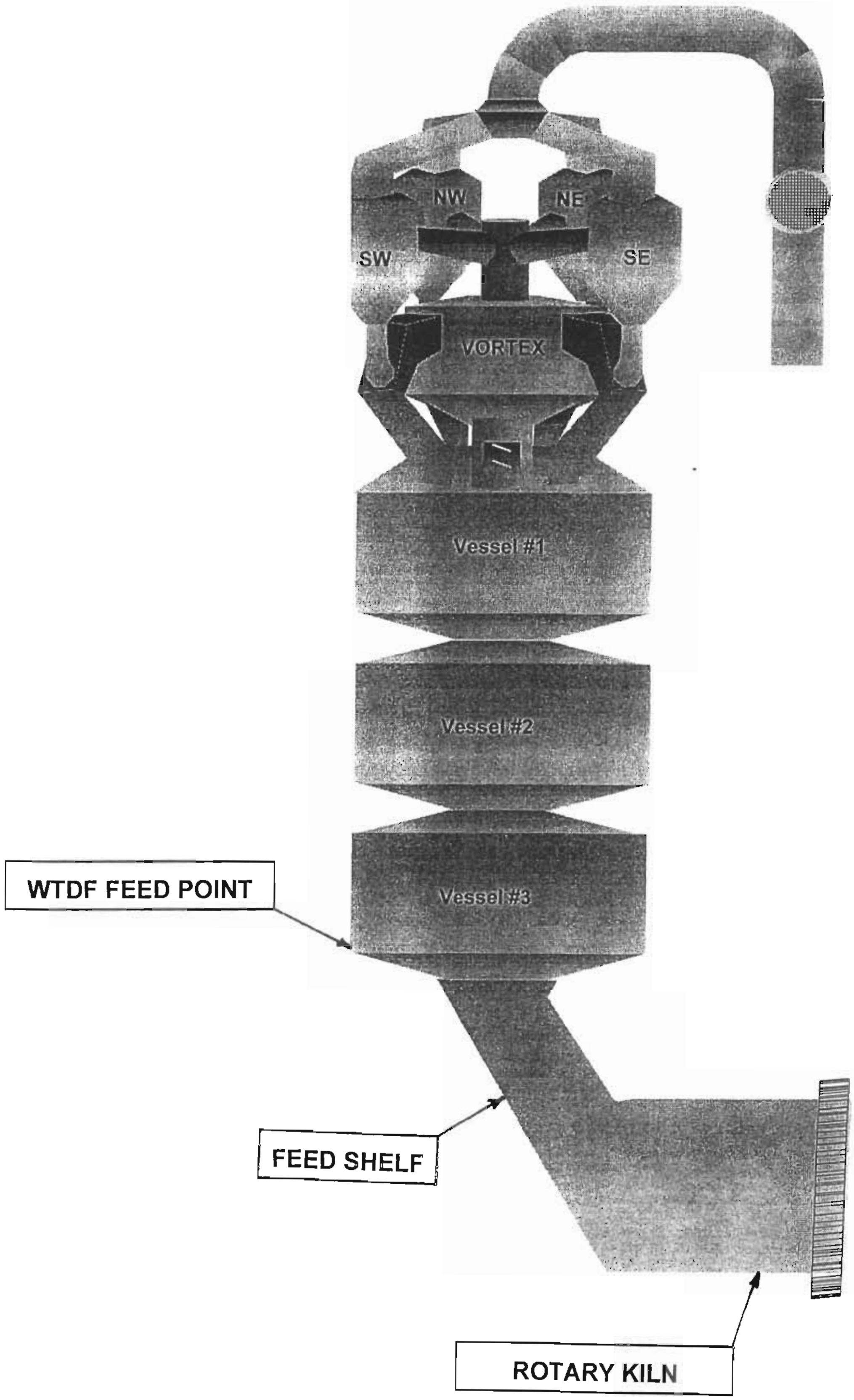

CEMEX


CEMEX


CEMEX




CEMEX
FIRST AIR LOCK
SECOND AIR LOCK


NW
NE
SW
SE
VORTEX
Vessel #1
Vessel #2
Vessel #3
WTDF FEED POINT
FEED SHELF
ROTARY KILN