TIRE DERIVED FUEL:

ENVIRONMENTAL CHARACTERISTICS AND PERFORMANCE

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PERSPECTIVE

We are slowly awakening to the reality of global resource limitations and environmental liabilities. We are recognizing the importance of conserving natural resources through optimum utilization, including minimizing and reusing resources contained in materials previously considered to be "wastes". We are also recognizing that our air and aquatic environments have limited abilities to absorb abuse. In an ideal world, we would endlessly recover and reuse all resources - and we would do so without detrimental impact upon our environment.

Although most of us agree with this ideal objective, we have significant differences of opinion about practical compromises required in today's real world. Some are fixed on achieving the ideal "perpetual recycling" objective and are unwilling to support interim compromises for fear of jeopardizing achievement of the ultimate objective. Others recognize the value of resources conserved through interim steps and believe that these steps contribute to the evolution of even greater conservation.

This debate has impacted virtually all "waste" materials, including scrap tires. Tires represent a significant resource. Ideally, a tire's polymerized rubber mixture would be perpetually reused. However, today's applications for this material consume less than 10% of the waste tires generated annually in North America. These markets are growing, but even the most optimistic projections show markets for less than 30% in 5 years.

Should the remainder of this resource be squandered through landfilling? Should it become a public liability and health hazard through stockpiling in hopes that market limitations will miraculously disappear sometime in the future? Or should it be utilized as an energy resource? Since no one consciously wants to waste a valuable resource, the answer should depend upon its compatibility with our environment. Avoiding unnecessary consumption of natural resources through alternative use of waste tires is a worthwhile objective if it can be done without a counter-balancing negative impact on our environment. As a result, it is appropriate to examine chemical characteristics and historical environmental experience of tires as an energy resource.

CHEMICAL CHARACTERISTICS OF SCRAP TIRES

The chemical characteristics of any energy resource impact its environmental acceptability. Tires are a hydrocarbon-based material derived from oil and gas. Some inorganic materials are added to enhance reactions or performance properties. Tires have a heat content of 7,800 to 8,600 kcal/kg (14,000 to 15,500 Btu/pound), depending on the type of tire and degree of wire removal. By comparison, coal that may be displaced by use of tires typically contains 5,550 to 7,200 kcal/kg (10,000 to 13,000 Btu/pound).

The composition of tires and coal vary depending on type and source. However, Exhibit 1 provides representative proximate and ultimate (elemental) analyses of tire-derived fuel (TDF) with 90+% of the reinforcing wire removed and a bituminous eastern US steam coal.

A comparison of the proximate analyses indicates that tires offer efficiency advantages versus coal. For instance, tires generally have lower moisture content than coal. Since the energy required to heat and vaporize inherent water is generally non-recoverable in the energy conversion process, lower moisture content can translate into higher energy utilization efficiency. The lower ash content of TDF without wire offers a similar advantage versus coal. A tire's higher volatile-to-fixed carbon ratio enhances its ability to combust rapidly and completely. Based on proximate analysis, tires compare favorably to coal as an energy source.

Based on ultimate analysis, tires offer some additional advantages and disadvantages. When compared to many eastern coals, TDF's lower sulfur content (especially in terms of pounds/million Btu) offers the potential advantage of decreasing SOx emissions. However, many western coals have lower sulfur content.

TDF has a lower carbon-to-hydrogen ratio, theoretically reducing carbon dioxide greenhouse gas generation since hydrogen converts to water in the combustion process. Lower inherent nitrogen content can marginally decrease NOx emissions.

The chlorine content of tires is higher in this specific example, but it is comparable to many coals. In addition, the chlorine content has been significantly reduced in many newer tires as the chlorinated butyl inner liner has been replaced by alternative materials.

Elemental ash analysis provided in Exhibit 2 indicates that tires generally contain metal concentrations comparable to, or lower than, coal with one notable exception. Zinc oxide is added to tires as part of the rubber vulcanization process at levels approaching 1.0 - 1.5% by weight. Therefore, zinc levels in tires are much higher than coal. As a result, applications using tires as an energy resource must be able to control zinc emissions to avoid a negative environmental impact.

From a chemical standpoint, tires offer both environmental advantages and disadvantages versus coal and coke. Therefore, tires must be used in applications that utilize their advantages and properly control their disadvantages for them to provide a valuable and environmentally-friendly energy resource.

HISTORICAL ENVIRONMENTAL PERFORMANCE

Background

Scrap tires have been utilized as a supplemental energy source in Japan, Europe and the United States since the 1970s. The experience base has increased significantly during the last 10 - 15 years as tires have been recognized as an acceptable fuel for some combustion processes. Applications using scrap tires have broadened to include cement kilns, industrial boilers, traditionally-conservative utilities and dedicated electrical generation facilities. The following discussion provides examples of demonstrated environmental performance for major applications.

Pulp and Paper Industry

The pulp and paper industry combusts bark and waste wood in stoker-fired boilers to provide steam and power required for processing operations. Wood is combusted on moving grates that also transport residual ash from the boiler. Coal, oil or gas can be fired into the boiler above the grate to enhance combustion and maintain operating temperatures, especially when wood moisture content is high.

This application utilizes tire derived fuel (TDF) obtained by processing scrap tires into uniform, flowable chips generally about 2 inches by 2 inches in size. Bead wire is often removed magnetically to avoid fouling of grates and ash handling systems. TDF can be introduced separately or as an integral part of the wood mixture with relatively simple, inexpensive metering systems. TDF's high volatile component enhances combustion of wood on the grate and improves fuel efficiency.

The environmental impact associated with use of TDF in this application is dependent upon characteristics of the displaced fossil fuel and system environmental control equipment. The two predominant factors controlling environmental acceptability are SOx and particulate (zinc oxide) emissions. SOx emissions may decrease if TDF displaces coal or oil with a higher sulfur content. Alternatively, SOx can be controlled by scrubbers present in some systems, especially if the scrubbers operate at a neutral or basic pH. Particulate emissions can be controlled by electrostatic precipitators (ESPs) or baghouses. In general, the most environmentally acceptable applications occur when coal is displaced in systems with baghouses or ESPs.

Based on review of available information, 18 U.S. paper mills used approximately 20 million scrap tires/year as TDF in compliance with applicable regulations in 1999, with others undergoing testing. However, this consumption represented a decline of 10 - 15 million tires/year from peak usage in 1996 due to the following factors:

(1) Wisconsin's tire management program sunsetted, resulting in elimination of price supports that had economically encouraged development of major TDF applications. The subsidy helped to off-set transportation costs and operating cost differences. As a result, some consumers stopped TDF usage.

(2) Bead wire contained in TDF produced by some suppliers can cause operating problems with grates and ash handling systems, offsetting fuel savings. If suppliers cannot produce suitable material, the mill ceases TDF use.

(3) Zinc contained in TDF is captured and transferred to ash settling ponds in some cases. If zinc is not properly neutralized and precipitated in the ponds, it can exceed allowable discharge limits and force decreased TDF usage. The ash is increasingly spread on agricultural land as a nutrient instead of landfilling. Zinc can decrease allowable loadings and increase disposal costs, off-setting TDF's economic savings.

Recent cost increases for fossil fuels have led to a significant resurgence in TDF usage in paper mills as new mills have completed environmental testing and existing users have maximized consumption, especially in southeastern facilities.

The Champion facility in Bucksport, Maine has been one of the largest users of TDF since 1990. Their boiler is capable of consuming up to 3.5 tons of TDF per hour (14.5% by heat input) to produce almost 500,000 pounds of steam per hour.

Exhibit 3 provides environmental data associated with performance testing conducted at this site. A baseline test was conducted using their normal mixture of gas, bark, coal and sludge. TDF was then substituted for coal at levels representing 6.3%, 10.3%, and 14.5% of heat input. At the maximum TDF level, NOx, SOx and total hydrocarbon emissions remained virtually unchanged, while particulate matter increased 6%. Among the metals, beryllium and chromium decreased, lead remained below detection limits and cadmium increased. Zinc increased significantly percentage-wise, but total quantities remained acceptable. Overall particulate emissions remained well within acceptable limits.

Performance data has also confirmed environmental acceptability of TDF in similar paper mills and industrial boilers in 20 states. Several of these states (including Oregon, Washington and Florida) are recognized for their environmental sensitivity and rigorous regulatory enforcement. However, these applications must be carefully screened to define facilities capable of using TDF within environmentally acceptable limits. Only a small percentage of industrial boilers have the required combination of system design, permitting conditions and fuel usage conducive to appropriate TDF usage.

Public Utility Boilers

By the end of 1999, there were at least 15 utility facilities consuming the equivalent of 25 million tires. This represents an increase of 25% versus 1996 in spite of rapid changes in the industry structure. This growth appears to have continued since 1999.

TDF can only be used efficiently in specific types of utility boilers (primarily cyclone, fluidized-bed and stoker-grate units) offering adequate retention time for complete combustion of nominal 1 inch (minus 2 inch) TDF, the smallest material that can generally be produced at costs competitive with coal and other fossil fuels. These units consume large quantities of fuel, so small percentages of TDF (2-4%) can use up to 5,000,000 tires/year in a single boiler.

Several factors influence use of TDF in the utility industry, including:

(1) Canada and the United States executed agreements designed to reduce the impact of acid rain through mandatory reductions in SOx emissions. Major coal-fired utilities using midwestern and eastern coals have been under intense pressure to achieve mandatory reductions at minimal cost to their customers. They are faced with purchasing expensive low-sulfur coal or making substantial capital investments in additional air pollution control equipment. As a direct result, conservative utilities have begun to recognize the potential value of TDF as an alternative fuel with a lower sulfur content than some local coal. Use of TDF offers an opportunity to concurrently reduce both SOx emissions and fuel

costs, while providing a partial solution to historical scrap tire disposal and stockpiling problems.

(2) Deregulation of utilities has been a double-edged sword in terms of TDF usage. Some older marginal units that were using TDF have been shut down, decreasing TDF usage. However, more utilities are considering TDF usage as a method of cost reduction in an extremely competitive environment.

(3) The Clean Air Act Amendment has not yet been fully developed, but it could significantly impact all facilities using solid fuels. It could force conversion to oil and gas as an alternative to expending millions of dollars to achieve conformance on existing coal fuel. Depending on the final form of this regulation, all solid fuels, including TDF, could be negatively impacted.

TDF usage in utility cyclone boilers is expanding with recent additions. Pulverized coal is introduced tangentially into a large cylindrical chamber and combusted, with ash falling into a fluid collection system at the bottom. TDF must generally meet stringent size restrictions (minus 2 inches in all dimensions, averaging 1 inch or less) to enhance complete combustion and material handling through coal systems.

Otter Tail Power Company has been using up to 60,000 tons of TDF per year at its plant in Big Stone, South Dakota. TDF has reportedly proven to enhance combustion control and efficiency when added to their primary low-Btu lignite fuel. The facility operates in compliance with all applicable regulations, but detailed data is not available.

Wisconsin Power and Light has conducted extensive tests using TDF as a supplemental fuel in its cyclone boiler at Beloit. The system has an ESP for particulate control. Comparative criteria pollutant data is provided in Exhibit 4. Particulate, SOx, hydrochloric acid and hydrofluoric acid concentrations decreased with use of 7% TDF. However, NOx, CO and hydrocarbons increased, but remained within applicable permit limits. WP&L constructed its own TDF processing facility based on economics and supply considerations, but encountered initial difficulty in achieving production expectations. In addition to these examples, TVA and Illinois Power have conducted extensive trials and are using TDF in cyclone boilers.

Circulating fluidized bed boilers represent one of the newer systems designed to minimize environmental impact from use of solid fossil fuels. High turbulence and uniform heat distribution allow fluidized beds to operate at lower temperatures to minimize NOx formation. Ammonia injection may also be used for supplemental NOx reduction. Limestone is commonly used as the circulating bed media, providing efficient SOx control through integral mixing with combustion gases. Sophisticated baghouses and/or electrostatic precipitators provide particulate removal.

These systems represent environmentally-viable candidates for use of nominal 1-inch TDF. Stockton Cogen in Stockton, California conducted extensive trials with financial assistance from the California Integrated Waste Management Board to define the emissions characteristics associated with use of up to 20% TDF (by heat). The results of this analysis are compared to the facility's pre-existing lower (state or local) permit limit in Exhibit 5. All emissions were well within permit limits, with particulate and hydrocarbons being less than 25% of established limits.

Tires have even been used as a primary fuel in dedicated, specially designed power boilers in California and Connecticut using 5 million and 10 million tires per year, respectively. After some initial difficulties associated with scale up of this technology, these facilities have reportedly operated in compliance with strict new-source performance criteria. The Connecticut facility is still operating, but the California plant has been shut down due to economic and political factors associated with a major fire (initiated by a lightening strike during a storm) in an adjacent stockpile.

Cement Kilns

Scrap tires have been used as a supplemental fuel in cement kilns in Europe and Japan since the 1970s and currently represent the largest application in North America. Only Calvaras Cement in California consumed waste tires 10 - 12 years ago, but 35 facilities currently use whole tires or TDF as a supplemental energy source in 53 kilns. Others are conducting performance tests targeted at future use.

Some factors impacting current interest in scrap tires as a supplemental energy source in kilns deserve mention:

Logistics - Kilns are often located near market population centers with large waste tire quantities and difficult tire disposal problems, providing efficient logistics.

Energy Intensity - Kilns are energy intensive, allowing consumption of 500,000 - 1,500,000 million tires/year/kiln. TDF energy cost savings versus fossil fuels can provide a competitive economic advantage.

Rigorous Combustion Conditions - A unique combination of high temperatures, long residence times and turbulent air flow promote complete combustion of organic compounds contained in tires.

Inherent SOx Control Limestone used in cement manufacture is commonly used in APC systems to absorb SOx, providing inherent SOx control.

Ash Utilization - Ash resulting from tire combustion becomes an integral component of the cement product, eliminating ash disposal requirements.

Steel Use - Reinforcing wire is constructively consumed as a replacement for purchased natural resources or alternative materials containing iron.

Broad Applicability - Demonstrated technology allows use of tires in older long kilns, as well as newer preheater and precalciner units. Some kilns can use whole tires without additional processing.

Although these factors encourage use of tires as a supplemental fuel in kilns, demonstrated performance is a critical consideration in establishing environmental acceptability of this application. Extensive environmental data has been generated for a variety of kiln configurations and fuel displacements. Time limitations preclude discussion of all available data, but several examples are included.

Exhibit 6 provides comparative data resulting from comprehensive tests conducted by Florida Crushed Stone. TDF representing 14% energy displacement was introduced into the riser section of their preheater kiln. Particulate and SOx emissions declined with TDF use. Volatile organics increased but semi-volatile organics decreased by an even greater margin, resulting in a net reduction in organic emissions. Changes in metal concentrations were nominal. Comprehensive testing of dioxins and furans showed a net reduction of over 50% with TDF use. Florida Crushed Stone is currently using approximately 800,000 scrap tires per year as an alternative energy source in full compliance with all applicable regulations.

Performance results for Ashgrove Cement's kiln in Durkee, Oregon are provided in Exhibit 7. Emissions of particulate, SOx, chlorides and all heavy metals declined or remained constant. Total hydrocarbons increased about 10%, but polynuclear aromatics declined about 10%. This facility completed a comprehensive PSD review associated with its use of hazardous wastes, and is expected to resume tire usage. This plant's performance is accepted in one of the most environmentally-sensitive states in the U.S.

Several of the southwestern cement plants have undergone extensive testing. Results of California Portland Cement Company's emissions results for its Colton plant are summarized in Exhibit 8. Some criteria and compounds decreased with use of tires, while others increased. For example, total particulate increased less than 10%, while non-methane hydrocarbons decreased about 18%. Recognized carcinogens like benzene and toluene decreased. Total PCDD/PCDF materials increased nominally in quantity, but the normalized toxicity equivalence actually decreased. Most PCBs and PAH's declined with tire usage, while hydrochloric and hydrofluoric acids increased.

Hexavalent chromium, barium, cadmium lead and nickel emissions declined, while zinc and mercury increased. While the most salient impacts will probably depend upon the reviewer's perspective, most changes were relatively minor and the net impact appears to be relatively balanced.

In order to place these relative impacts into technically-structured perspective, Cal Portland engaged an experienced contractor to conduct a comparative Health Risk Assessment using the latest versions of the ISC dispersion model and ACE health effects model specified by the California EPA. Based on this evaluation, the individual carcinogenic risk declined 47% with TDF usage, while the non-carcinogenic health effects resulting from short-tern exposure (acute hazard index) fell 94% and the non-carcinogenic health effects of continuous exposure (chronic health impact) decreased 72%. While none of us like to contemplate any exposure and some question the assessment methodology, most of us prefer reductions.

Cement kilns constructively utilize more waste tires than any other single application. Kilns are an important component of waste tire management in most states considered to have successful programs. Any state that is not fully utilizing its waste tire resource may wish to objectively evaluate the environmental and economic merits of this application.

SUMMARY

Scrap tires can be an environmentally-compatible alternative energy resource when used in appropriate applications. Energy utilization is an important component of successful scrap tire management programs within the U.S., allowing this resource to be used rather than wasted. The net result has been substantial conservation of non-renewable fossil fuels. When the demonstrated performance of tires as an energy resource is objectively evaluated, many jurisdictions have concluded that our environment is better served by recognizing the value of this resource rather than wasting it while waiting for ideal solutions. Good programs recognize the importance of diverse applications.

EXHIBIT 1

COMPARATIVE CHEMICAL CHARACTERISTICS

CHARACTERISTIC	EASTERN BITUMINOUS COAL	TDF (90+% WIRE FREE)
PROXIMATE ANALYSIS (% AS RECEIVED)		
MOISTURE	7.76	0.62
ASH	11.05	4.78
VOLATILE	34.05	66.64
FIXED CARBON	47.14	27.96
TOTAL	100.00	100.00
ULTIMATE ANALYSIS (% AS RECEIVED)		
CARBON	67.69	83.27
HYDROGEN	4.59	7.09
NITROGEN	1.13	0.24
SULFUR	2.30	1.83
ASH	11.05	4.78
MOISTURE	7.76	0.62
OXYGEN (by difference)	5.48	2.17
TOTAL	100.00	100.00

EXHIBIT 2

ELEMENTAL METALS ANALYSIS

(%, OXIDE FORM)

ELEMENT (OXIDE)	EASTERN BITUMINOUS COAL	TDF (90+% WIRE FREE)
Aluminum	2.29	<0.01
Barium	-	nd
Cadmium	-	0.0006
Calcium	0.36	0.378
Chromium	-	0.0097
Iron	2.09	0.321
Lead	-	0.0065
Magnesium	0.08	<0.01
Manganese	-	<0.01
Phosphorous	0.07	<0.01
Potassium	0.22	<0.01
Titanium	0.09	<0.01
Silicon	5.30	0.516
Sodium	0.05	<0.01
Strontium	-	<0.01
Zinc	0.01	1.52
Chloride	-	0.149
Fluoride	-	0.001

EXHIBIT 3

COMPARATIVE EMISSIONS
CHAMPION INTERNATIONAL MILL
BUCKSPORT, MAINE

(EXPRESSED AS POUNDS/MM BTU)

CRITERIA	BASELINE	14.5% TDF (BY HEAT)	PERCENT CHANGE
NOx	0.274	0.273	0
SOx	0.508	0.51	0
PARTICULATE	0.053	0.056	6
TOTAL HYDROCARBONS	1.17 E-3	1.18 E-3	1
BERYLLIUM	1.06 E-6	0.73 E-6	-31
CADMIUM	0.60 E-6	0.78 E-6	30
CHROMIUM	12.1 E-6	6.36 E-6	-47
LEAD	<10 E-6	<10 E-6	0
ZINC	0.26 E-3	2.56 E-3	885

EXHIBIT 4

COMPARATIVE EMISSIONS FROM A CYCLONE BOILER WISCONSIN P&L

CRITERIA	UNITS	BASELINE	7% TDF (BY HEAT)	PERCENT CHANGE
N O x	LB/MM BTU	0.79	0.91	16
S O x	LB/MM BTU	1.14	0.87	-34
PARTICULATE	LB/MM BTU	0.52	0.14	-73
CO	LB/HR	1.52	7.26	377
TOTAL HYDROCARBONS	LB/HR	5.16	10.27	99
HCL	LB/HR	25.27	19.89	-23
HF	LB/HR	1.86	1.34	-28

EXHIBIT 5

EMISSIONS FROM A CIRCULATING FLUIDIZED BED BOILER

STOCKTON COGEN

(STOCKTON, CALIFORNIA)

(EXPRESSED AS POUNDS/HOUR)

CRITERIA	20% TDF (BY HEAT)	LOWER PERMIT LIMIT
N O x	25.06	39.00
S O x	33.40	59.20
PARTICULATE	2.19	10.00
CO	20.90	22.90
TOTAL HYDROCARBONS	<0.38	1.68

EXHIBIT 6

ENVIRONMENTAL PERFORMANCE DATA
TDF INTRODUCTION INTO THE RISER SECTION OF FLORIDA CRUSHED STONE'S PREHEATER KILN

(expressed as pounds/hour)

CRITERIA	BASELINE	14% TDF
PARTICULATE	56.80	52.21
S O x	595.15	551.30
VOLATILE ORGANICS		
Acetone	0.02	0.02
Benzene	0.08	0.15
Toluene	0.01	0.20
Chloromethane	<0.01	0.03
Others	<0.03	0.04
TOTAL	0.15	0.44
SEMI-VOLATILE ORGANICS (C16-C18)	5.01	0.90
METALS		
Aluminum	6 86	8.13
Arsenic	<0.004	<0.004
Barium	0 02	0.02
Cadmium	<0.005	0.01
Chromium	0.02	0.01
Cobalt	0.01	<0.002
Copper	0.03	0.03
Iron	1.39	1.30
Lead	0.13	0.04
Magnesium	0.50	0.55
Mercury	0..04	0.01
Molybdenum	0.02	0..02
Nickel	<0.02	<0.02
Selenium	<0.004	<0 004
Silver	<0.009	<0.009
Titanium	0.22	0.26
Vanadium	<0.02	<0.02
Zinc	3.12	1.68

EXHIBIT 6 (CONTINUED)

ENVIRONMENTAL PERFORMANCE DATA
TDF INTRODUCTION INTO THE RISER SECTION OF FLORIDA CRUSHED STONE'S PREHEATER KILN

(expressed as pounds/hour)

CRITERIA		AVG EMISSION RATE (10 E-6 LBS/HR)		EQUIV 2378-TETRA DIOXIN EMISSIONS (10 E-6 LBS/HR)	
		COAL	14% TDF	COAL	14% TDF
DIOXINS					
2378-tetra	1.00000	0.004	ND	0.004	ND
12378-penta	0.50000	0.035	ND	0.017	ND
123478-hexa	0.04000	0.048	ND	0.002	ND
123789-hexa	0.04000	0.084	ND	0.003	ND
123678-hexa	0.04000	0.125	ND	0.005	ND
1234678-hepta	0.00100	1.210	0.062	0.001	<0.001
octa	0.00000	5.221	1.100	0.000	0.000
other tetra	0.01000	0.308	0.061	0.003	0.001
other penta	0.00500	0.473	0.079	0.002	<0.001
other hexa	0.00040	0.766	0.114	<0.001	<0.001
other hepta	0.00001	1.693	0.114	<0.001	<0.001
SUBTOTAL		9.667	1.530	0.037	0.001
FURANS					
2378-tetra	0.10000	0.096	0.061	0.010	0.006
12378-penta	0.10000	0.024	ND	0.002	ND
23478-penta	0.10000	0.036	ND	0.004	ND
23478-hexa	0.01000	0.048	ND	<0.001	ND
123678-hexa	0.01000	0.024	ND	<0.001	ND
234678-hexa	0.01000	0.024	ND	<0.001ND	
123789-hexa	0.01000	ND	ND	ND	ND
234678-hepta	0.00100	0.060	ND	<0.001	ND
234789-hepta	0.00100	ND	ND	ND	ND
octa	0.00000	0.048	ND	0.000	ND
other tetra	0.00100	0.204	0.149	<0.001	<0.001
other penta	0.00100	0.130	0.088	<0.001	<0.001
other hexa	0.00010	0.006	0.009	<0.001	ND
other hepta	0.00001	0.072	ND	<0.001	ND
SUBTOTAL		0.883	0.307	0.017	0.006
TOTAL (10E-6 LB/HR)		10.550	1.837	0.054	0.007

EXHIBIT 7

ENVIRONMENTAL PERFORMANCE DATA TDF INTRODUCTION INTO RISER SECTION OF ASHGROVE CEMENT'S PREHEATER KILN

CRITERIA	UNITS	BASELINE	9-10% TDF	PERMIT LIMIT
PARTICULATE	lbs/hr	5.27	4.83	18
S O x	lbs/hr	<1.5	<1.2	6.3
CHLORIDES	lbs/hr	0.268	0.197	NA
TOTAL HYDROCARBONS	lbs/hr	3	3.3	NA
PNA	lbs/hr	0.0058	0.0053	NA
HEAVY METALS				
Arsenic	micrograms	0.2	0.2	NA
Cadmium	"	3	2	NA
Chromium	"	30	ND	NA
Nickel	"	30	ND	NA
Zinc	"	35	35	NA
Copper	"	37	13	NA
Lead	"	ND	ND	NA
Iron	"	400	200	NA
Barium	"	ND	ND	NA
Vanadium	"	ND	ND	NA

EXHIBIT 8

ENVIRONMENTAL PERFORMANCE DATA

CALIFORNIA PORTLAND CEMENT KILN

(expressed as pounds/hour)

CRITERIA	EXPONENT	BASELINE	TDF
PARTICULATE		7.35	8.01
N O x (ppm)		208.80	104..2
CO (ppm)		104.20	159.30
VOLATILE ORGANICS			
Acetaldehyde		0.34	0.05
Benzene		2.65	2.29
Formaldehyde		0.88	0.11
Toluene		3.98	3.17
Dichloromethane	E-3	1.79	0.87
O-xylene	E-3	1.89	2.14
Trimethyl benzenes	E-3	1.56	3.99
METALS			
Antimony	E-4	2.32	2.28
Arsenic	E-4	4.05	8.48
Barium	E-3	1.20	0.48
Cadmium	E-4	2.27	1 77
Chromium (Total)	E-4	3.44	3.94
Chromium (Hexavalent)	E-4	2.33	1.13
Copper	E-3	1.11	0 72
Lead	E-3	1.19	0.59
Manganese	E-3	1.96	2 06
Mercury	E-3	4.54	17.33
Nickel	E-4	5.81	3.00
Selenium	E-4	<1.97	<1.35
Silver	E-5	<3.94	<4.55
Thallium	E-5	<2.52	<2.47
Zinc	E-3	4.71	9.41

EXHIBIT 8 (CONTINUED)

ENVIRONMENTAL PERFORMANCE DATA

CALIFORNIA PORTLAND CEMENT KILN

(expressed as pounds/hour)

CRITERIA	EXPONENT	BASELINE	TDF
NON-METHANE HYDROCARBONS		18.16	14.81
PCDD/PCDF	E-6	1.58	1.93
2378 TCDD TOX EQUIV	E-8	1.05	1.68
PCB's	E-6	3.16	2.89
PAH	E-2	4.29	3.35
HCl		<0.017	0.43
HF		0.02	0.02