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WORLD ENVIRONMENT CENTER

WASTE MINIMIZATION IMPACT PROJECT AT BROCENI JOINT STOCK COMPANY

SALDUS REGION
LATVIA

TRIP #1 AND #2 REPORT

OCTOBER 2-5, 1994 and JANUARY 16-18, 1995

World Environment Center
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DISTRIBUTION

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(2) File

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I. INTRODUCTION

Pursuant to the technical assistance program for Central and Eastern European countries funded by the United States Agency for International Development (USAID), the World Environment Center (WEC) team visited Joint Stock Company "Broceni" on October 2 through 5, 1994 and January 16 through 18, 1995. The purpose of the visits was to assist Broceni in implementing WEC's Waste Minimization Impact Project (WMIP). During the visits, the WEC team identified waste minimization opportunities for Broceni and recommended waste minimization equipment and process modifications.

II. EXECUTIVE SUMMARY

Although Broceni is handicapped by lack of money for necessary improvements, the plant, under the direction of the Technical Director, Janis Klavinsh, the leadership of the General Director, J. Reasons, is making a real progress in implementing the Waste Minimization Impact Project (WMIP).

This report covering the visit to Broceni on January 16, 17, and 18, 1995 and the previous visit to Broceni on October 2, 3, 4 and 5, 1994, describes the work done through January 1995, and the future plans for improvements.

A study of improvements required to reduce gas and particle emissions to acceptable levels while reducing fuel usage and operating costs is underway and will be completed by May 1995. The cost of necessary improvements is estimated to be about $3.0 million USD, not including the cost of installing the equipment by Broceni's personnel. Broceni's management is currently investigating sources of capital required for theses improvements.

Improvements are necessary in order for the plant to be in compliance with Latvian environmental regulations and requirements of the European Community. Because Broceni is the only cement plant in Latvia, it is being counted on to supply much of the cement to rebuild and modernize the country.

III. APPENDIX A

Report of Frank C. Stevens, Stevens Consulting Co.

Waste Minimization Impact Project at
Broceni Joint stock Company
Saldus Region, Latvia

October 2-5, 1994

Visit #1

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1.0 Introduction and Background Information

The World Environment Center (WEC) is an independent, not-for-profit, non-advocacy organization with its headquarters in New York City. Established in 1974, WEC contributes to the worldwide development by strengthening industrial and urban environment, health and safety practices. Using volunteer experts, contributed services and materials from industry, academia, and government, WEC provides "pro bono" assistance worldwide to industries and government in environmental/waste minimization programs. This report describes the Waste Minimization Impact Project (WMIP) being implemented at Broceni Joint Stock Company (Broceni), near Saldus, Latvia in cooperation with WEC. Broceni was selected as a participant in the WMIP because the plant is one of the largest manufacturing plants in Latvia and the country's only cement plant. This plant will require improvements to survive environmentally and economically. Its management is committed to responding to environmental requirements and will take advantage of the training and assistance that WEC can provide.

Latvia, the newly independent Baltic nation located in Eastern Europe between Estonia and Lithuania, is undergoing profound economic and political changes. Since its independence from the former Soviet Union in 1991, Latvia has been striving to become self-sufficient and a member of the European Community. Its topography is quite flat. Fishing, banking, agriculture, cement, lumbering and paper manufacturing are currently its major industries. Riga, Latvia's largest city, is situated on Riga Bay and offers an excellent port for exports and imports.

The Broceni plant is located adjacent to the town of Saldus, 120 km southwest of Riga. Broceni is a joint stock company. Ownership includes the Latvian government, Broceni employees and management, local banks and industries, and a German construction company, which is also one of its major export customers.

The older Riga plant founded in 1876 currently employs 143 people, and is used as a cement distribution center for Latvia and export. The Broceni plant founded in 1938, now has four small kilns, and employs 685 people. It manufactures cement (nominal capacity is 250,000 tons per year), lime, ceramic and corrugated roof tiles, and limestone. The use of asbestos in roof tile is to be discontinued in July, 1995. Asbestos waste has been and will continue to be disposed of in a contained landfill.

Appendices attached to this report include: an Environmental Assessment Questionnaire (Appendix D-3), the Basic Concept of Development of A/5 Broceni, (Appendix D-5), and the Quality Manual of Broceni (Appendix D-4). These reports were requested by WEC to summarize the status of the plant and action to be taken for improvements and growth. The Quality Manual includes: a historical sketch of Broceni; flow chart; and environment data - all of which are useful in the assessment of Broceni's operation.

In 1994, Broceni's production was 220,000 tons cement per year. In the past, production reached up to 600,000 tons per year; however, this rate could not be maintained due to ecological problems and economic reasons (high operating costs). With proposed expenditures

of approximately 15.0 million USD, production could be increased to 350,000 tons per year, as well as achieve Broceni's compliance with environmental standards of the Latvian Ministry of Environmental and Resource Development (MERD).

This visit to Broceni Cement took place on October 2 through 5, 1994. Initially, the Waste Minimization Committee (WMC) presented progress made since the WEC team's previous visit to Broceni. The WEC team, Frank Stevens and Franklin Phillips, and the Broceni WMC evaluated the work performed by the two local consultants hired jointly by WEC and Broceni. Progress reports were given to Broceni's Technical Director, the Financial Manager, and the Manager of Laboratories.

All meetings were encouraging and indicated that considerable progress had been made in implementing the WMIP. The major obstacle and deterrent for an environmentally sound plant is start up capital for investment. In the Environmental Assessment Questionnaire the plant stated it is "without profit". However, at this time Broceni's Management did not know the amount and types of investment a German company would make in 1995 and subsequent years for needed plant improvements.

2.0 Findings and Observations

As part of a WEC sponsored U.S. study tour on May 28 through June 4, 1994, representatives from Broceni Cement, and Akmenes Cementas in Akmene, Lithuania, as well as environmental regulatory agencies of Latvia and Lithuania attended the International

Cement Seminar of the Institute of Electrical and Electronics Engineers (IEEE) in Seattle, Washington. Here, the representatives talked with their American counterparts, attended meetings on the latest developments in cement manufacturing, and observed "state of the art" cement technologies. The group visited two modern cement plants near Seattle: Holnan's wet process plant and Ash Grove's precalciner plant, which is the newest plant in the U.S., and Continental wet process plant in Hannibal, Missouri, which burns coal and hazardous wastes as supplementary fuel. The latter plant had been updated with the latest environmental equipment and controls. In addition, the representatives talked with the U.S. EPA officials from Region IX in Chicago, and with Indiana's State Environmental Agency. Subsequently, they toured the wet process cement plant of Lone Star Industries in Indiana.

Observations made during the U.S. study tour set the pace for implementing the WMIP at Broceni. The study tour also resulted in a more positive interaction between Latvian and Lithuanian environmental officials and the cement plant management. Permitting cement kilns to burn alternative fuels is considered feasible in Latvia primarily due to exposure of Baltic Environmental officials to successful alternative fuel incineration at the U.S. cement plants. During the October 2 through 5, 1994 meetings, the WMC was very receptive to suggestions made by WEC's team. Items discussed during these meetings are outlined in the sections that follow.

2.1 Waste Minimization Committee Activities

The WMC has been very active since the U.S. Study Tour in May of 1994. Broceni has used a portable gas analyzer to test kiln exit gases for oxygen (0_2), carbon monoxide (CO), and carbon dioxide (CO_2). On August 23, 1994, the kiln gaseous emissions exit gas was sampled for particulates, such as toxic gases (NOx, SO_2, and CO) and heavy metals (V, Pb, Cr, Mn, Fe, Zn, Ni, and Cu). Tests were conducted on September 1, 1994 by the Latvian Republic Laboratories. Results of these tests are presented in Appendix D-9.

Data showed that O_2 levels in Nos.1 and 4 kilns were too high indicating excess air through the kiln that resulted in reduced fuel efficiency and excessive dusting. Without proper instrumentation, high O_2 must be used in the kiln to avoid the risk of CO explosions in the electrostatic precipitators (ESPs). When the portable gas analyzers controlled the oxygen to a 1% to 2% range, the fuel usage dropped from a high of 1700 kilocalories to 1500 kilocalories per kilogram of clinker produced. As part of the WMIP, Broceni would like to purchase, with WEC's assistance, an on-line O_2 and CO analyzers to optimize their inlet air feed (see Appendix D-7).

Another instrument which Broceni is interested in purchasing is an infrared pyrometer to measure the temperatures in the burning zone in order to control the clinkering action at discharge end of the kiln. Excess temperatures result in fuel losses and damage to the refractory brick in the kiln. WEC and Volunteer Experts were requested to report back in January 1995 regarding quotations from several pyrometers and analyzer supplies.

2.2 Cement Plant

Discussions were conducted on how to make the plant profitable and environmentally cleaner and safer.

As previously mentioned, asbestos used in corrugated roofing and siding will be discontinued as of July, 1995 and substituted by a synthetic fiber. Asbestos fiber board waste has been placed in an abandoned clay quarry serving as a dedicated land fill. In addition, the approximately 1000 tons of the kiln dust waste per month is placed into the same landfill. Since kiln dust is partially calcinated raw materials, it should solidify, and minimizing the possibility of adversely affecting ground-water systems. When money becomes available, equipment and controls will be installed that will enable most of the kiln dust to be returned to the kiln system.

Equipment additions and modifications required for cleaner operation and reduced expenses are expected to cost approximately $15.0 million USD.

2.3 In-Country Consultant Activities

Karl Roze and Nicolai Garmanov are the "in-country" consultants for Broceni's WMIP. Mr. Roze will participate in the WMIP only through December 31, 1994. He is currently working on the heat transfer balance for Nos. 1 and 4 kilns. Mr. Garmanov is evaluating the feasibility of alternative fuel incineration at Broceni. In November 1994, Mr. Garmanov visited a

number of cement plants in Russia which are using alternative fuels to supplement their energy requirements.

2.4 Ownership and Future Operation

A German construction company has recently bought 30% of Broceni. The new management team is studying ways of improving the operation.

2.5 Proposed Improvements

Plant management and WEC are studying the proposals for improving plant operation in order to save money and meet existing requirements of Latvian MERD (Appendix D-5). The Basic Concepts of Development Program for A/S Broceni were discussed with the A/S Broceni Board. These studies will be continued and presented in a final report during 1995.

3.0 Conclusions and Recommendations

The Broceni cement plant was built using Russian technology and equipment. From 1938 through 1970 the plant manufactured large quantities of cement; however, production was economically inefficient and environmentally unacceptable by today's standards. Wet process plants in the United States were updated during the past 40 years and today are clean and cost efficient. The types of improvements needed were seen by the Latvian - Lithuanian U.S. study group in May and June, 1994 and can be implemented, as soon as sufficient funding is available.

3.1 Broceni Action Items

With the help of WEC, Broceni will purchase a 0_2 and CO analyzer needed for improvement. It will also implement additional low cost minor improvements that are necessary to clean up the plant using its employees. Broceni continues to study needed improvements for 1995, including the purchase of an infrared pyrometer.

3.2 WEC Action Items

Broceni has asked WEC to obtain more information on the equipment required to burn alternative fuels in place of high cost No. 6 Bunker "C" fuel oil and natural gas. The Russians have continually increased fuel prices throughout 1993 and 1994, making the cost of oil now $80 to $100 per ton, while supply is not always readily available. The price of natural gas on an equivalent kilocalorie basis is $100 to $150 U.S. Dollars per ton. Alternative fuels which are available in Latvia include petroleum for $40 per ton USD, tires, and solid organic wastes for less that $15.00 per ton.

A review was made of U.S. and Russian systems for handling tires and solid wastes. The cost of shredding tires is more expensive and not as suitable as the system of adding whole tires as supplement fuel for Broceni's kilns. Brochures on tires and solid waste fuels were left with the management of Broceni.

Discussions were held with Broceni's management on how best to improve the overall operation of the plant. A proposal by a Danish equipment supplier was reviewed but not

accepted because it was incomplete and costly. Frank Stevens is further reviewing the proposal and will provide a lower cost alternative.

3.3 Improvement Proposals

At the time of the visit, no proposals were firmed up. Direction is required from Broceni's German partner regarding funding available in 1995.

3.4 Other Recommendations

In past years, the plant was capable of producing 600,000 tons of cement per year with four kilns in operation. In 1994, the production rate was 220,000 tons of cement per year. The cement grinding capacity is about 500,000 tons/year, which exceeds the practical clinker capacity of 300,000 tons per year. As the economy and export market grow in Latvia, the sale of cement is expected to increase to 500,000 tons and eventually to 1,000,000 tons per year which would exceeds the capacity of the plant. Latvia's population of 2,500,000 people and increasing will demand more cement. Therefore, the plant should be updated to a new 750,000 ton per year precalciner kiln. Utilizing the best of the existing crushing, raw grinding mills, cement grinding mills, and cement shipping facilities, the addition of new kilns will cost between $40,000,000 and $60,000,000 USD. This extension will include equipment that make the process environmentally cleaner, comply with the latest Latvian regulations, and render the plant profitable.

4.0 Summary

The progress to date of the WMIP has been good. Several studies are underway. The plant is being cleaned up environmentally and the management shows itself responsive. New 0_2 and CO analyzers are scheduled for purchase, and an infrared pyrometer is being considered.

IV. APPENDIX B

Report of Frank C. Stevens, Stevens Consulting Co.

Waste Minimization Impact Project at
Broceni Joint Stock Company
Saldus Region
Latvia

Visit #2

January 16-18, 1995

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1.0 INTRODUCTION

Pursuant to the technical assistance program for Central and Eastern Europe countries funded by the U.S. Agency for International Development, the World Environment Center conducted a Waste Minimization Impact project visit to Broceni, and at Joint Stock Company in Latvia. the visit took place between January 16 and 18, 1995.

2.0 EXECUTIVE SUMMARY

Even though Broceni is handicapped by lack of funds for needed improvements, the plant under the direction of Janis Klavinsk, Technical Director, the leadership of the J. Reasons, General Director, is making real progress for the implementation of an Environmental/Waste Minimization program. Activities of improvements in 1994 are continuing and expanding in 1995.

This report covering the mission to Broceni on January 16, 17, and 18, 1995 along with the previous report on the visit to Broceni, October 2, 3, 4 and 5, 1994, outlines the work completed and the program for 1995.

The study on improvements needed to reduce gas and particle emissions to acceptable levels while reducing operating costs is underway and will be finalized by May of 1995. The cost for these necessary improvements is about $3.0 million USD plus the cost of installation by Broceni personnel. Sources for the capital required for these improvements is currently being investigated by the Broceni Management. They have identified sources that include the Ready Mix Company in Retinga Germany, equipment suppliers, USAID, IMF and/or the World Bank.

The improvements are needed in order for the plant to comply with Latvian environmental regulations and to meet standards set by the European Community necessitated by the one-third ownership of Broceni by a German company.

3.0 FINDING AND OBSERVATIONS

The supply of fuel oil and gas from Russian has been unreliable and the cost has increased from $60 per ton 12 months ago to $110 per ton in January, 1995. These actions by the Russians require that Broceni convert its plant to use alternative fuels including tires, solid waste, pet coke and low cost coal, as other European cement plants have done. As soon as the money is available, Broceni will install equipment that can burn tires and solid organic wastes as supplementary fuel to operate the kilns,.

When final quotations are received in May of 1995, Broceni expects to purchase a gas analyzer for measuring oxygen (0_2) and carbon monoxide (CO). These instruments will enable the plant to control emissions, reduce excess air and fuel usage.

Studies are continued on kiln modifications, electrostatic precipitators (ESP) improvements, and clinker cooler changes for reducing particulate emission and gas emissions (CO, NOx and SO_2), while improving the fuel economy. Results will be reported later this year. These proposed improvements will meet the requirements of the Latvian Environmental Agency (LEA).

3.1 Waste Minimization Committee Activities

In 1994, under the supervision of the Latvian government, the laboratory Environmental Data Center tested the emissions of Kiln No. 4 at Broceni. A complete report has been attached as

Appendix E. The metal contents of exhaust gases from ESP were very low and will pass the LEA regulations. The other emissions are:

Emission	Unit of Measure	Test Results	Latvian Standards
Particulates	mg/m^3	213	Not Finalized
N0x	mg/m^3	273	
SO_2	mg/m^3	0	
CO	mg/m^3	101	

The Committee report, completed January 17, 1995 is included in Appendix E.

The Committee reported on water conservation projects, heat recovery ideas, and health and safety programs.

3.2 Ownership Broceni

Ready Mix Zemet GMCH of Ratinger Germany owns 30 % of Broceni as of January 18, 1995. The German partner will buy more of the exported cement in 1995 and will participate in the financial investments for plant improvements.

3.3 Fiberboard (corrugated) Plant and Other Products

In 1995, Broceni plans to finalize Fiberboard plant improvements using synthetic fibers instead of asbestos fiber.

3.4 Alternative Fuels, Tires and Solid Wastes

Broceni wants to proceed with the installation of a system which uses tires and solid organic wastes to reduce fuel costs. This system will cost $250,000 USD and reduce fuel costs by 5% to 10%. The plan is to use a system feed whole tires and solids to mid kiln.

3.5 Environmental Emissions and Requirements for Compliance

As shown in sections 2.0 and 2.1, Broceni exceeds the not yet finalized emission limits. System improvements for reducing fuel consumption by 300 kilocalories per kilogram will result in compliance and fuel economies. Cost is estimated to be $3.0 million USD. The source for the capital is yet to be found.

3.6 Operational Problems and Improvement Requirements

The biggest problem in the plant is the absence of an O_2 and a CO analyzer.

Appendix E contains a report on Dust Emissions. The Technical Manager of Broceni discussed the improvements required for the system to operate at $30,000 USD cost and result in an estimated $280,000 USD savings per year. The report has been received and approved by Broceni and WEC. The selection involving the gas analyzer system is to be finalized in May of 1995. The volunteer expert will assist in the installation and start-up of the O_2 and CO analyzers.

4.0 Conclusion and Recommendations

4.1 Broceni Action Items

As discussed in our meeting with Broceni management on January 17 and 18, 1995, the following will be implemented:

- Prepare an Environment Impact Statement and Policy for Broceni's compliance.

- Finalize an employee incentive program for Waste Minimization.

- Put into action a program to reclaim and sell all scrap metal and equipment in the plant.

- Workers and supervisors will institute a program that aims at avoiding spills through improvement of maintenance and operating procedures. In addition, implementation of proper clean-up procedures in case of accidents.

- Complete the testing and compliance of ISO quality standards for cement manufactured in the plant (EN197).
  Note: Latvia became a member of the European Council (EC) in February 1995.

- Install and use O_2 and CO analyzers for reducing emissions and savings of fuel Equipment ordered in April, 1995 will take 16 weeks for delivery.

- When money is available, proceed with installation equipment for feeding tires and solid organic wastes into No. 4 kiln.

- Finalize studies for reducing emissions of particulates from 200 mg per cubic meter to 50/mg per cubic meter.

- Maintain regularly all dust collection equipment. Reduce dust emissions and fuel costs as money becomes available for improvements. This cost will come to approximately 3.0 million USD.

- Use synthetic instead of asbestos fibers for building corrugated panels. Complete changeover in 1995.

- Implement recommendations of the two paid consultants supported by WEC and Broceni. Complete the report by June of 1995.

- Perform a stack emission test for the particulates CO, N0x, $S0_2$ after analyzers are installed.

- Submit a report to WEC on the results of the Technical Development Program discussed with Broceni Board of Directors in 1994. (See proposals in Appendix F)

4.2 WEC Action Items

- Obtain Analyzer and Sample probe quotation for O_2 and CO measurements by April of 1995. Assist in the installation and training during 1995.

- Assist in the improvements required to reduce emissions and reduce fuel use.

- Send Broceni a copy of BIF regulations, testing procedures, and operational requirements to comply with USEPA use of alternative fuels.

- Obtain information on use of synthetic fibers in place of asbestos fibers, in U.S. plants manufacturing synthetic building panels and pipes.

- Obtain a copy of typical emissions test results from a U.S. wet process kiln system similarly to Broceni's No. 4 kiln, for metals, SO_2, H_2O, N0x, THC, CO, CO_2, NH_3, HCL and O_2 in kiln exit gases.

- Send information on Dioxins and Furans in U.S. cement Industries. Note: Dioxins and Furans emissions from cement kilns, are very low and are dependent on organics in raw materials, and fuels and temperature of kiln gas emissions.

4.3 Consultant Trainee Assignments

In 1994, two consultants, Nicolay Garmano and Karli Roze, were hired jointly by WEC and Broceni. Report on their activities was presented orally on January 18, 1995, and will be submitted in writing by April 1995. Their performance was good.

4.4 Equipment Proposals

As presented in Appendix B, a summary of analyzers and pyrometer quotations was discussed with the Broceni Management. Selected for firms were:

Biley
Ametek
Teledyne

For Pyrometer, quotes selected for firm quotations were:

Everest 4000B
Quantum Logic QL 3200F-3A

Broceni requires a firm quotation for Parr Calorimeter. This will be sent to them.

APPENDIX C

Report of Franklin C. Phillips
Phillips Environmental Training and Resources Associates, Inc.

Waste Minimization Impact Project at
Broceni Joint Stock Company
Saldus Region, Latvia

Visit #1

October 2-5, 1994

III. Broceni Cement Plant, Latvia - Summary Report

Mr. Phillips arrived at the Broceni Cement Plant on Tuesday 10-4-94 and participated in the technical meeting being conducted by Mr. Frank Stevens with various plant and office personnel attending including Dr. Janis Klavinsh, Dr. Karlis Roze, and Mr. Galindomus. The facility currently produces Portland cement, ceramic tiles, and corrugated roof sheets containing asbestos. Two ragulated hazardous waste streams are geerated: 800 tons / month of ash from cement kilns, and 20 tons / month of asbestos cements sludge. The asbestos containing cement sludge is landfilled on site in an old clay quarry with permission from state authorities. 1,000 tons per month of cement kiln dust is recycled. The use of asbestos as new material in product manufactured is scheduled to be halted by July 1, 1995.

It is this author's opinion that if progress is to be made in protection of worker's health and safety, and in protecting the environment, an outside team or person with waste minimization experience needs to spend one to two weeks at the plant with a team of plant personnel. The plant personnel must dedicate most of their workday and evening time during this period to learning the specifics of waste management, waste minimization assessment, hazards recognition and safety management. After learning the principles for two or three days, a two day thorough site assessment should be performed by the WEC volunteer consultant who will point out areas of consideration for waste minimization, process changes, and safe work practices. The team should spend one or two days evaluating the opportunities and select the most implementable no-cost/ low-cost options. A final report should be written containing the anticipated safety, economic, and environmental benefits that would be attained.

A plant with no SPCC / Contingency / Preparedness and Prevention Plan is far more likely to have a serious environmental release, lost time = injury in fatality, than a plant where the effort, planning, and spill response supplies have been made available.

VI. APPENDIX D

Additional Technical Information

D-1 Itinerary of Mission: October 2-5, 1994 and January 16-18, 1995

D-2 Broceni Waste Minimization Committee

D-3 Broceni Environmental Assessment Questionnaire

D-4 Quality Manual of Broceni

D-5 The Basic Concepts of Development for A/S Broceni

D-6 Preliminary Estimates of Profits for Waste Minimization

D-7 Equipment Proposals Gas Analyzers, and Pyrometer

D-8 Waste Minimization Committee Reports

D-9 Stack Emissions Test on Kiln #4

D-10 Fuel Composition Report

D-11 Seminar Materials for the Use of Alternative Fuels in the Cement Industry

D-12 Air Emissions Associated with the Combustion of Scrap Tires for Energy Recovery

D-13 Business Cards of Contacts

D-14 Curriculum Vitae for Frank S. Stevens and Franklin C. Phillips

Appendix D-1

Itinerary of Mission to Broceni

October 2-5, 1994

and

January 16-18, 1995

Appendix D-1

Itinerary of Missions to Broceni

October 2-5, 1994 and January 16-18, 1995

➢ October 2 through 5, 1994 Mission

- October 2, 1994:
- Meeting with Broceni's Technical Director and Laboratory Manager.
- October 3, 1994:
- Plant tour, Discussion on the Latvian economy, role of Broceni, operations and sales, environmental, waste minimization, alternative fuels, gas analyzers, and tire burning.
- October 4, 1994
- Continued discussion on improvement program. Brought management up to date on waste minimization proposals.
- October 5, 1994:
- Completed survey and action items list.

➢ January 15 through 27, 1995 Mission

- January 17, 1995:
- Meeting with plant management : Reviewed Waste Minimization Program, quotations on O_2 and CO analyzers, and pyrometer. Discussed action items.
- January 18, 1995: Finalized consultants assignments, Broceni action items, and WEC action items

Appendix D-2

Broceni Waste Minimization Committee

1) A/S vice president, technical director, dr.sc.ing. Janis Kalvins - Leader;

2) Deputy of technical director in ecological questions Laurinovica Romualda - control of terms of project fulfillment, connection with organization of environmental protection;

3) Production director Andersons Arturs-control of project fulfillment, production, program;

4) Manager of resources department control of resources consumption;

5) Economist of resources department Dzintra Karele-calculations of project feasibility;

6) Engineer of resources department Smeltered Lilita-control of consumption control;

7) Manager of labor safety department;

Appendix D-3

Broceni Environmental Assessment Questionnaire

ENVIRONMENTAL ASSESSMENT QUESTIONNAIRE

1. Facility Name: Joint stock company „BROCENI"

Address: Brocēni LV 3851
Saldus district
Latvian Republic

Telephone: (371) 38 65212 Brocēni; (371) 2 212587 Rīga

Fax: (371) 38 65067 Brocēni; (371) 9 348058 Rīga

Facility Manager: JURIS REISONS

Environmental Contact: JANIS KLAVINSH

Name of Property Owner (If different from facility name):

1. State owned part of enterprise 64%
2. Joint stock company INTERLATVIJA 35%
3. Saldus Municipality 1%

2. Facility Age: Rīga - 1866y. Brocēni - 1934y. Square Footage (under roof) Rīga - 14 000 m² Brocēni - 49 000 m² TOTAL: 63 169 m²

Owned Rīga - 30,6h Broc. - 98,7h TOTAL: - 129,3h Leased 301,9ha Lease Expiration Date 2092y.

Total Acreage (facility boundaries): 431,2ha

Year in which the company started production at the site: A/s BROCENI, Febr. 11, 1993

Number of employees: Rīga — 143 Brocēni — 685 ; in TOTAL: 828 (at present)

Typical work week (e.g., 24 hours; 7 days per week):
24 hours · 7 days per week
70% employees

Describe previous uses of site prior to your occupancy:
Stock company SMIDTH

Surroundings: Industrial 98,7ha Commercial ____
Residential ____ Other ____
Wetlands ____ Coastal Zone Rīga, 30,6ha

(10/14/93)

3. What products(s) is/are currently manufactured at the facility? Please list.

Portlandcement: according ГОСТ standart M400, M500; according DIN 1164 PZ 35F, PZ45F.
Ceramic tiles: for wall – 150×150×6 mm; for floor – 150×150×9 mm and 250×140×9 mm
Corigated roof sheets ± – 1200×780. Till 1.07.1995 – asbest sheets. From 1.07.1995 – unasbest sheets
Burning lime, Limestone flour, Crumbled limestone

4. What raw materials are used to make the product(s)? Please list.

Cement: limestone, clay, gypsum, iron slag, fly ash
Fuel: mazut (heavy oil). Ceramic tiles: clay, crumbled tiles
For glaze: Na_2CO_3; M_2BO_3, K_2CO_3, sand, nepheline, dolomit, limestone, kaolin, ceramic colour, fuel – gas. Asbests roof sheets: asbest and cement
Unasbest roof sheets: cellulose, microbilica, cement
Limestone: burning lime, limestone flour, crumbled limestone

5. Generally describe the manufacturing process(es):
Cement – wet process: slurri mills 2.6×13 m, kiln 4×150 m
cement mills 2.6×13, 2.2×13 – open cycly.
Ceramic tiles: remidrye presporder, double firing process, roller kiln, moterfal type glaging process, TWO-colored decoration printed process
Corigated sheets – hot-schex process
Burned lime – shaft kilns

6. Attach a list of all hazardous chemicals present at the facility in excess 1000 liters at any one time, and the amounts of each used annually (facility inventory records are acceptable).

We don't hair hazardous chemicals present

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Solid and Hazardous Wastes

Has each waste stream been assessed to determine whether or not it is hazardous regulated waste:

(YES) NO

List all wastes generated at the facility and the approximate quantity generated of each on a monthly basis.

1) The ash from cl. kilns - 800 tpm
2) Asbest and cement sludge - 20 tpm

Has the appropriate agency been notified of the generation of regulated hazardous waste streams?

(YES) NO

Are any wastes (regulated and non-regulated) generated at the facility disposed of on-site (incineration, landfill) ?

YES NO

If yes, list the type and amount of waste and the method of disposal

landfill → asbest + cem. sl.

Are all wastes (regulated and non-regulated) generated on-site disposed of in a permitted or regulated waste management facility?

(YES) NO

If yes, what is the name and location of the facility(ies), and how much per week is sent there:

Old clay quarry

Have the above facilities been evaluated by enterprise personnel?

(YES) There is a permission of state authorities. NO

How long are regulated hazardous wastes stored at the enterprise? Not

Is there a contingency plan maintained at the enterprise which is designed to minimize hazards to the public health or the environment from fires, explosions, or unplanned releases of regulated hazardous waste or chemicals? Theoretical (we need investments for fullfilment)

(YES) NO

(Documentation should be made available for review during assessment)

Are Annual (or Biannual) Waste Reports submitted to a governmental agency?

(YES) NO

Does the facility have a waste minimization and/or toxicity reduction plan in place?

YES (NO)

(Documentation should be made available for review during the assessment)

Does the enterprise use or implement any on-site recycled operations (solvent recovery)?

(YES) NO

If yes, please describe what is recycled, amounts, and the recycling process:

Kiln dust recycle 1000tpm

If off-site recycling operations are used, please describe what is recycled, amounts, the recycling process, and the name and location of the recycling contractor:

Have the above facilities been evaluated by facility personnel?

YES NO

11. Are steps being taken to redesign processes to reduce hazardous waste streams? If yes, please give examples.

We don't have a gas anolizator

12. Are steps being taken to redesign processes to eliminate hazardous reagents such as bis-chroromethyl ether? If yes, please give examples.

Asbests using will be stoped after July 1, 1995

COPIES OF ALL REGISTRATIONS, LICENSES, AUTHORIZATIONS, PERMITS, ETC. RELATED TO HAZARDOUS AND SOLID WASTE SHOULD BE AVAILABLE FOR REVIEW DURING THE ASSESSMENT.

Spill Prevention and Control

1. Does the enterprise have a Spill Prevention and Control Plan?

YES (NO)

Conduct spill prevention training?

YES (NO)

Have a spill response group?

YES (NO)

(Documentation should be made available for review during the assessment)

2. Have there ever been any discharges of oil; petroleum products; or other hazardous chemicals at the facility during the past three years?

(YES) NO

3,0 t of heavy oil

Water Pollution

1. Does the facility discharge wastewater to:

   Navigable waters No Local treatment works Yes

   Privately-owned treatment works ___ Septic system Yes

   Underground injection well No surface or groundwater(dry wells) No

   Other — Describe: —

2. Does the facility sample its wastewater discharges?

   (YES) NO

3. Does the facility have a permit or authorization for these discharges?

   (YES) NO

4. What is the average discharge volume per day? average in 1992y – 700 m³

   Total process discharge volume per day? —

5. What is the average amount of raw water incoming to the plant on a daily basis? (with all needs) – 6000 m³

6. If the waste water is discharged to an off-site treatment works what is the name and size/capacity of the local treatment works?
   BIO – 150 m³pd Oil catcher – 410 m³pd
   settler – 8150 m³pd

7. Does this local treatment works require pretreatment of the waste water?

   YES (NO)

8. What is the name of the receiving body of water? Ciecere lake and underground well

9. Where does your stormwater discharge to? Broceni lake

10. Is a permit required for the stormwater discharge?

    (YES) NO

(10/14/93)

11. Describe the system used to convey wastewater to either an on-site treatment system, and/or the local waste water treatment system? Include the type(s) of piping materials that are utilized and whether the piping has ever been integrity tested or can be visually inspected.

_____
_____
_____
_____

12. Are steps are being taken to redesign processes to reduce waste streams? If yes, give examples.

_____
_____
_____
_____

COPIES OF ALL REGISTRATIONS, LICENSES, AUTHORIZATIONS, PERMITS AND LOCAL SEWER USE LAWS FOR WASTEWATER, AS WELL AS WASTEWATER SAMPLING RESULTS SHOULD BE AVAILABLE FOR REVIEW DURING THE ASSESSMENT.

Safe Drinking Water

1. Does the facility:

Obtain any portion of its drinking water from on-site well or surface water source?

YES NO

Monitor its drinking water?

YES NO

COPIES OF ALL REGISTRATIONS, LICENSES, AUTHORIZATIONS, PERMITS, AND SAMPLING RESULTS SHOULD BE AVAILABLE FOR REVIEW DURING THE ASSESSMENT.

Underground Storage Tanks (USTS)

1. Does the site contain any storage tanks for hazardous liquid material whose volume is 10% or more beneath the ground surface?

   (YES) NO

   If yes, please the list the tank, tank volume and contents.
   3 x 8 m³

Aboveground Storage Tanks (ASTS)

1. Does the site contain any storage tanks contain oil or hazardous materials whose surface area is not entirely covered with earth or other material, or any tank which can be inspected in a subterranean vault?

   YES (NO)

   If yes, please list the tank, tank volume and the material they contain.

2. Does the facility employ programs for preventing transfer spills and accidental discharges including monitoring, maintenance, inspections, inventory, and operation methods and procedures?

   YES (NO)

3. How does the facility manage and dispose of rainwater and other liquids that accumulate in tank containment and spill containment areas.

   There is a rainwater condition

COPIES OF ALL REGISTRATIONS, LICENSES, AUTHORIZATIONS, PERMITS RELATED TO UNDERGROUND AND ABOVE GROUND STORAGE TANKS SHOULD BE MAY AVAILABLE FOR REVIEW DURING THE ASSESSMENT.

Air Pollution

1. Does the facility have air pollution permits or registrations?

   YES NO

2. Does the facility have a list or site plan including all air emissions sources (i.e., reactors, distillation units, dryer, boilers, etc.).

   YES NO

3. Does the facility conduct any air emission monitoring?

   YES NO

4. Does the facility conduct periodic Volatile Organic Compound monitoring?

   YES NO

5. Does the facility dispense any fuel to trucks, automobiles, or other equipment?

   YES NO

6. Does the facility store or use any chlorofluorocarbons or halon compounds on site? No

7. Are vapors from reactions liberating acidic or toxic gases scrubbed before venting into the atmosphere?

   YES NO

   If yes, please describe.

_____

_____

_____

_____

COPIES OF ALL DOCUMENTATION, REGISTRATIONS, LICENSES, AUTHORIZATIONS, PERMITS RELATED TO AIR POLLUTION SHOULD BE MAY AVAILABLE FOR REVIEW DURING THE ASSESSMENT.

PCBs

1. Does the facility use any PCB containing equipment such as electrical transformers, capacitors or breaker switches?

YES (NO)

Hazardous Materials Transportation

1. Does the facility ship materials which are considered hazardous materials by international treaty (European Agreement concerning the Carriage of Dangerous Goods by Road "ARD") ?

YES (NO)

3. Which types of hazardous materials (actives, intermediates, and/or final products) are either at or shipped from the facility?

____ Flammable/Combustible liquids ____ Flammable Solids
____ Corrosives ____ Poisons ____ Oxidizers ____ Organic Peroxides
____ Explosives ____ Inhalation Hazards ____ Etiologic Agents
____ Radioactive Materials ____ Other (please explain)

Asbestos

1. Do any areas of the facility contain asbestos or asbestos-containing materials?

(YES) NO

2. Has the air within the facility ever been tested for the presence of asbestos?

YES (NO) Dust contamination level has been tested

3. Has a survey ever been conducted to determine whether asbestos-containing material are contained at the facility?

YES (NO)

(Documentation should be made available during the assessment)

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General

1. Has the facility ever completed an Environmental Impact Statement or Environmental Assessment?

   YES | (NO)

   If yes, please describe: _____

2. Does the facility use, store or generate any radioactive materials?

   YES | (NO)

   If yes, please explain: _____

3. Does the facility generate medical, biomedical, or Biohazardous waste?

   YES | (NO)

   If yes, describe how the waste is handled and disposed of: _____

4. Has the facility been inspected by any governmental agency within the past three years?

   (YES) | NO

5. Has your facility ever received a Warning Letter, Notice of Violation, Cease and Desist Letter, Administrative Consent Order or any other enforcement action as a result of an inspection?

   (YES) | NO

   If yes,. please explain:
   Notice of Violation for production with switched off electrofilters

(All documentation should be made available during the assessment)

Appendix D-4

Quality Manual of Broceni

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RECEIVED 4 OCT. 1994

3.1 A Historical Sketch

A/S *Brocēni* was founded on 11.02.1993, amalgamating state owned Brocēnu cement and asbestos slate combine and Rīgas Cementnieks plant and A/S *InterLatvija* share capital.As A/S *Brocēni* founder with 1 % of shares also Saldus region municipality takes part.

Production of cement in Latvia started in 1876.in the premises of present A/S Brocēni. In times of Latvian free state Rīga Cement Plant belonged to A/S A/S *Schmidth*. After building Rīga - Liepāja railway A/S *Schmidth* started to erect a new cement plant in Brocēni. Construction works were finished in 1938.
Technological equipment was supplied by *FLS Smidth* from Danmark. At that time Brocēni cement plant was one of the most modern cement production plants in Europe. The production capacity of the plant till 1941 was 70 thousand tonns of cement annually.

During the Second World War a plant was under a control of German firm *Wilke* , which started erection of two more clinker kilns, an additional clinker store and cement mills.

In 1962 Brocēni plant production capacity was considerably increased, when the fourth clinker firing kiln, with 840 tonns of clinker output was commisioned. At same time new limestone quarries was started to excavate, a new limestone crushing and sieving plant was built, three slurry mills was put into the operation. As the result of these activities cement production capacity became 520 thousnd tonns annually.

The production capacity was increased also in 1984 - 1985 , when the second clinker firing kiln was made longer and electrofilters where installed for kilns #1, #2, #3. Subsequently production capacities arosed to 630 thousand tonns of cement annually.

In Riga Cement Plant up till 1992 in operation there were two clinker firing kilns. At preasent they are standing both due to ecological and economical reasons. Now this plant is functioning

only as milling department for clinker produced in Brocēni Plant. The milling capacity is 240 thousand tonns of cement annually.

3.2 A Simplified Production Scheme with a Short Description

Location :	* Limestone Quarry	Saldus r."Kūmas"
	* Clay Quarry	Brocēni
	* Limestone Crushing and Sieving	Saldus r. Sātini
	* Clinker Production	Brocēni
	* Cement Milling and Packing	Brocēni un Rīga
	* Dispatching of Cement	Brocēni un Rīga

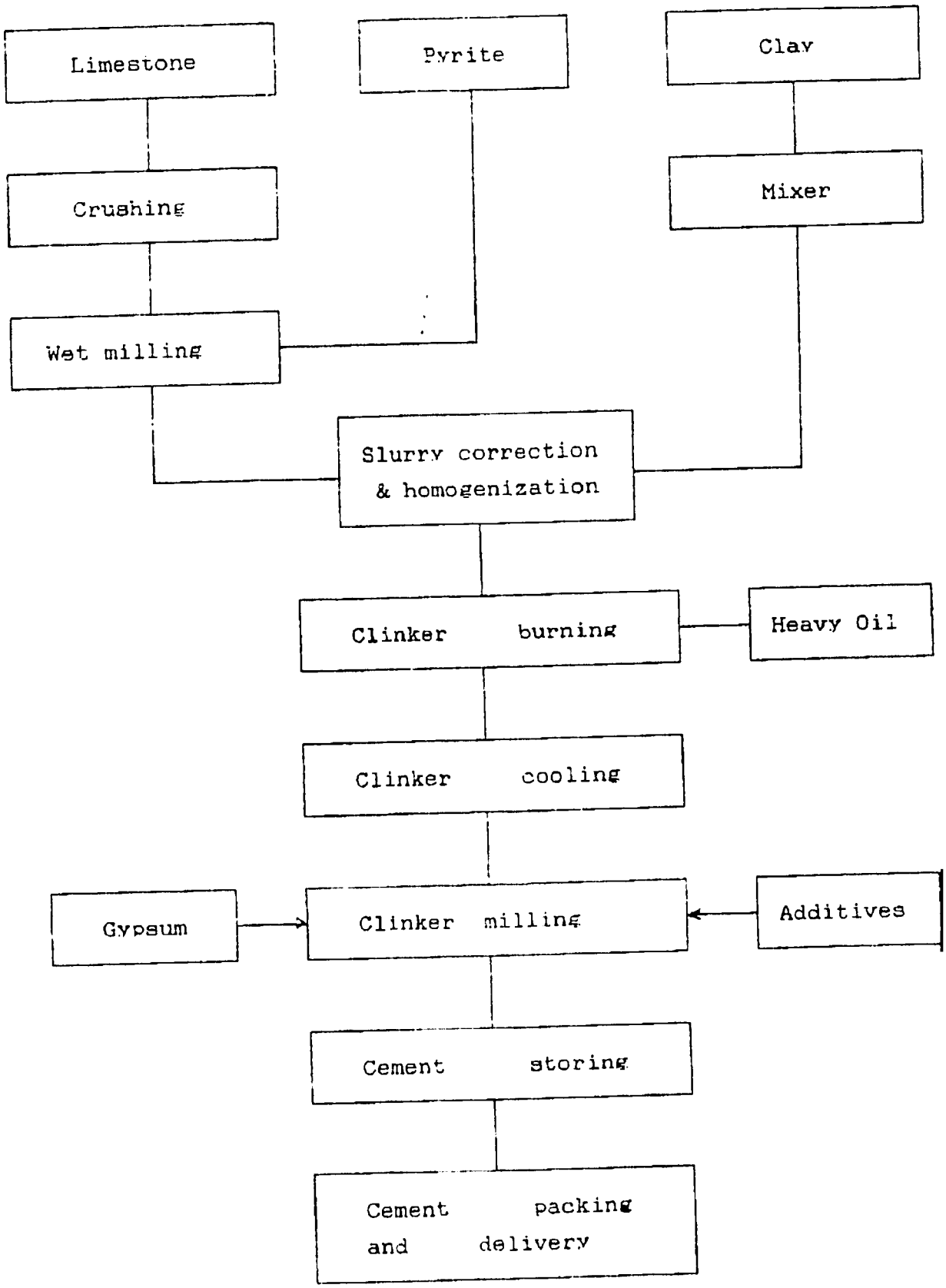
Production Process : Cement production after the wet method.

Cement production capacity with kiln # 4. : 280 th tonns a year.

Fuel : mazut 100 (heavy oil).

Clinker milling : three mills in Brocēni with productivity 64 tonns per hour and two mills in Rīga with productivity 36 tonns per hour.All the mills with open cycle.

A Simplified Production Scheme



3.3 The Basic Equipment

The Basic Equipment
of Limestone Quarry :

* Dragline Excavator	ЭШ 10/70А	1 piece:
* Excavator	ЭКГ-5 А	4 pieces:
* Drill Tower	4 СБШ	2 pieces.

Productivity of limestone quarry equipment is up to 1000 tonns per hour.From quarry limestone is transported by electric railway in 60 tonn tipper wagons (dump cars).

The Basic Equipment
of Clay Quarry :

* Dragline Excavator	Э - 1234	1 piece:
* Excavator Hydraulic	ЭДГ-1023	2 pieces.

Productivity of clay quarry equipment is up to 300 tonns per hour. From quarry clay is transported by heavy lorries.

The Basic Equipment
of Limestone Crushing and Sieving Department :

* Jaw Crusher	(350 t/h)	ЩКД - 8	1 piece:
* Vibrating Screen	(250 t/h)	ГГТ - 42	4 pieces:
* Hammer Crusher	(250 t/h)	ДМПП - 1	4 pieces.

The Basic Equipment
of Clay Mixing Department :

* Mixer СМ - 493(427.1) (prod.200 m^3/h)		2 pieces:
* Centrifugal Slurry Pumps	8 ШНВ	2 pieces.

The Basic Equipment
of Slurry Department :

* Ball mill.open cycle.two chambers СЗТМ diam. 2.6 m, length 13 m.output 42 t/h		3 pieces
* Correction Silo (volume 324-413 m^3)		10 pieces
* Centrifugal Slurry Pumps	6 ФШ - 7А	11 pieces

The Kiln # 4 :

* The Kiln - Brianskii Plant diam.4.0 m .length 150 m.
* Clinker cooler ВОЛГА КС-35 Volgocemmaš Plant.
* Electrofilter ДГПН - 32x3 2 pieces.

The productivity of the Kiln # 4 is 35 tonns of clinker per hour.

The Basic Equipment
of Brocēni Milling Department :

* Ball mill . open cycle. two chambers УЗТМ diam. 2.4 m. length 13 m.output 16 t/h 1 piece :
* Ball mills. open cycle. two chambers СЗТМ diam. 2.6 m. length 13 m.output 23 t/h 2 pieces.

The Basic Equipment
of Rīga Milling Department :

* Ball mills. open cycle. two chambers УЗТМ diam. 2.4 m. length 13 m.output 16 t/h 2 pieces.

Cements is being transported to silos using pneumatic chamber pumps.

The Cement Storage in Brocēni :

* Silo with 2600 t capacity 4 pieces:
* Silo with 2200 t capacity 2 pieces.

The Cement Storage in Rīga :

* Silo with 1500 t capacity 4 pieces:
* Silo with 200 t capacity 2 pieces.

The Cement Packing in Brocēni :

* Packing machine for 50 kg bags output 100 t/h 1 piece :
* Packing machine for 1.5 tonn big bags output 30 t/h 1 piece :
* Packing machine ACMA for 3-5 kg bags 1 piece.

The Cement Packing in Rīga :

* Packing machine for 50 kg bags output 100 t/h 1 piece.

3.4 Produced Cement Types

For local market A/S Brocēni is producing in accordance with GOST 10178 - 85 the following types of cement :

* M 400;
* M 500.

For export market A/S Brocēni is producing in accordance with DIN 1164.(DS 427,NEN 3550) the following types of cement :

* PZ 35 F;
* PZ 45 F.

6. Raw Materials and their Quality Control

6.1 Limestone

Detailed investigations of limestone deposits in Saldus region in vicinity of "Kūmas" farmhouse were produced in early 70's.Results of these investigations were published by V.P.Čurnasov in 1975 under she title "Report of detailed investigation of "Kūmas" limestone deposits for Brocēni cement plant".

According to it limestone reserves for cement production in "Kūmas" deposite of A+B+C_1 categories in 1975 were 81 024 832 tonns.

Limestone from the quarries is transported in railway wagons to crushing devices in Sātini.This crushing plant has three stages. the first one is a jaw crusher and other two are hammer crushers. Fraction of limestone used for clinker burning is 0 - 40 mm size.

A sample of limestone fraction 0 - 40 is taken from railway wagon at deloading place in Brocēni plant. The titre and moisture content is determined daily.
Full chemical analyses (Full An.)of limestone are made each month. Typical chemical composition of limestone fraction 0 - 40 mm is :

SiO_2	3,0 %
Al_2O_3	0,5 %
Fe_2O_3	0,6 %
CaO	51,0 %
MgO	1,9 %
SO_3	0,3 %
R_2O	0,6 %
titre	93 %
loss on ignition	41,8 %.

6.2 Clay

Detailed investigations of **clay** deposits in **Saldus** region in was carried out in 1979 - 1980 by **"Centrģeoltrud"**.

According to it clay reserves for cement production in **Brocēni** - 2 deposite of A+B+C_1 categories were 27 000 000 tonns.

Clay is transported from quarry to clay mixer by trucks .
Typical chemical composition of clay is :

SiO_2	49,3 %
Al_2O_3	11,5 %
Fe_2O_3	4,9 %
CaO	11,5 %
MgO	5,2 %
R_2O	3,4 %
SO_3	0,2 %
titre	20,6 %.
loss on ignition	42,8 %.

6.3 Gypsum

Gypsum is delivered from Saurieši by railroad in wagon. Each delivery is chemically analyzed by taking a subsample from every wagon and combining these into a main sample.
It is analyzed for SO_3 and moisture content.

A sertificate of quality is provided from the supplier.

In the event of a disagreement about the analysis a representative from the supplier is called and together with a representative of the factory a new sample is taken.
This sample is divided into three parts.one for the supplier.one for the factory and one for independent test laboratory.

6.4 Heavy Oil Fuel

Heavy oil is delivered from Russia by railroad. It is 100 grade.

The main characteristics of this heavy oil are :

Parameter	Unit of Measure	Value
Viscousity at 80°C	cSt	< 118,0
Ash content	%	< 0,14
Sulphur content	%	< 2,0
Stiffening temperature	°C	25
Specific caloric value	kJ/kg	40 530
	kCal/kg	9 650

6.5 Pyrite

Pyrite is delivered from Cerepovec a town in Russia.It is loaded in railway wagons.

In general its composition is not very stable. Fe_2O_3 content can deviate from 66 % till 80 %.

One of possible chemical compositions is given below :

SiO_2	11,8 %
Al_2O_3	2,5 %
Fe_2O_3	78,8 %
CaO	1,7 %
MgO	0,7 %
SO_3	3,4 %
R_2O	0,3 %
loss on ignition	2,2 %.

6.6 Fly Ash

Fly ash is delivered from Estonia from Narva region power plant by railroad in wagons.It represents the finest fraction of electrofylter dust obtained in process of oil shale burning.

The main constituents of the chemical composition are :

SiO_2	32 %
Al_2O_3	11 %
Fe_2O_3	4 %
CaO	32 %
CaO free	10 %
SO_3	9 %

6.7 OPOKA

Opoka is delivered from Lithuania from **Stoniškai** deposit. It is loaded in railway wagons. This is natural mixture of amorphous and crystalic silica with some admixtures of calcium silicate kind.

One of possible chemical compositions is given below :

SiO_2	54,4 %
Al_2O_3	1,5 %
Fe_2O_3	0,9 %
CaO	21,9 %
MgO	0,3 %
SO_3	0,7 %
R_2O	0,5 %
loss on ignition	19,5 %.

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A Sertificate of :

1) CHEMICAL COMPOSITION OF CLINKER
(average in 1994)

SiO_2	21.74 %	C_3S.....	62.8 %
Al_2O_3	4.82 %	C_2S.....	14.8 %
Fe_2O_3	3.33 %	C_3A.....	7.1 %
CaO	65.19 %	C_4AF....	10.1 %
MgO	3.62 %		
R_2O eq	0.61 %		
fr. CaO	0.19 %		

2) PHYSICAL AND CHEMICAL PROPERTIES OF CEMENT
PZ 45 F
according to DIN 1164

1) Chemical properties :
LOI - 1.09 %
SO_3 - 2.90 %
Insoluble residue - 0.69 %
Cl - 0.001 %

2) Physical properties :
1. Initial setting time 3h 20 min
Final setting time 4h 50 min
2. Fineness of cement
2.1. sieve residue on 200 μm - 0.2 %
2.2. specific surface, (Blaine)
3560 cm^2/g
3. Stability (le Chatelier test) - 1.9 mm
4. Compressive strength (MPa)
1 day - 14.0
2 days - 26.1
3 days - 33.1
7 days - 42.1
28 days - 53.9

3.10.94 Laboratory Manager G.Zauerhägena

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9. Расчетные формулы

Концентрация CO_2

$$CO_2 = \frac{CO_{2max} \times (21 - O_2)}{21}$$

CO_2max: максимальная концентрация CO_2 для выбранного вида топлива
21: концентрация O_2 в воздухе
O_2: измеренная концентрация O_2 в дымовых газах

Потери тепла с уходящими газами q_2 (qA)

$$q_2 = (AT - VT) \times \left[\frac{A_2}{(21 - O_2)} + B \right]$$

AT: температура уходящих газов
VT: температура воздуха для горения
A_2/B: постоянные для выбранного топлива коэффициенты (см. табл.↗)
21: концентрация O_2 в воздухе
O_2: измеренная концентрация O_2, округленн до целого

$$q_2 = f \times \frac{AT - VT}{CO_{2max}}$$

Формула "Siegert" для топлив с коэффициентами A_2 и B =0.

Коэффициент избытка воздуха α (λ)

$$\alpha = \frac{CO_{2max}}{CO_2}$$

CO_{2max}: максимальная концентрация CO_2 для выбранного вида топлива
CO_2: расчетное значение концентрации CO_2 (выше↗).

Концентрация CO, приведенная к α =1: (unverdünnt) $CO_{\alpha=1} = CO \times \alpha$

Таблица постоянных коэффициентов для наиболее распространенных видов топлива:

Топливо	A_2	B	f	CO_{2max}	Топливо	A_2	B	f	CO_{2max}
Мазут	0,68	0,007	-	15,5	Бурый уголь	0	0	0,90	19,2
Природный газ	0,63	0,009	-	11,9	Каменный уголь	0	0	0,60	18,5
Сжиженный газ	0,63	0,008	-	13,9	Коксовый уголь	0,6	0,011	-	-
Кокс, дрова	0	0	0,74	20,0	Городской газ	0,63	0,011	-	11,6
Брикеты	0	0	0,75	19,3	Контрольный газ	0	0	-	13,0

Пересчет концентрации газов из (ppm) в (мг/м³) с приведением к $O_{2норм.}$:

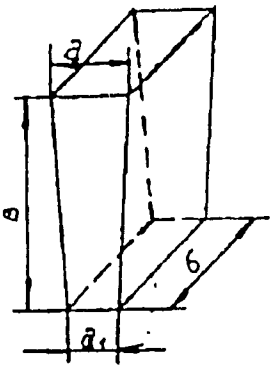
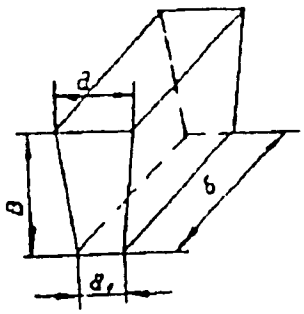
$$CO\ (мг/м^3) = \left[\frac{21 - O_{2норм}}{(21 - O_2)} \right] \times CO\ (ppm) \times 1{,}25$$

$$NO_2\ (мг/м^3) = \left[\frac{21 - O_{2норм}}{(21 - O_2)} \right] \times 2{,}05 \times (NO(ppm) + NO_2(ppm))$$

$$SO_2\ (мг/м^3) = \left[\frac{21 - O_{2норм}}{(21 - O_2)} \right] \times SO_2\ (ppm) \times 2{,}93$$

FOR KILN No4

15.

Kiln zone	Lenght of zone m	Firebricks	double-sided surfical wedge				double-side angular wedge				Quantity t
											
			a	a_1	б	в	a	a_1	б	в	
1. Cooling	2.35	ШУ-1	100	88	150	300					18
		ШУ-2	75	55	150	300					
	4.64	ШУ-3	100	92	150	200					23
		ШУ-4	75	65	150	200					
2. Roasting	42.0	ХПШ ПХШ Nr 28 Nr 29					65 80	55 73	150 150	230 230	330
3. Decarbo-nation	30.0	ДУ-3 ШУ-4	100 75	92 65	150 150	200 200					150
4. Dehydra-tion.	3.0	ШО-3 ДО-4	100 75	92 65	150 150	200 200					14
	16.9	ШО-16	100	94	200	150					62
	3.0	ДУ-19	100	95	200	120					9
5. Heating and drying											

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3.Chemical engineer

Refractory lining bricks for kiln Nr 4

No 4 Kiln

1.

Lining bricks	Raw material basis	Chemikat analysis %						Refraktoriness	Cold crushing strength after heating to 110 N/mm²	Apparent porosity %	Thermal-shock resistance	Reversible linear thermal expansion,% 800°C 1200°C	Density Kg/m³
		MgO	Cr_2O_3	Fe_2O_3	CaO	Al_2O_3	SiO_2						
1	2	3	4	5	6	7	8	9	10	11	12	13	14
BASIC FIREBRIKS kiln zone 2													
СШЦ	Periclas - Spinel	>65	>7-15						>30	<23	>4	<2,0	3000
ПХЦ	Periclas - Chrome	>65	>8-18						>25	<24	>8	<2,0	3000
ХПЦ	Chrome - Periclas	>42	>20-30						>20	<25	>2	<2,0	3000
ALUMINA FIREBRIKS kiln zone 1,3,5(Chamotte ШЦУ),4(Chamotte ШЦО)													
ШЦУ	Chamotte					>32	Не норм.	>1710	>25	<20	>4	0,30	2150
ШЦО	Chamotte					>28	Не норм.	>1670	>13	<26	>3	0,70	1900

Appendix D-5

The Basic Concepts of Development for A/S Broceni

The Basic Conception of Development of A/S Brocēni

Appendix C

The Conceptual Objectives of Development and Directions of their Accomplishment :

1.Market

To achieve with better quality of goods, competitive price and wide distribution network a stable domination of A/S Brocēni production in Latvian market.

To increase the possibilities of export improving the quality of goods, decreasing self cost and developing our export terminals in Rīga and in Liepāja.

To search and attract partners who can ensure trade increase today and development in future.

2.Property

To achieve better managing of property creating subsidiaries, who have resources from common property to attract capital, technical know-how and market potential of reliable partners, who act on basis of private incentive and are on agreement relations with A/S Brocēni.

3.Image

To achieve and maintain an image of stable and successful firm with positive advertisement of its performance :

- managing activities of the "SWH-Brocēni" basketball club,
- taking part in the utilisation program of the Latvian industrial waste,
- taking the lead in development of Latvian EN compatible standards in these branches of industry where Brocēni production takes place,
- sponsoring social undertakings which are corresponding to the interests of A/S Brocēni.

To use the image of A/S Brocēni, co-operating with state authorities of taxes and environmental questions, for political struggle of defence of market, for international support in transactions with partners and banks.

A Survey of Undertakings of The Technical Development Program discussed on the Meetings of the A/S Brocēni Board

1.Technological fuel

The natural gas was stopped to use for clinker production in September 1992. On 5th of October 1993 clinker production was restarted using as a technological fuel the heavy oil.

The designing of heavy oil receiving and storage complex, which will allow to increase heavy oil fuel reserves from 2000 tons to 7000 tons, has been finished in April of 1994. On 5th of May construction of this object was started and it is planned to finish in January 1995. Total cost of building the complex will be 350 000 Ls.

Complex will permit to purchase cheaper heavy fuel oil without intermediaries, to decrease payments of wagons idle standing to state railway and will grant additional profit of selling the heavy fuel oil. Premonitory yearly profit of 271 400 Ls will cover expenses in a year and four months.

2.Reduction of clinker kilns energy consumption

Implementation of the program will yield the reduction of relative energy consumption from 1785 kcal to 1540 kcal. There are two versions of program execution :

a) F.L.Smidth proposed one; which includes a retrofit of the clinker cooler, an installation of a new Swirlax oil burner, gas analysis equipment, kiln shell temperature scanner.

This proposal includes also cement packing plant with a capacity of 2400 bags/h of 50 kg bags, together with palletising and shrinking facilities, QCX laboratory for analysis of Si, Al, Fe, Ca, Mg, K, Cl and S, the Mastersizer particle size analyser and 6 Dosimat weigh feeders for cement mills.

The price of the offer is 19 594 400 DKK (FOB Danish port) or 1 749 780 Ls. The F.L.Smidth proposal contains also possible financing through a Danish bank with a guarantee from the Danish Export Credit Council. The guarantor of credit is to be Investment Bank of Latvia or Rīga Komerzbank. Repayment 7 years with interest DKK 8,30 %, USD 8,11 %, DEM 7,67 %.

b)at present feasible for A/S Brocēni, which includes a portable gas analyser Testo 33 and two stationary oxygen content analysers produced in Estonia (installed on 30.08.94) heavy fuel oil consumption devices, clinker weighing equipment, reconstruction of clinker cooler grates, reduction of slurry moisture content from 39 % till 35 % by milling together limestone and clay and by adjusting chain and heat exchanger zone in clinker firing kiln.Total

costs of this version is 245 000 Ls. Premonitory yearly profit reducing clinker firing fuel consumption at the heavy fuel oil price 70 USD/ton will be 305 130 Ls or 558 250 USD. The period of repayment does not exceed 1 year. It is planned to implement until 1.09.1995.

3.Ensuring the Quality of Production

According to the program in November 1993 the Quality Manual conforming to EN standards was worked out. Premises for laboratory of physical and mechanical tests of cement were finished. Until May 1994 cement mortar compacting device, automatic cement mortar mixer, set of moulds, compressive strength testing press, etc. were purchased. In May A/S Brocēni produced PZ 35 F received certificate allowing to export it to Germany, in August such a certificate for PZ 45 F was obtained.

The program also envisages further laboratory improving with equipment : digital pH meter, flame photometer, thermohydrograph, spectrofotometer, calorimeter what altogether will cost 23 000 Ls. If the financing will be adequate than laser diffraction granulometer and simultaneous X- ray spectrometer system will be purchased. This equipment is in F.L.Smitdh proposal.

The program also foresees following undertakings in realisation now and to be finished until 1.07.94:
- cement mill weight feeder installation for four mills in Brocēni and two mills in Rīga. Costs are expected not to exceed 80 000 Ls.
- separation of kiln electrofylter last field dust with an intention to reduce the content of alkalis in clinker up to 0,6 % of sodium equivalent. Project is ready and costs will be 8000 Ls.
- preparing and introducing of EN compatible standards for cement, ceramic tiles, fibre cement roofing sheets and burnt lime. Expected costs 5000 Ls. Premonitory gain is based on defence of internal market against the goods which does not correspond to EN standards.
- transition to imported frits usage in production of ceramic wall tiles.
- transition to payment system which is based quality guided principles and on independent from producer control system (already functioning in ceramic wall tiles department from 1.06.94 and in clinker department from 1.07.94).

4.Rehabilitation of Equipment According to the Production Program of 1995

According to the program it is planned to increase the cement production from 210 000 tons in 1994 till 360 000 tons in 1995 and this must be done reconstructing clinker firing kiln # 2 for heavy fuel oil consumption (costs 110 000 Ls), cement mill # 3 dedusting system (costs 15 000 Ls). All these

works is planned to finish until 1.05.95. The increase of production gives profit of 164 000 Ls.

5.Introduction of Personal Computers in Control, Accounting and Analysis

For this program includes the following :

- Accountancy computer net (costs 11 000 Ls).
- Information system for production manager enabling to follow to the consumption of all the resources and to compare it with technological base model. This computer net process and stores information about all installed equipment (costs 8000 Ls).
- Information system for central laboratory enabling to store and analyse all technological information (costs 3000 Ls).

6.Partial replacement of technological fuel by Latvian Industrial Waste

In the frame of this program at present designing and experiments on the optimum incineration solutions are taking place. Estimated expenses 83 000 Ls. Self cost of liquid waste generated heat energy is 0,81 USD/Gkal. Estimated amount of utilisable liquid waste is 20 000 tons annually. Premonitory yearly profit is 380 000 Ls.

The second stage foresees development of automobile tyres incinerating using so called "mid kiln technology" where it will be possible to incinerate whole tyres. Utilisation capacity is estimated 11 000 tons annually, costs 177 000 Ls. Self cost of generated heat energy is estimated to be 4,07 USD/Gkal. Premonitory yearly profit is 289 000 Ls.

It is planned to test liquid waste incineration this year, but "mid kiln technology"in the first half of the next year.

7.Underetakings to increase sales

In this field the program can be characterised with the following :

- In the spring of 1993 the distribution net of A/S Brocēni was formed. In November 1993 a shop in Rīga in Zalves street was opened. At present goods of A/S Brocēni are sold in 31 trading point.
- On 5.06.94 terminal in Rīga factory territory was put into operation and exports of bulk cement to Netherlands, Danmark and Finland commenced with capacity of 200 000 tons annually.
- The minimal program for development of this terminal is erection of 120 m of railway siding (costs 36 000 Ls), purchase of 20 tank wagons (costs 196 780 Ls) for increasing the ship loading capacity to 360 000 tons annually (total costs 232 780 Ls).Estimated profit 225 900 Ls yearly.
- There is also the maximum program for development of this terminal which could be implemented in co-operation with suitable foreign partner. It

envisages building of two piers with capacity 750 000 tons annually limited by railway carrying capacity. The maximum depth of port is 10,6 m. Total costs of 1,3 km railway, two piers, cement silos, loading and deloading facilities and portal cranes are estimated to be 3 215 000 Ls.

8 Creating the subsidiaries

In the frame of this program the following enterprises are created :

- Bazalts Ltd which will produce concrete pavement blocks in part of premises of previous syporex department in Rīga factory.
- Laternīts Ltd which will produce fibre cement roofing materials in other part of premises of previous syporex department.
- At present partners for ceramic wall tiles and limestone product departments development are searched.

Table #1

The Production Program of 1995

Month	Clinker	Cement	Slate sheets	Tiles	Limest. flour	Limest. crude	Cement packing
	th. tons	th. tons	pieces	th. m^2	th. tons	th. tons	th. tons
I	7,0	8,0	-	22,0	-	-	2,0
II	7,0	8,0	-	22,0	-	2,5	2,0
III	20,0	22,8	107700	22,0	-	2,5	5,0
IV	30,0	34,2	175000	22,0	3,0	2,5	7,0
V	38,0	43,3	175000	22,0	5,0	5,0	10,0
VI	38,0	43,3	175000	22,0	5,0	5,0	10,0
VII	38,0	43,3	175000	8,0	5,0	5,0	10,0
VIII	38,0	43,3	175000	22,0	5,0	5,0	10,0
IX	38,0	43,3	175000	22,0	5,0	5,0	10,0
X	38,0	43,3	175000	22,0	3,0	5,0	10,0
XI	20,0	22,8	175000	22,0	-	5.0	5,0
XII	7,0	8,0	175000	22,0	-	2,5	2,0
Total	319,0	363,6	1507800	250,0	31,0	45,0	83,0

Table #2

The Premonitory Profit of Investments

According to

Technical Development Program

#	Undertaking	Investment Ls	Annual Profit Ls
1	Technological fuel	350 000	271 400
2	Reduction of energy consumption : a) F.L.S. version b) A/S Brocēni version	 1 749 780 245 000	 Not disclosed 305 130
3	Ensuring the Quality of Production	116 000	Better Sales Possibilities
4	Rehabilitation of Equipment According to the Production Program of 1995	137 000	164 400
5	Introduction of PC in Control, Accounting and Analysis	22 000	
6	Partial replacement of technological fuel by Latvian Industrial Waste : - liquid waste - tyres	 83 000 177 000	 380 000 289 300
7	Rīga Cement Export Terminal : - minimum program	 232 780	 225 900
8	Total	1 362 780	1 636 130
9	Rīga Cement Export Terminal : - maximum program	 3 215 000	

Appendix D-6

Preliminary Estimates of Profits for Waste Minimization

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A/S Brocēni Project

Reduction of Dust Amount Produced During Clinker Firing.

Process of clinker firing takes place in rotating kiln with diam.4,0 m and length 150 m.This is a wet process. The kiln is equipped with electrofilter and a grate cooler.Produced dust precipitates in electrofilter and than is returned to the kiln's hot end.Heavy oil (9300kcal/kg) is used as a fuel.Consumption of heavy oil is 160 till 190 kg per 1 tonne of clinker.

Increased consumption of the heavy oil is observed with portable gases analyzer in these cases, when in the kiln exhaust gases content of O_2 is 6 - 7 % ,and in system kiln - electrofilter circulates 6 tonnes of dust in hour. It is the result of big volume of kiln exhaust gases .. 300 000 m^2/h.

Decrease of O_2 content till 1,3 - 1,5 % diminishes the volume of exhaust gases till 250 000 m^3/hand the amount of circulating dust till 4 t/h.This is followed by decreased consumption of heavy oil till 160 kg/t.

This is giving an economy of :

(180 -160) x 0,07 = 1,4 USD/t of clinker ;

where price of heavy oil is 0,07 USD/kg.

Production of 20 000 tonnes of clinker is giving economy :

20 000 x 1,4 = 28 000 USD/monthly .

Lack of permanent and constant control of the exhaust gases does not allow to work at the optimal economy conditions.After installing of gases analyzer it will be possible to stabilize technological process on production of minimal amount of the exhaust gases, circulating dust, what in its turn will produce less emissions of dust in the atmosphere.

Decrease of emissions is :

$(250\ 000 - 300\ 000) m^3/h \times 200\ mg/m^3 = -10\ kg/h$;

where efficiency of electrofilter is 200 mg/nm^3.

The decrease of emissions will be 10 kg/h or 17 %.

For implementing this project in life we need :

1. Consultation to choose and install a gases analyzer;

2. Purchase of selected gases analyzer (the price of such could be around 30 000 USD).

A/S Brocēni technical director
member of the board

J.Klavinš

26.04.94

WEC - Latvia Waste Minimization Project Description

Company Name : **Stock Company Brocēni**
Date completed : **17.01.95**
Company Representative and Title : **Jānis Kļaviņš**
Technical Manager

In what year was the company founded? Brocēni cement factory was built in 1938. Present Stock Company A/S Brocēni was founded on 11.02.93.

What product(s) does the company produce? Crushed Limestone, Clinker, Cement, asbestos cement corrugated sheeets and ceramic wall tiles.
Does the company export products outside Latvia? Yes, it exports to Finland, Germany and Danmark.

How many emplyees does the company have? 950.

What are the company's annual earnings (in dollars) ? Without profit.

In what year did the company first have an enviromental division or employees working on enviromental affairs ? 1984.

Does the company have a separate environmental division, or are employees at all levels of staff and management involved in enviromental affairs for their divisions ? A/S Brocēni employs assistant of technical manager on enviromental questions.

Please describe the kinds of enviromental training given to employees not directly involved in enviromental affairs ? Until now no trainings have taken place.

Please give a brief history of environmental activities at the company, including any waste minimization projects completed prior to WEC projects Prior to WEC project a substitution of asbestos with used paper (10 % of asbestos content).

WEC - Latvia Waste Minimization Project Description

Company Name : **Stock Company Brocēni**
Date completed : **17.01.95**
Company Representative and Title : **Jānis Kļaviņš**
Technical Manager

Waste Minimization Project Title : Diminishing of dust emissions in clinker firing process.

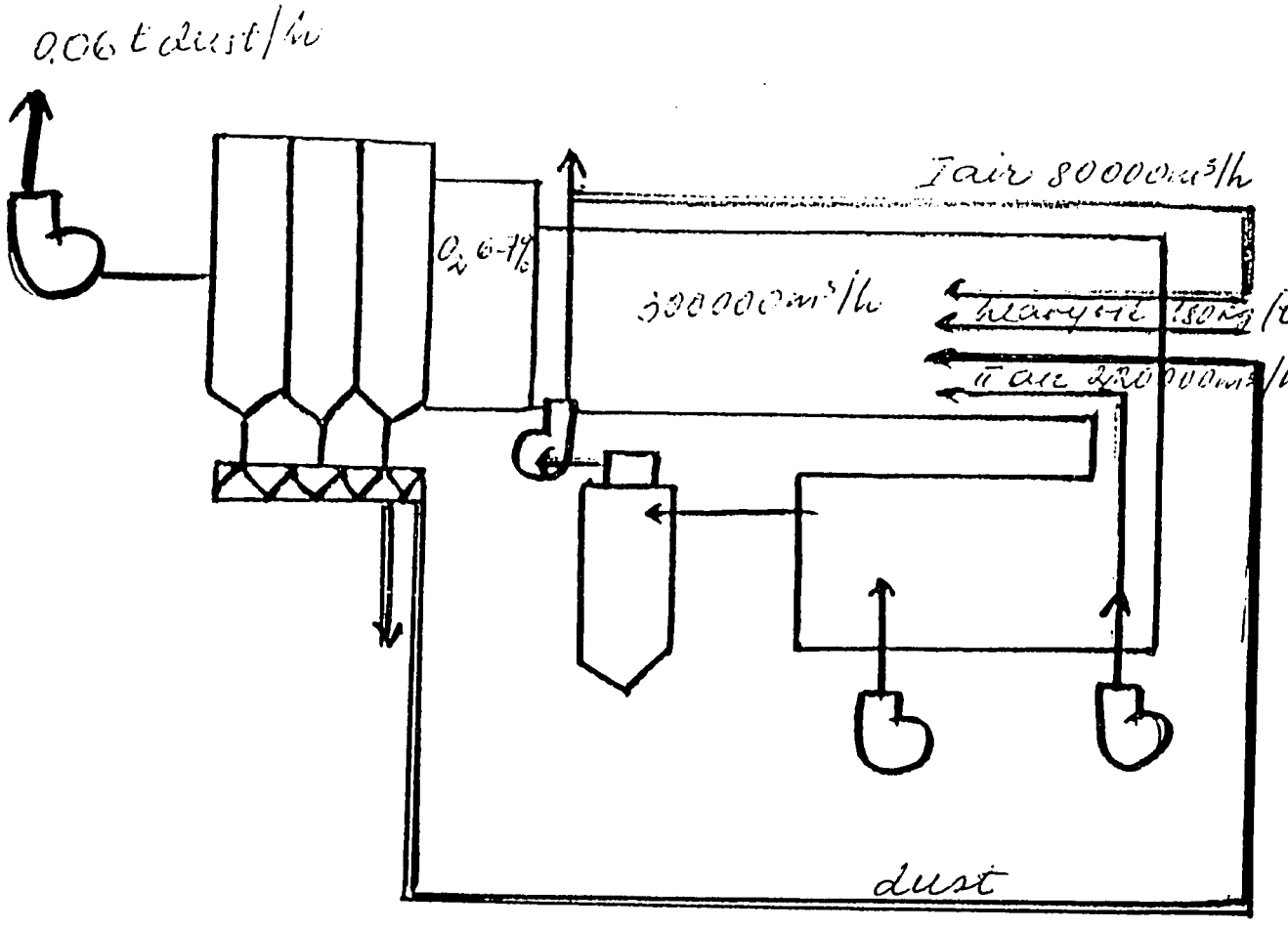
Products impacted by Waste Minimization Project : Oxygen, air, dust, heavy oil.

Process Description : Clinker is being fired in rotary kiln (4m diameter, 150 m length). Clinker cooling takes place in grate cooler. Exhaust gases are are filtrated in electrofylter. In electrofylter collected dust is transported back to the hot end of the kiln. Fuel is heavy oil (9300 kcal/kg), with consumption from 160 till 190 kg/t of clinker.

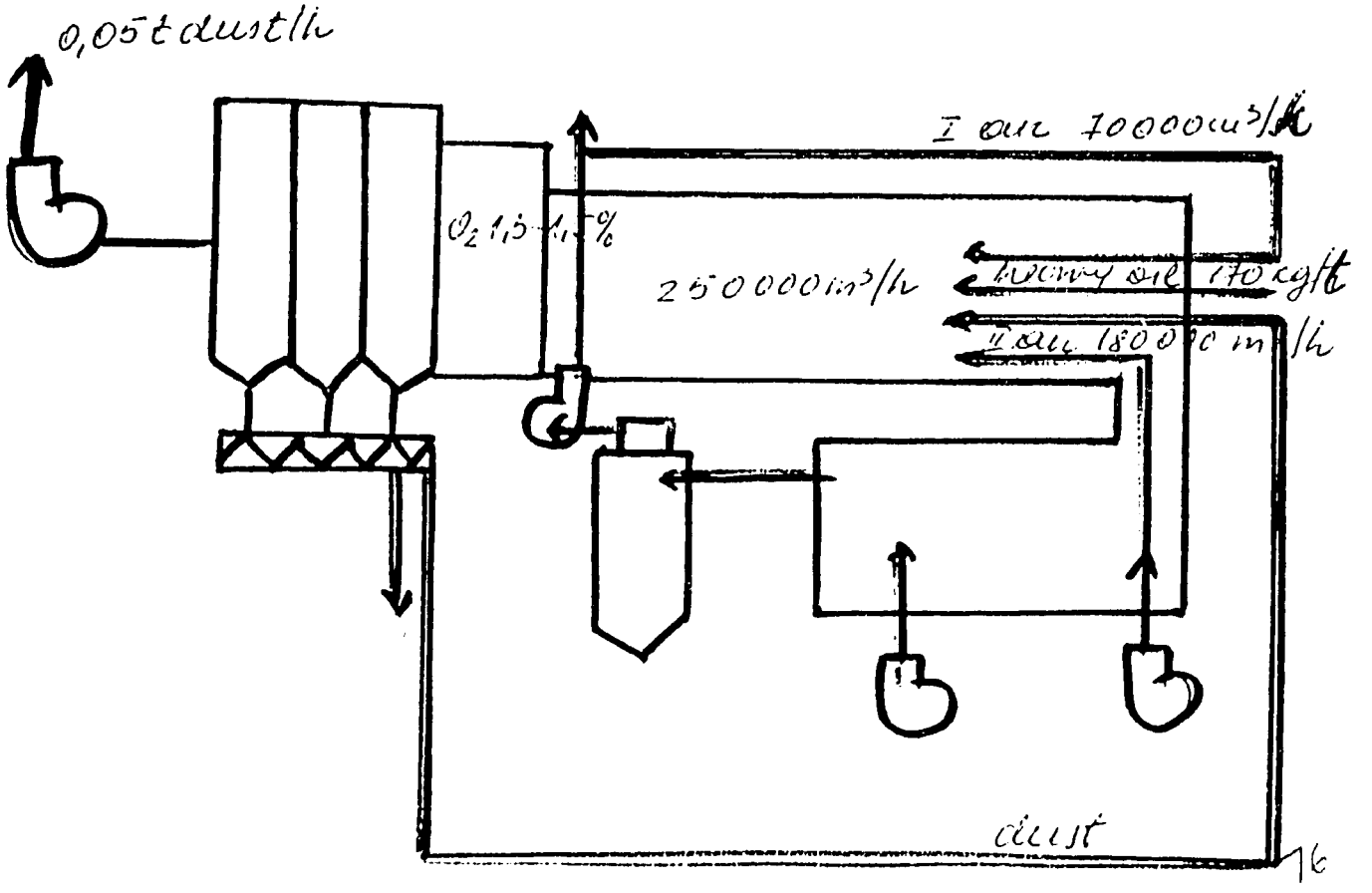
Description of Waste Minimization Project : The consumption of heavy oil increases, if O_2 content in exhaust gases is increased to 6-7 %. Then in system kiln-electrofylter circulates 6 tons of dust and exhaust gas amount reaches 300 000 m^3/h.

When dcreasing O_2 content till 1,3 - 1,5 %, the amount of exhaust gases decreases to 250 000 m^3/h and circulating dust amount to 4 t/h and heavy oil consumption till 160 kg/h.

Installing gas analyzer could stabilize technological process, decrease the amount of exhaust gases and dust circulating in kiln and dust getting into atmosphere.


0,06 t dust/h
I air 80000 m³/h
O₂ 6-7%
500000 m³/h
II air 220000 m³/h
dust

After CO/O₂


0,05 t dust/h
I air 70000 m³/h
O₂ 1,5-1,5 %
250000 m³/h
heavy oil 170 kg/h
II air 180000 m³/h
dust

WEC - Latvia Waste Minimization Project Description

Company Name : **Stock Company Brocēni**
Date completed : **17.01.95**
Company Representative and Title : **Jānis Kļaviņš**
Technical Manager

No 4 Kiln

1. Waste Minimization Project Title	Diminishing of dust emissions in clinker firing process		
2. Waste Minimization Technique* (circle all that apply)	CH EQ (OP) PR PS Other (describe)		
3. Chemical(s) or Energy Units Effected (use additional sheet if necessary) Role and form of chemical in production process: G = gas, L = liquid, S = solid (circle all that apply)	Chemical Name Raw material G L S Product G L S Waste (G) L (S)	Chemical Name Raw material G L S Product G L S Waste G L S	Energy Units (check all that apply) Electricity ☐ Steam ☐ Coal ☐ Natural Gas ☐ Other (describe) ☐ Heavy oil ☒
4. Quantity of constituent reduced (a) Amount reduced annually as waste	55 t /year		
(b) Amount of waste reduced per unit of production	0,3 kg /t clinker		
(c) Amount reduced annually as raw material or energy	heavy oil 4000 t /year		
(d) Amount of raw material or energy reduced per unit of production	0,02 t /t clinker		
5. (a) Percent reduction of waste generated	16 %		
(b) Percent reduction of raw material or energy used	11 %		
6. Capital costs for implementation (U.S. dollars)	30 000		
7. Dollars saved (annually) 3 70/ton fuel oil	4000 x 70 = = 280 000		
8. Did the product or process yield change due to the activity? (If yes, please give percent change and indicate direction)	% (Increased) Decreased	% Increased Decreased	
9. How was the minimization project first identified?	It was idea of technical manager		

* CH = chemical substitution, EQ = equipment change, OP = operational change, PR = product change, PS = process change

WEC - Latvia Waste Minimization Project Description

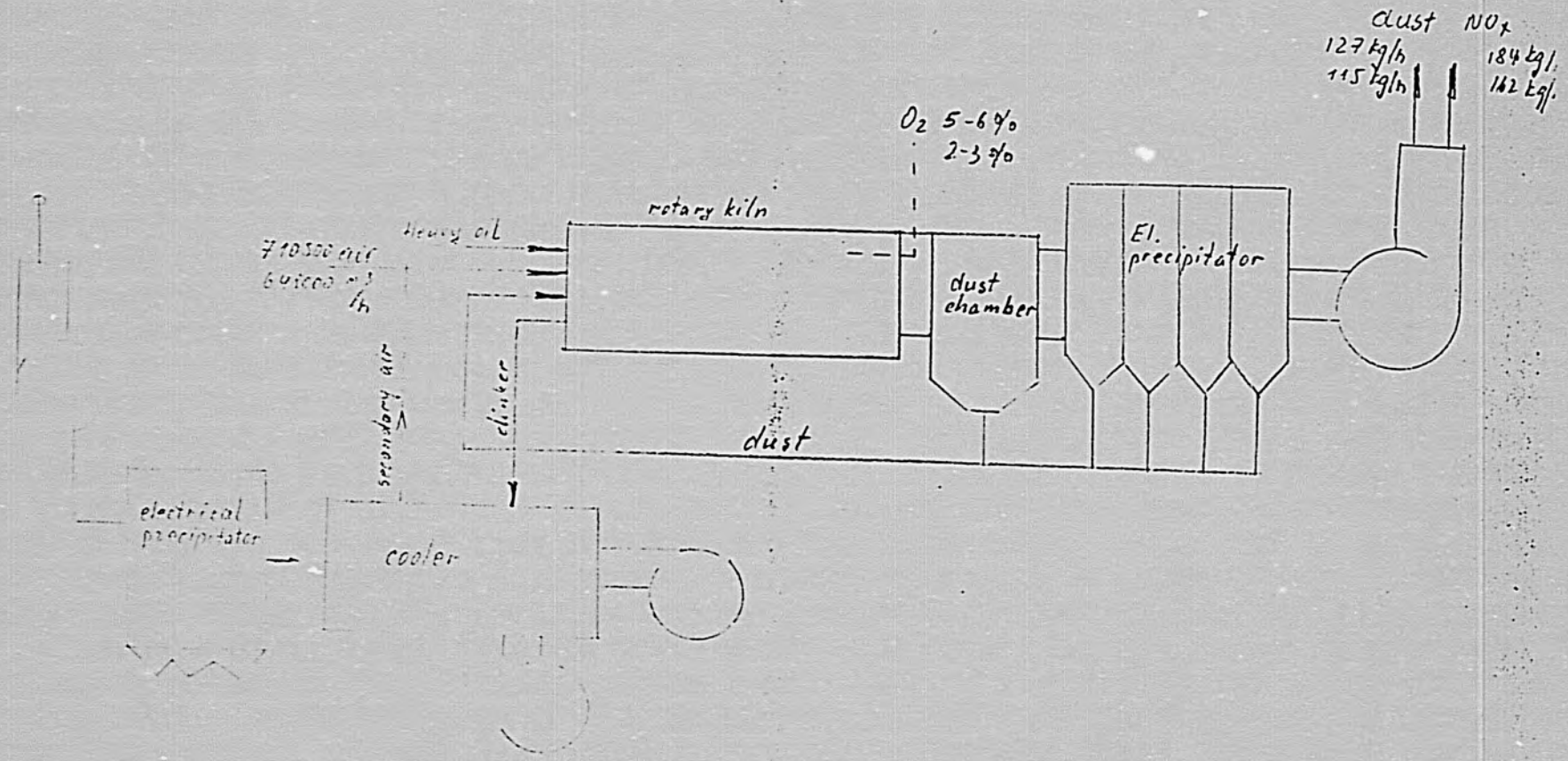
Company Name : **Stock Company Brocēni**
Date completed : **17.01.95**
Company Representative and Title : **Jānis Kļaviņš**
Technical Manager

No 4 Kiln

1. Waste Minimization Project Title	Diminishing of dust emissions in clinker firing process		
2. Waste Minimization Technique* (circle all that apply)	CH EQ (OP) PR PS Other (describe)		
3. Chemical(s) or Energy Units Effected (use additional sheet if necessary) Role and form of chemical in production process: G = gas, L = liquid, S = solid (circle all that apply)	Chemical Name Raw material G L S Product G L S Waste (G) L (S)	Chemical Name Raw material G L S Product G L S Waste G L S	Energy Units (check all that apply) Electricity ☐ Steam ☐ Coal ☐ Natural Gas ☐ Other (describe) ☐ Heavy oil ☒
4. Quantity of constituent reduced (a) Amount reduced annually as waste	55 t/year	NOx 26 t/yr Dust 33 t/yr	
(b) Amount of waste reduced per unit of production	0,3 kg/t clinker	0.1 kg/t	
(c) Amount reduced annually as raw material or energy	heavy oil 4000 t/year	940 t/yr	
(d) Amount of raw material or energy reduced per unit of production	0,02 t/t clinker	1.72 kg/t clinker	
5. (a) Percent reduction of waste generated	16 %	NOx 1.8% dust 3.35%	
(b) Percent reduction of raw material or energy used	11 %	1%	
6. Capital costs for implementation (U.S. dollars)	30 000	60 000	
7. Dollars saved (annually) 70/ton fuel oil	4000 x 70 = = 280 000	6860	
8. Did the product or process yield change due to the activity? (If yes, please give percent change and indicate direction)	% (Increased) Decreased	% Increased Decreased	
9. How was the minimization project first identified?	It was idea of technical manager		

* CH = chemical substitution, EQ = equipment change, OP = operational change, PR = product change, PS = process change

18


dust
127 kg/h
115 kg/h
NO_x
184 kg/h
162 kg/h
O_2 5-6 %
2-3 %
rotary kiln
heavy oil
710300 m³/h
610000 m³/h
dust chamber
El. precipitator
secondary air
clinker
dust
electrical precipitator
cooler

Appendix D-7

Equipment Proposal, Gas Analyzers

Pyrometer Comparison

60

COLUMBUS • CINCINNATI • CLEVELAND

1st Choice

SIMCO CONTROLS
1149 RARIG AVE.
COLUMBUS OH 43219

SIMCO controls

SIMCO CONTROLS
1149 RARIG AVE.
COLUMBUS OH 43219

NA108

QUOTATION NUMBER
1005056-0000-01

QUOTATION NUMBER
1005056-0000-01

NEW ACCOUNT

GREG CARSON

HARRY BHATT

MALCOLM PIRNIE
445 HUTCHINSON AVENUE
SUITE 350
COLUMBUS OH 43235-5667
HARRY BHATT

QUOTATION***QUOTATION******QUOTATION******QUOTATION******QUOTATION***

QUOTATION NUMBER	SLSMN.	QUOTE DATE	TAKEN BY	INQUIRY NUMBER/NAME		PAGE
1005056-0000-01	108	12/15/94	153	HARRY BHATT		1

QUOTATION

SHIPPING INFORMATION

SHIP BEST WAY ATTN: HARRY BHATT FRT. P

QUANTITY			E D P NUMBER		MANUFACTURER • CATALOGUE NO. • DESCRIPTION	U/M	UNIT PRICE	AMOUNT
					**** 1984-1994 "10" YEARS ****			
					****** OF EXCELLENCE! ******			
1					*BA SMA21411	EA	8657.00	8657.00
					SMART O2 & COe ANALYZER			
					W/1500 DEG F PROBE			
					W/OPTIONAL DUAL FILTER			
					W/120 VAC BLOWBACK SOLENOID => 220V / 50 Hz			
					W/2-STAGE AIR FILTER			
					W/50-FOOT CABLE			
					BAILEY CONTROLS			
					plus spare parts			

TOTAL CONTINUED

TERMS AND CONDITIONS

1 Our terms are [redacted], net 30.
2 This quotation is a firm quotation for a period of 30 days from above date. We reserve the right at any time to correct clerical errors.
3 Shipping promises or delivery promises date from receipt by us of complete specifications.
4 Material in stock is offered subject to prior sale.
5 All claims for shortages and damages must be received by us within 30 days from date of invoice.
6 Simco Controls shall not be liable for any delay in the performance of this contract, or the delivery or shipment of goods, or for any damages suffered by the Buyer by reason of such delay when the delay is directly or indirectly caused by any cause beyond the control of Simco Controls.

THANK YOU FOR YOUR INQUIRY! MAY WE HAVE THE PLEASURE OF ENTERING YOUR ORDER?

If This Quotation Is Accepted, Please Sign And Return 1 Copy. DATE ACCEPTED BY

Do Demonstration use Bailey Vers no Recommend

SIMCO CONTROLS

1149 RARIG AVE.
COLUMBUS OH 43219

NA108

QUOTATION NUMBER
1005056-0000-01

NEW ACCOUNT

GREG CARSON

HARRY BHATT

SIMCO controls

SIMCO CONTROLS

1149 RARIG AVE.
COLUMBUS OH 43219

QUOTATION NUMBER
1005056-0000-01

MALCOLM PIRNIE
445 HUTCHINSON AVENUE
SUITE 350
COLUMBUS OH 43235-5667
HARRY BHATT

QUOTATION***QUOTATION******QUOTATION******QUOTATION******QUOTATION***

QUOTATION

QUOTATION NUMBER	SLSMN.	QUOTE DATE	TAKEN BY	INQUIRY NUMBER/NAME		PAGE
1005056-0000-01	108	12/15/94	153	HARRY BHATT		2

SHIPPING INFORMATION

SHIP BEST WAY ATTN: HARRY BHATT

FRT. C

QUANTITY			E D P NUMBER		MANUFACTURER • CATALOGUE NO. • DESCRIPTION	U/M	UNIT PRICE	AMOUNT
1					*BA SMA21511 SMART O2 & COe ANALYZER W/3000 DEG F PROBE W/120 VAC BLOWBACK SOLENOID W/2-STAGE AIR FILTER W/50-FOOT CABLE BAILEY CONTROLS ~~~~~~~~~~~~~~~~~~~~~~~~~~ TERMS: NET 30 DAYS FOB: COLUMBUS, OH FRT: PREPAY & ADD DELIVERY: 4-8 WEEKS ARO (TO DOMESTIC US DESTINATION) ~~~~~~~~~~~~~~~~~~~~~~~~~~ CONTACT INFO: HARRY BHATT PH: 614-888-4953 FX: 614-888-6295	EA	9025.00	9025.00

Don't need 3000°C probe

TERMS AND CONDITIONS

1 Our terms are [redacted] net 30.
2 This quotation is a firm quotation for a period of 30 days from above date. We reserve the right at any time to correct clerical errors.
3 Shipping promises or delivery promises date from receipt by us of complete specifications.
4 Material in stock is offered subject to prior sale.
5 All claims for shortages and damages must be received by us within 30 days from date of invoice.
6 Simco Controls shall not be liable for any delay in the performance of this contract, or the delivery or shipment of goods, or for any damages suffered by the Buyer by reason of such delay when the delay is directly or indirectly caused by any cause beyond the control of Simco Controls.

TOTAL 17,682.00

THANK YOU FOR YOUR INQUIRY! MAY WE HAVE THE PLEASURE OF ENTERING YOUR ORDER?

If This Quotation Is Accepted, Please Sign And Return 1 Copy. DATE ACCEPTED BY

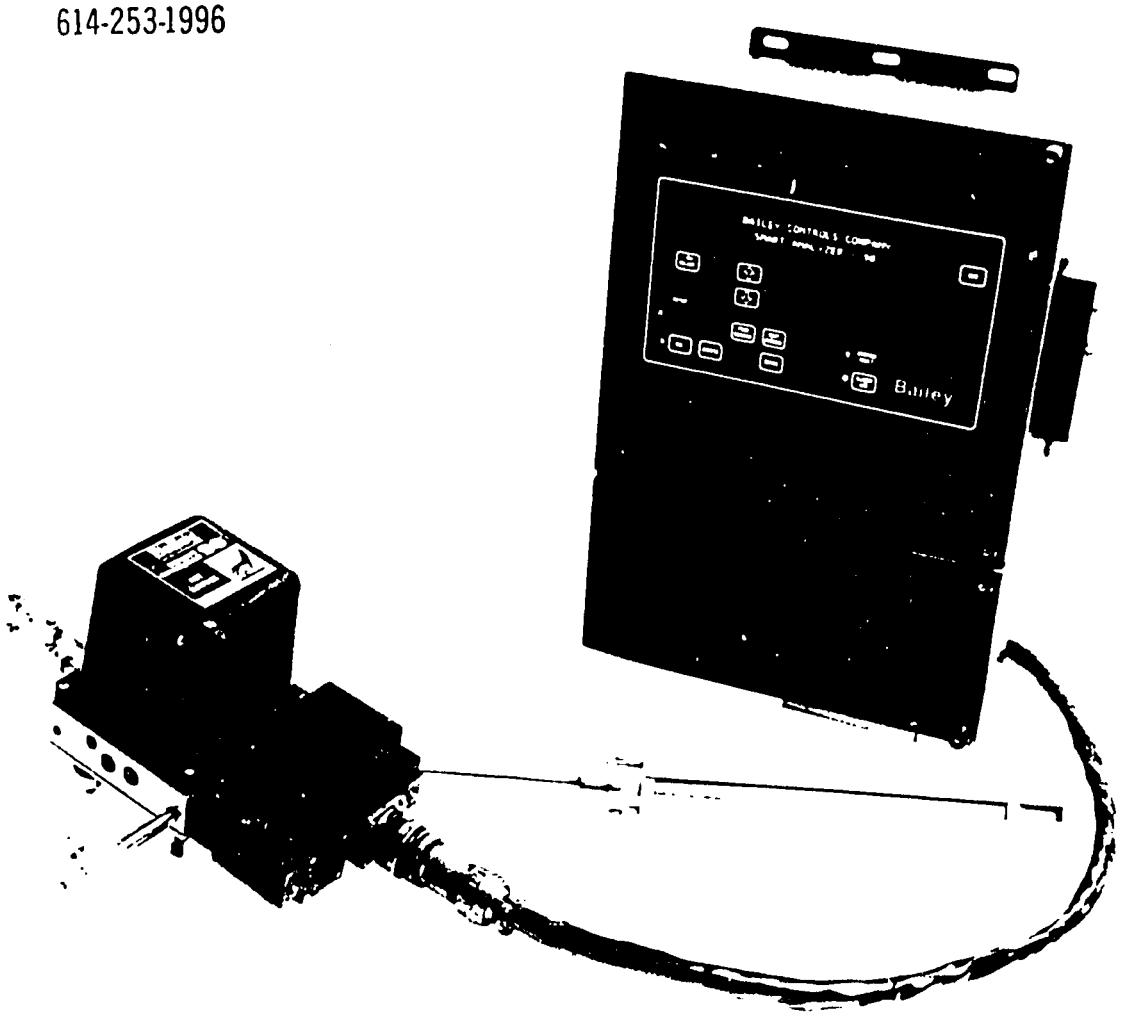
Bailey

PRODUCT SPECIFICATION

E65-76

Smart Analyzer 90
Type SMA

SIMCO CONTROLS
1149 RARIG AVE.
COLUMBUS, OH 43219
614-253-1996



A1045

Figure 1. Type SMA Smart Analyzer 90

The Type SMA Smart Analyzer 90 is a combustion analyzer. It continuously samples and analyzes industrial flue gases. The Type SMA1 Smart Analyzer 90 monitors oxygen (O_2) only. The Type SMA2 Smart Analyzer 90 monitors both O_2 and carbon monoxide equivalent (CO_e).

Features/Benefits

- **New Rugged Industrial Design**. The stainless steel heater block, extrusion honed metals and corrosion resistant plastics have hardened this rugged design. The Type SMA Smart Analyzer 90 is built to withstand demanding utility, petrochemical and other industrial applications.

- **Highly Accurate Sensors**. The patented O_2 sensor is a reliable zirconium oxide design. It has built in contaminate protection and an integral self-controlled heater for longer life expectancies. A catalytic type, RTD based sensor is used for the CO_e measurement. The high sensitivity of the RTDs combined with the poison resistant catalyst provides improved performance. The accuracy of both O_2 and CO_e measurements are not affected by flue gas temperature, particulates or variations in either water vapor or carbon dioxide.

- **Self-Diagnostics and Alarming**. The microprocessor based electronics continuously analyzes and monitors the operation of the sensors, analyzer and combustion process. Sensor calibration data is normalized against known test gas concentrations to warn of an impending sensor failure. Analyzer alarm messages display on the screen in English. Form C relay contacts are provided for alarms.

- **Patented Close Coupled Sample System**. The close coupled sample system saves maintenance time and increases the life of the sensor when compared with in situ measurement techniques. The floppy filter removes flue gas particulates before analysis while the patented self cleaning action eliminates filter build up and plugging. The industry proven hot gas sample system uses heated passages to keep the process sample at a temperature above dew point to ensure trouble free operation.

- **High Temperature Operating Range**. The analyzer assembly with the standard stainless steel probe and floppy filter assembly handles flue gas temperatures up to 649°C (1200°F). Other optional probe and filter assemblies are available for temperatures up to 1650°C (3000°F).

- **Easy Installation and Start up**. Flange mounting, plug in cable connectors and menu driven start up procedures significantly reduce installation, commissioning and operator training times.

- **Simplified In House Maintenance**. The sensors are field replaceable without having to remove the sensor assembly. Easy access is provided to all sensor components and electrical connections. Extensive self-diagnostics and optional filter blowback further reduce maintenance requirements

- **Automatic Sensor Calibration (Standard)**. The automatic calibration permits unattended operation and eliminates periodic labor intensive calibration checks required by other analyzers. Calibrations can be programmed to start automatically at specific intervals, manually via the operator interface or remotely by contact inputs. Contact outputs indicating calibration alarms and calibration in progress signal external control systems of the analyzer calibration status.

- **Low Cost Integrated Solution**. No other combustion analyzer provides both O_2 and low range CO_e measurements, automatic calibration and efficiency calculations in a single, low cost package.

- **On Line Combustion Efficiency Calculation (Standard)**. The Type SMA analyzer can work with existing boiler controls to achieve maximum fuel efficiency.

- **Remote Blowback (Optional)**. The analyzer may be fitted with an optional dual filter and remote blowback solenoid to offer added protection in applications with abnormally high levels of fine particulate (i.e., cement and lime kilns).

- **Distinctive Operator Interface**. A ten key keypad and a two line 80 character vacuum fluorescent display provide a highly visible, menu driven operator interface. Front panel mounted LEDs readily indicate the status of the analyzer.

Product Overview

The Type SMA Smart Analyzer 90 (see Figure 1) is a microprocessor based industrial grade combustion analyzer that continuously samples and analyzes industrial flue gases. The analyzer is designed for use on gas, oil or coal fired combustion processes. Typical applications include those found in the utility and petrochemical industries. The Type SMA1 analyzer monitors the oxygen (O_2) using a single sensor design. The Type SMA2 analyzer monitors both the O_2 and the unburned carbon monoxide equivalent (CO_e) using a dual sensor design.

The O_2 reading indicates the percent by volume measurement of the oxygen. Typically, the O_2 reading is the primary indicator for combustion applications. The CO_e measurement is often used to optimize combustion control in terms of efficiency and emissions.

The analyzer consists of a sensor assembly, probe and filter assembly, microprocessor based electronics assembly and interconnecting cable assembly (see Figure 2). Standard features include automatic and remote initiation of the sensor calibration, inlet/outlet temperature measurements for calculating combustion efficiency, integrated flashback protection, alarms with Form C relay contacts and isolated outputs.

See Figure 3 for the outline and clearance requirements of the sensor assembly. See Figure 4 for the outline and clearance requirements of the electronics assembly. See Figure 5 for the analyzer installation overview. Refer to Table 1 for the product specifications. Refer to Table 2 for the product nomenclature. Refer to Table 3 for a list of accessories.

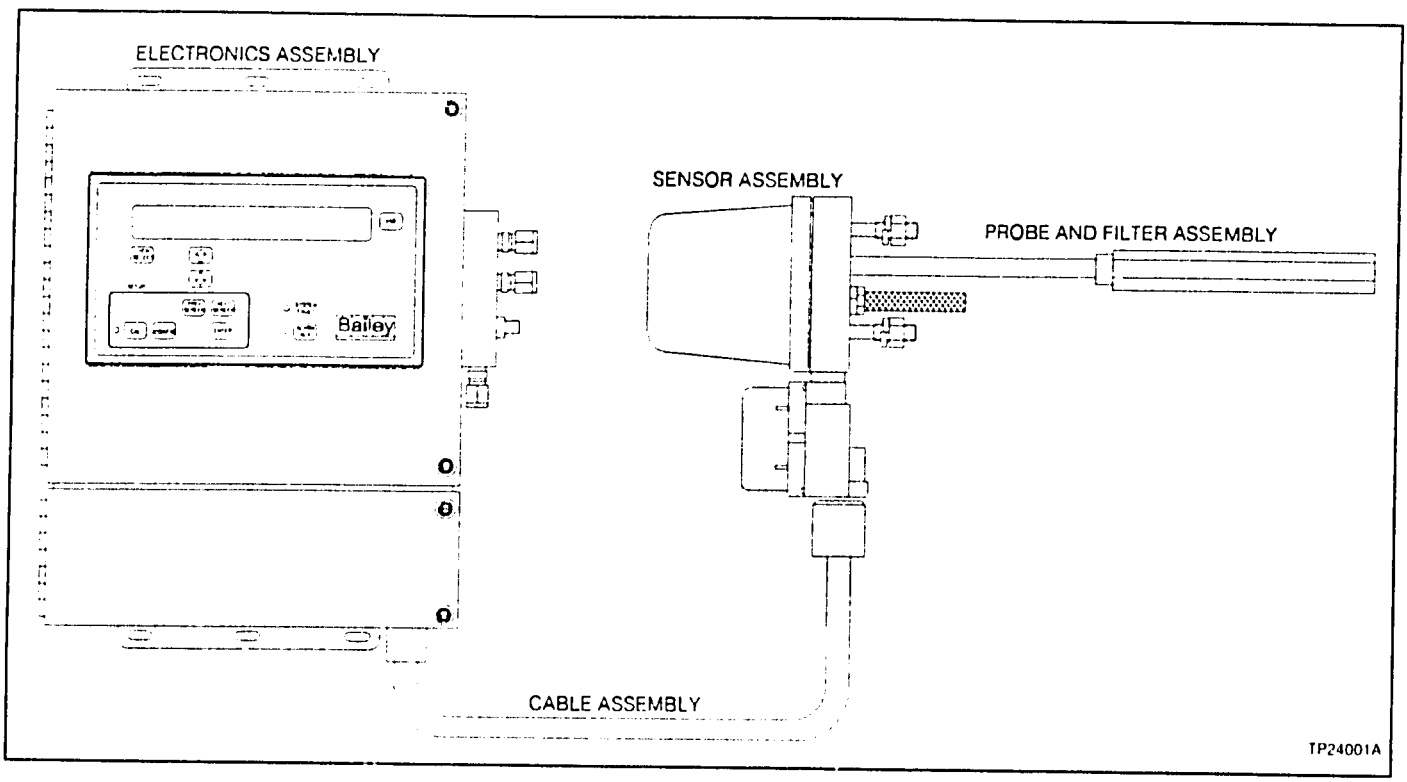


Figure 2. Smart Analyzer Assemblies

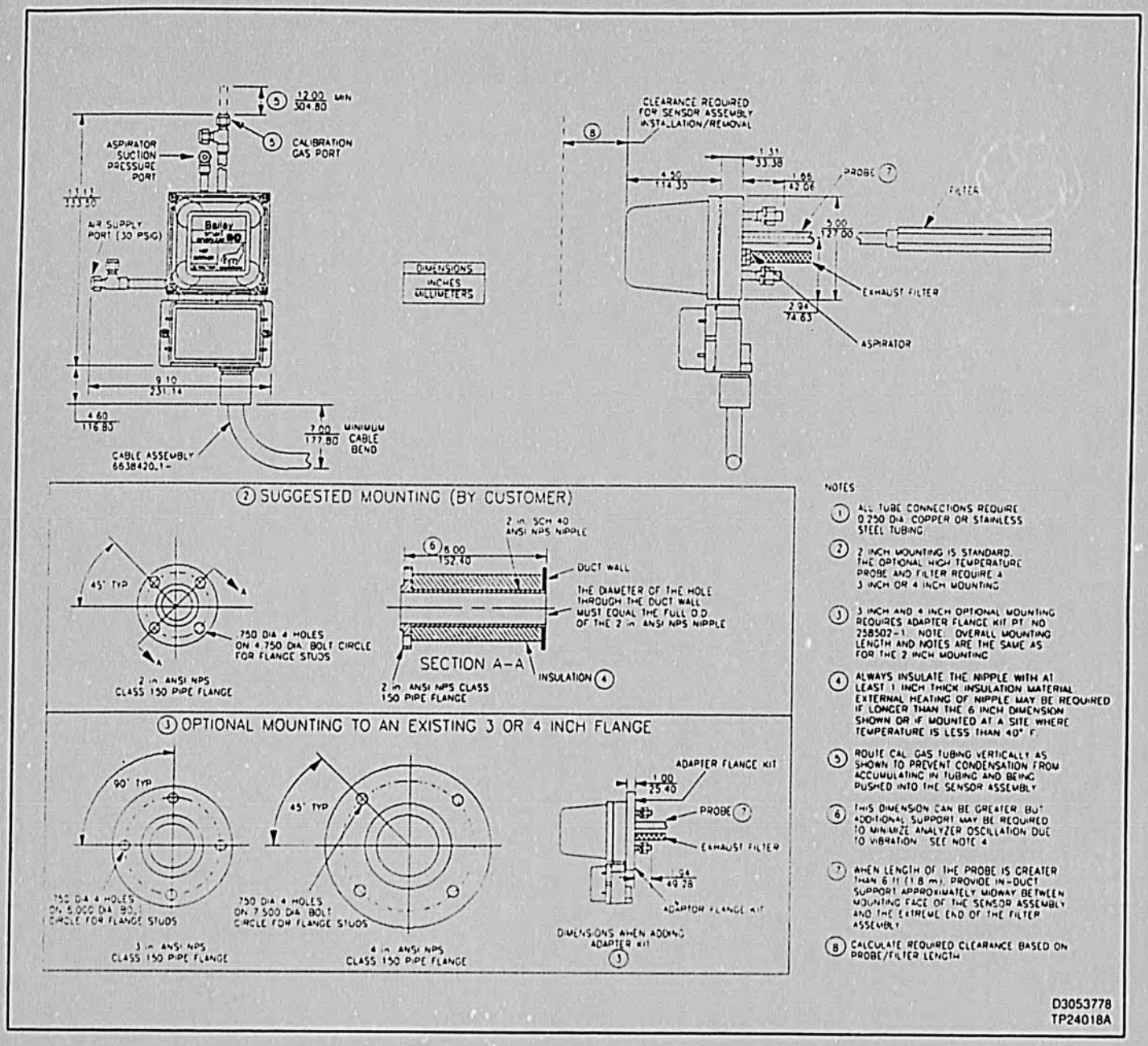


Figure 3. Outline and Clearance Requirements (Sensor Assembly)

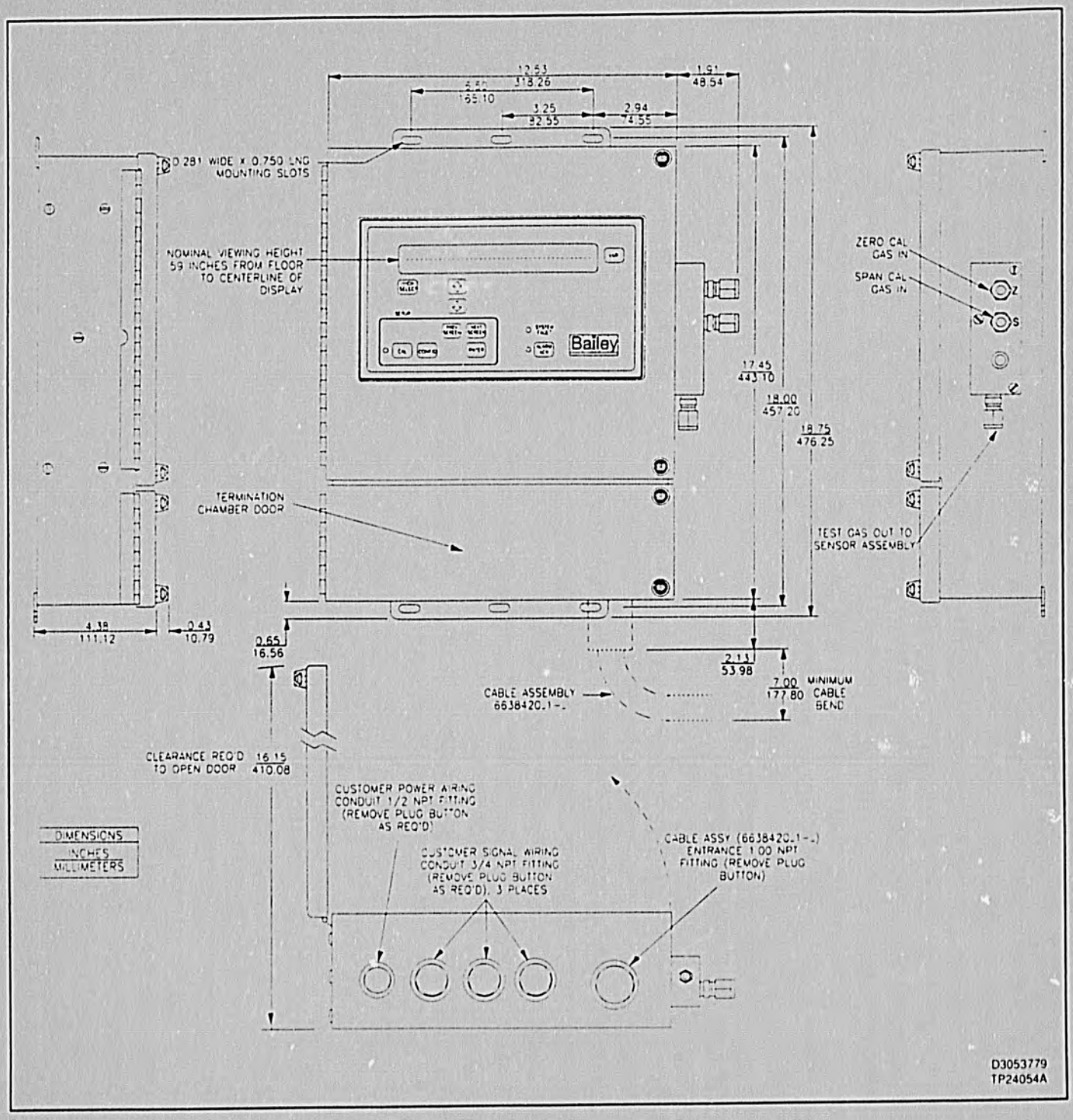


Figure 4. Outline and Clearance Requirements (Electronics Assembly)

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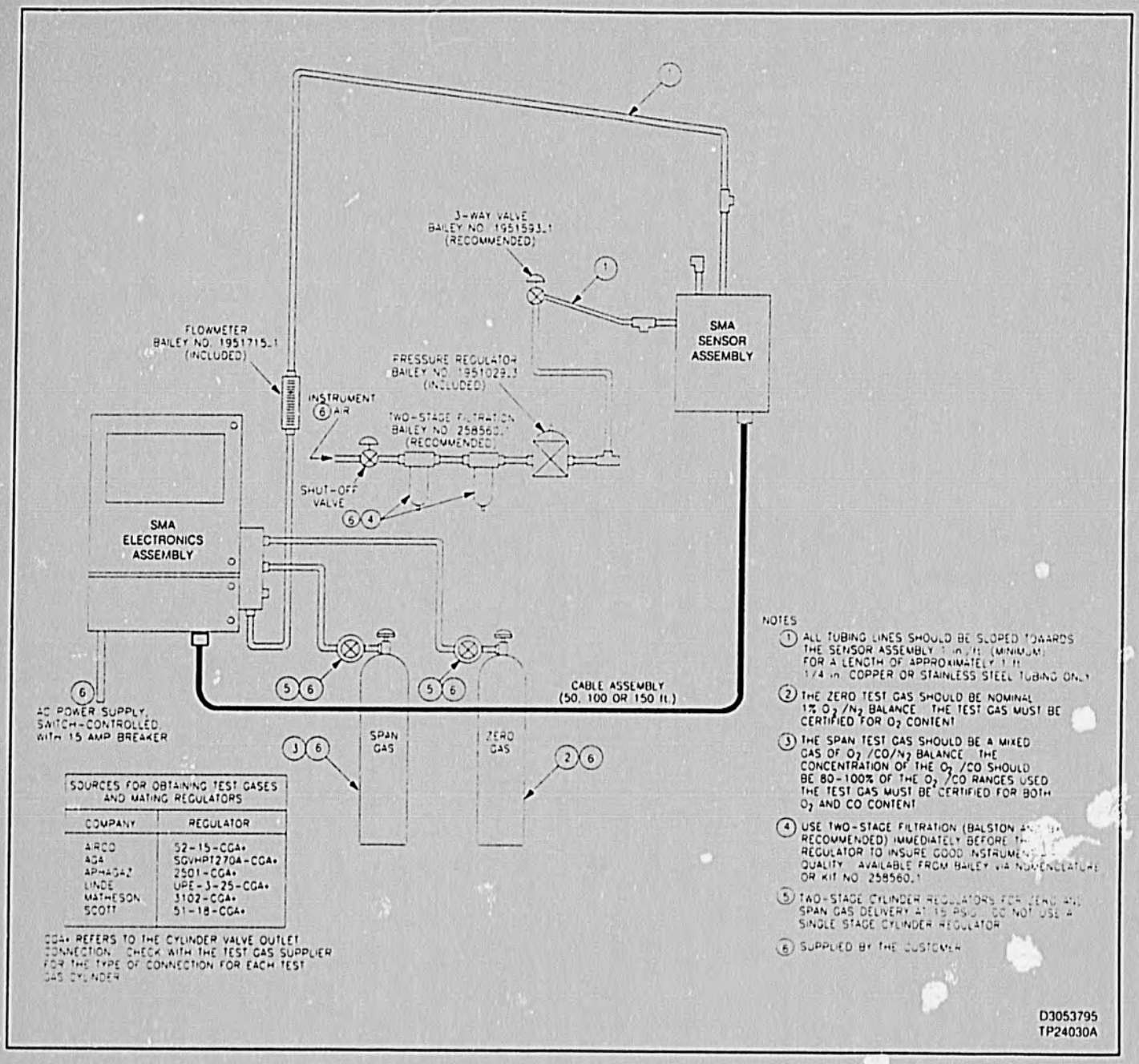

SOURCES FOR OBTAINING TEST GASES AND MATING REGULATORS	
COMPANY	REGULATOR
AIRCO	52-15-CGA+
AGA	SGVHPT270A-CGA+
APHAGAZ	2501-CGA+
LINDE	UPE-3-25-CGA+
MATHESON	3102-CGA+
SCOTT	51-18-CGA+

CGA+ REFERS TO THE CYLINDER VALVE OUTLET CONNECTION. CHECK WITH THE TEST GAS SUPPLIER FOR THE TYPE OF CONNECTION FOR EACH TEST GAS CYLINDER

Figure 5. Analyzer Installation Overview

Theory of Operation

The sensor assembly flange mounts to a duct or process wall so that the probe and filter assembly protrudes into the flue gas stream. The probe and filter assembly draws in the sample which is then analyzed by the sensor assembly. Electrical outputs from the sensors are fed through the interconnecting flexible cable to the electronics assembly for analysis. The electronics assembly analyzes the flue gas measurements and transmits the resulting data accordingly.

Sensor Assembly

The Type SMA Smart Analyzer 90 is based on 50 years of proven reliability and expertise in analytical equipment development. These sensors provide a fast, accurate and continuous percent by volume measurement analysis that is not affected by particulates or by temperature fluctuations.

The NEMA 4X sensor assembly mounts to a duct or process wall so that the probe and filter assembly protrudes into the flue gas stream. An air powered aspirator creates a suction pressure to draw the process gas through the patented floppy filter. The floppy filter's self-oscillating motion filters the process gas sample and removes particulate build up from the filter.

The Type SMA analyzer uses a hot gas sample system that measures the flue gas samples on a wet basis by keeping all metal parts at a temperature above dew point. This prevents acidic vapors from condensing on sampling surfaces. Once in the sensor assembly, the incoming process gas is split into two separate heated passageways. One passageway diverts the sample to the highly reliable zirconium oxide sensor where the process gasses are analyzed for net oxygen content. This patented O_2 sensor contains a built in heater to regulate its own temperature. The other passageway diverts the sample to the catalytic combustibles CO_e sensor where the process gases are analyzed for combustible content. As the sample passes through a preheater mixing chamber, dilution air is added at a fixed rate to ensure a repeatable and reliable combustibles measurement. The diluted sample then flows into the CO_e sensor which consists of two RTD rods. One rod acts as a reference and the other is coated with a catalyst that oxidizes or burns the combustibles on the rod surface. The temperature rise of the catalyzed RTDs (relative to the reference RTD) represents the CO_e concentration.

After the process gas is analyzed by the sensors, it is combined with the aspirating air and is sent back into the duct through the aspirator exhaust filter. Electrical outputs from the sensors are fed through the interconnecting flexible cable to the electronics assembly for analysis.

Electronics Assembly

The NEMA 4 electronics assembly provides the microprocessor based architecture and overall intelligence necessary to monitor sensor calibrations, field input/output (I/O) signals, and the operator interface. The electronics assembly controls the flange manifold and CO_e block temperature. The low level analog signals received from the O_2 and CO_e sensors are amplified and converted into 4 to 20 milliamp or 1 to 5 VDC outputs.

The field I/O signals consist of both analog and digital formats. Four analog outputs are available for O_2, CO_e, efficiency and temperature. Six digital Form C alarm contacts are available for oxygen, combustible, temperature, efficiency, diagnostics and calibration in progress. The electronics accepts two thermocouple inputs for combustion inlet air temperature and flue gas outlet temperature. Four digital inputs are available for remote calibration, blowback, check gas insert and fuel efficiency select.

The operator interface consists of a highly visible vacuum fluorescent display with two lines of 40 characters each. Setup options such as output ranges, alarm limits, calibration data and efficiency information are adjusted using the keypad. Modification of system parameters is security code protected with a three character user definable password.

Automatic Calibration (Standard)

The Type SMA analyzer contains an automatic sensor calibration feature which uses test gases of known concentrations to calibrate both sensors and ensure continual accuracy. Solenoids required to route calibration gases to the sensor assembly are incorporated into the electronics assembly.

All zirconium oxide O_2 sensors analyze flue gas samples by measuring the partial pressure of the oxygen in the sample with respect to an air reference. If the duct or process pressure changes, the partial pressure of oxygen also changes. Calibration of the sensor automatically corrects for sensor and duct pressure changes since the last calibration.

The automatic calibration is an eleven minute sequence that includes filter blowback (if ordered) as well as insertion of zero and span gas. Sensor calibration can be selected to occur as frequently or infrequently as desired and at any time of the day or night without operator or process intervention. Manual and remote calibrations can also be initiated via the operator interface or contact inputs.

Table 1. Specifications

Property	Characteristic
Variable Analog Output Ranges ok	
O_2	Minimum 0 to 5 % Maximum 0 to 25 %
CO_e	Minimum 0 to 200 ppm (0 to 0.02 %) Maximum 0 to 20000 ppm (0 to 2 %)
Temperature	Minimum -18 to 260°C (0 to 500°F) Maximum -18 to 1649°C (0 to 3000°F)
Accuracy ok	
O_2	± 2.5 % of reading
CO_e	± 20 ppm of reading (span less than 1000 ppm) ± 2% of span (span greater than 1000 ppm)
Temperature	± 3.3°C (6.0°F)
ok **Ambient Temperature Effect**	
O_2	± 2.5 % of reading per 56°C (100°F)
CO_e	± 2.5 % of span per 56°C (100°F)
Temperature	1°C per 100°C (1°F per 100°F)
ok **Measurement Errors Due to Flue Gas Variables**	
CO_e	None
Water Vapor	None
Particulate	None
Temperature	None
ok **Sensor Response Time to 63% of Span**	
O_2	Less than 3 seconds
CO_e	Less than 18 seconds
Power Supply Requirements	
Supply Voltage	105 to 128 VAC, 47 to 63 Hz or 211 to 257 VAC, 47 to 63 Hz 220 W/ 50 Hz
Power (during start-up)	730 W
Power (operating)	310 W
Air Supply Pressure	208 kPa at 15.6 l/min (30 psig at 0.55 scfm)
Input Signals	
Two Analog	Type E, J, K, R, S or T (customer supplied, isolated[1]) Because to supply 2 thermocouples
Inlet T/C: Ambient Air Temperature	
Outlet T/C: Flue Gas Temperature	
Four Digital	120/240 VAC, 50/60 Hz or 24 VDC 220
DI1: Remote Calibration	
DI2: Remote Blowback	
DI3: Remote Check Gas	
DI4: Fuel Selection	
Output Signals	
Four Analog:	1 to 5 VDC or 4 to 20 mA (Isolated[1] or non-isolated)
AO1: Process O_2	
AO2: Combustibles (CO_e)	
AO3: Inlet Outlet Temperature	
X AO4: Combustion Efficiency	
ok Six Isolated Digital[2]	Form C relay contacts rated for 2 A at 120/240 VAC, 50/60 Hz or 24 VDC (isolated)
DO1: Process O_2 Alarm	
DO2: Process CO_e Alarm	
DO3: Temperature Alarm	
DO4: Combustion Efficiency Alarm	
DO5: Analyzer Fault Alarm	
DO6: Calibration in Progress	

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Table 1. Specifications (continued)

Property	Characteristic
Maximum Analog Output Loading	
Voltage Mode	250 kΩ, 600 mH
Current Mode	600Ω, 600 mH
Self Monitoring (Default Output)	
Digital Outputs	Alarm state: NC to COM is open and NO to COM is closed
Analog Outputs	Switch selectable to low or high output Low = 0 VDC or 0 mA High = 6.2 VDC or 25 mA
Probe and Filter Length	
Standard Probe and Filter	1.5 m (4.8 ft) or 2.4 m (7.8 ft)
Standard Probe and Optional Dual Filter	1.8 m (5.8 ft) or 2.7 m (8.8 ft)
Optional High Temperature Probe and Filter	1.6 m (5.1 ft)
Cable	
Standard Length	15 m (50 ft)
Optional Lengths	30 m (100 ft) 46 m (150 ft)
Minimum Bend Radius	17.8 cm (7 in.)
Maximum Diameter (Outside Diameter)	1.9 cm (0.75 in.)
Environmental	
Sensor Assembly (Pending)	NEMA 4X (indoor/outdoor)
Electronics Assembly (Pending)	NEMA 4 (indoor)
Maximum Probe and Filter Temperature	
Standard Probe and Filter	649°C (1200°F)
Standard Probe and Optional Dual Filter	816°C (1500°F)
Optional High Temperature Probe and Filter	1649°C (3000°F)
Ambient Temperature Limits	
Sensor Housing	-18 to 93°C (0 to 199°F)
Electronics Housing	0 to 60°C (32 to 140°F)
Cable	-18 to 93°C (0 to 199°F)
Humidity	
Sensor Assembly	95 % RH @ 93°C (199°F) non-condensing
Electronics Assembly	95 % RH @ 60°C (140°F)
Weight (Approximate)	
Cable Assembly	
Standard 15 m (50 ft)	7.3 kg (16 lbs)
Optional 30 m (100 ft)	14.5 kg (32 lbs)
Optional 46 m (150 ft)	21.8 kg (48 lbs)
Sensor Assembly	4.5 kg (10 lbs)
Electronics Assembly	9.1 kg (20 lbs)
Approvals Certifications	
Factory Mutual (Pending)	Approved against flashback into duct
Factory Mutual (Pending)	Approved for use in Class I, division 2, groups B, C and D; and for use in Class II, division 2, groups E, F and G
Canadian Standard Association (Pending)	Certified for use in ordinary non-hazardous locations

An ungrounded or isolated thermocouple must be used. Cold junction compensation is provided.
AO2 (CO_2) defaults to 4 mA or 1.0 VDC when a Type SMA1 analyzer is installed.
Analog outputs can be selected for isolation in pairs. AO1 and AO2 define a pair and AO3 and AO4 define another pair.
DO2 (Process CO_2 alarm) defaults to normal state when a Type SMA1 analyzer is installed.

Specifications Subject to Change Without Notice

Table 2. Product Nomenclature

Position	4	5	6	7	8		
Type SMA	☐	☐	☐	☐	☐	**SMART ANALYZER 90**	
						Measurement	
	1					O_2 only	
	2					O_2 and CO_e	
						Cable Length	
		1				Standard 15 m (50 ft)	
		2				Optional 30 m (100 ft)	
		3				Optional 46 m (150 ft)	
						Probe and Filter Type	**Probe and Filter Length**
			1			Standard Probe with Filter 649°C (1200°F)	1.5 m (4.8 ft)
			2			Standard Probe with Filter 649°C (1200°F)	2.4 m (7.8 ft)
			3			Standard Probe with Optional Dual Filter 816°C (1500°F)	1.8 m (5.8 ft)
			4			Standard Probe with Optional Dual Filter 816°C (1500°F)	2.7 m (8.8 ft)
			5			Optional High Temperature Probe with Filter 1649°C (3000°F)	1.6 m (5.1 ft)
						Blowback	
				0		None	
				1		120 VAC Solenoid	
				2		240 VAC Solenoid	
						Instrument Air Filters	
					0	None	
					1	Two Stage Filter System	

Table 3. Accessories

Accessory	Kit No.	Application
Blowback Solenoid	258525_1 (110 VAC) 258525_2 (220 VAC)	Performs a preventative maintenance activity to momentarily direct high pressure aspirating air to clean the probe and filter assembly.
Panel Mount Kit	258524_1	Allows for the electronics assembly to be panel or rack mounted.
Adapter Flange Kit	258407_1	Standard mounting uses a 2-in. flange. The kit contains an adapter piece for mounting to a 3-in. or 4-in. flange. This kit is included with the optional high temperature probe and filter assembly.
Probe Flange Kit	258536_1	Isolates probe and filter from the sensor assembly to ease maintenance in a positive pressure application.
Maintenance Kit	258432_1	Includes three-way valve and two pressure gauges used to measure suction and sample pressures.
Instrument Air Filters (ok - seems included)	258560_1	Recommended to clean instrument air before it enters the analyzer.
Test Gas Kit	258274_2	Portable maintenance test gas kit for one or two calibrations. Not meant to replace customer supplied test gas.

Table 4
Plus Spare parts Simulation to Ametek

VII. Pyrometer Comparison

1. The Davis M-400D unit is suspect regarding durability and application to constant cement kiln conditions. It's use is not advised without further information obtained from Davis, plus references from cement plant users.

2. The Everest 4000B and the Quantum Logic QL 3200F-3A units both should serve well as intermediate investment equipment selection. Use of these units requires understanding their operation, understanding their limitations, frequent parts cleaning and replacement, plus frequent visual inspection of the kiln flame to coordinate correctness of flame temperature readings (i.e., to make sure that it is the flame temperature that is being monitored, and not the side was (clinker) temperature). Frequent mechanical checks, calibration, and parts replacement is to be expected.

3. While the Quadtek Spyrometer is markedly higher in cost than non-scanning, non-imaging pyrometers, it is clearly the instrument of choice for advanced burner control / performance information. One distinct advantage is that if process changes should occur that would interfere with accurate temperature measurement, these changes would not only be displayed on the monitor, but remote repositioning of the pyrometer to the correct measuring point could be accomplished. Another advantage is the display of temperature measurement from up to six selectable points in the field of vision. The size of each of these six points is programmable, plus the system (unit) can determine the average temperature, peak (maximum) temperature, and minimum temperature within each region. Wide angle viewing of the field of interest is allowed.

Installation and application of this unit is not advised without employing either a Quadtek service professional, or WEC consultant familiar with the installation, operation and trouble-shooting of the Quadtek unit.

Instrument Manufacturer Model	Portable, or Fixed	Calibration	Temperature Range Accuracy	Field of View *Window Material *Microns *Scan Rate	Enclosure Material Maximum Ambient Temperature	a. Focus Adjust b. Video Level Adjust c. Weight	Operating distance Special features	Image Processor	Air cooling Water cooling	Cost (shipping not included)
Quadtek M551 Integrated Scanning Pyrometer	Fixed can be moved to second mounting	I.N.A.	759-1816 °C 1398-3250°F ± 1%	30:1 Sapphire Every 10 secs.	Nema 4 Waterproof Anodized Aluminum 20° F with vortex cooling	a. Screw, located on rear b. Auto-iris accessible from rear c. 30 lbs.		M201B x Targets: Min/Max/Avg on-screen graph of data	M405 at $1,250	$40,000 plus installation
Everest 4000B	Fixed mount	Model 1000 Kit at $765	30 to 1200 °C -22 to 2200 °F I.N.A.	Fixed, selectable 2°, 15°, or 60° Every 1 second	I.N.A. 120°F	a. b. c.	2 cm to 300 m			$1,089 sensor 765 calib [a] 435 trans [b] 1,000 monit [c] 500 cable $3,889 total
Quantum Logic QL3200F-3A	Fixed mount	I.N.A.	290 to 1650°C 550 to 3000°F I.N.A.		I.N.A. 140°F	a. b. c.			QL30R at $125 QL303 at $150	$4,250 total
Davis M 4061D	Fixed mount	I.N.A.	800 to 1500°C 1500 to 2700 °F ± 1%	Fixed, selectable 1° or 4°	I.N.A. 120 °F or add cooler	a. b. c.			AP 400 at $88 yes	$ 630 sensor 73 frame 63 bracket 38 lock nut 88 air purge 248 water 403 linarizer 1,543 total

I.N.A. – Information Not Available

a - calibration kit b - transmitter c - monitor

Pyrometer Comparison & Quotes

CO AND O2 ANALYZERS FOR BROCENI CEMENT PLANT

VENDOR	EQUIPMENT	FEATURES	PRICE
BAILEY CONTROLS C/O SIMCO CONTROLS Columbus, OH 614-253-1998 X.148 Fax 614-253-2033	SMA 21411, Dual Filter (1500 F) SMA 21511 Filter (3000 F)	* Smart Analyzer 90 * Combustion analyzer which continuously samples and analyzes O2 and COs. * O2 Sensor: Zirconium oxide * CO Sensor: Catalytic type RTD based sensor * Automatic sensor calibration * Remote blowback * Nema 4 enclosure	SMA 21411 $8657 SMA 21511 $9025.00
McNEILL INTERNATIONAL 7041 HODGSON RD MENTOR, OH 44060 1-800-MCNEILL Fax: 216-953-1933	DAI Model 10600X 103 Sampling filter system Model 7612 Inconnel Probe 7'long	* Sensors: electrochemical, disposable minimum life - 1 year.Cost: O2-$140, CO-$276 * Calibrate once a month with cal gas * Filter replacement-once every six months * Power: 120VAC, 60 Hz, converter necessary * Local readout: Display - 3 1/2" analog meters * Nema 4 enclosure	$8868.75 Filter:$700.00 Probe:$1505 Total:$11073.75 Blowback to be provided by plant
ENVIROPLAN 3 BECKER FARM ROAD ROSELAND, NJ 07068 C/O D.J. SHINKLE 708-501-3579	CEMEX Extractive System	* Heated SS probe * Sample pump, peristaltic pump * Dragon Cement, Portland, ME * Sample control panel * Gas filter correlation CO Analyzer * Paramagnetic O2 Analyzer * O & M Manual -- 2 copies * System drawings * NEMA1 instrument rack * 40 feet umbilical cord	$58000
SERVOMEX 90 KERRY PLACE NORWOOD, MA 02062-4733 617-769-7710 1-800-862-200 C/O JOHN DOLE, 216-631-0600	SERVOMEX 700B Zirconia analyzers	* Heated sensor unit * Aspirator (air or steam) for sampling * Wide range of probe options -- temperature ranges -- dust loading factors * Self-diagnostic indicators * Missouri Portland Cement Plant, Independence, MO * "Blowback" not required * Two - way communications possible between the analyzer and a computer or terminal * Easy calibration, once a month	$11000
ROSEMOUNT ANALYTICAL,INC 1201 N. MAIN ST,PO DRAWER 901 ORRVILLE, OH 44667 1-800-628-1200 X 658		* In-situ type analyzer * 1300 F max, needs accessory for cooling down	O2 Analyzer: $4500 CO Analyzer:$15500
TELEDYNE ANALYTICAL INSTRUMENTS VICKI STEWART 818-961-9221	IN-SITU SYSTEM Model 9300	* Electrochemical microfuel cell for O2 * Infra-red sensor for CO * Both sensors being fed by a single probe * Installations in cement plants - Essroc Cement, Bessemer,PA * Blowback to clean the inside of probe * Vent-on pump for stack sampling	Model 9300: $18000 Dry type probe with wet wash to keep clear of particulate deposits. $5000.00 Total: $23000
AMETEK,INC Process and Analytical inst. Div. Jim Wall, 614-889-2150	Oxygen - In Situ AMETEK WDG - In Situ CO - Infra Red EI - 20	* Screening, probe(9"-108"), electronics * Manual flow calibration * Measurement across the stack * Air blowing system to keep transducer lenses clean	$5,000 $12,500 Total: $17,500

Information required from Broceni for more accurate pricing:
Flow System: Temperature, pressure, constituents, What kind of outputs are needed -- alarms, etc indication, recording, process control What do you want to do with the output?

bro2/hgb

Ametex Quotation

MODEL WDG-HPIIC PPM

Item: 1
Quantity: 1
Ametek Model WDG-HPIIC Microprocessor Based Flue Gas Oxygen and Combustibles Analyzer for 115 VAC (230 VAC) 50/60 Hz operation in general accordance with Bulletin P-270 consisting of:

Sensor in stainless steel enclosure with lift-off cover and including:

1. Heaters to maintain components above the dew point of flue gas.
2. Convection flow loop with furnace and zirconia cell and catalytic combustibles detector.
3. Mounting plate for welding to vertical wall or onto 3 1/2" or 4" pipe nipple as flange.
4. 48" (60 cm) stainless steel sample probe/filter assembly to 1300°F (704°C).
5. 25 ft. (7.6 m) of interconnecting cable P/N 21185 JE.
6. 20 Micron SS filter - maximum 800°F.

Series 2000 Control Unit (Following features are standard)

1. 4 line x 20 characters/line vacuum fluorescent display shows combinations of oxygen (0-100%), combustibles (ppm or %), time & date, cell temperature, user-programmable text, T/C mV or cell mV.
2. Password protection, programmable pressure compensation and context-sensitive help are standard. Display line 4 is reserved for full text error and diagnostic messages.
3. Two isolated current outputs for oxygen and one for combustibles. Select oxygen, combustibles, cell temperature, T/C mV or cell mV as current output. Each can be 4-20 mA, 0-20 mA, 20-4 mA or 20-0 mA. Adjustable to correspond from 0-1% oxygen to 0-100% oxygen and from 0-200 ppm to 0-5% combustibles. Select hold or track during calibration.
4. Two oxygen alarms, each high or low selectable and energize or de-energize on alarm. Assign alarm 1 as Oxygen, Calibrate or verify. Two high Combustibles alarms.
5. Diagnostics includes watchdog timer, service alarms, system tests and a 10-entry event log.
6. RS-485 2-way addressable communications port.
7. Real-time clock/calendar.
8. Manual calibration or calibration verification.
9. Choice of general purpose wall mount, panel mount or 19" rack mount enclosure.
10. Meets requirements of Class I, Div. 2 hazardous area.

PRICE: $8010.00 net each

OPTIONAL EQUIPMENT

X **Remote Calibration Unit (Optional)**

This option includes the calibration box (Nema 4X) complete with valves, regulators, flowmeter, flow controller, check valve and auto calibration module for the Series 2000. This allows an automatic calibration (or verification) cycle to be performed: a) at a timed interval, b) remotely on demand either by contact closure or via the RS485 port or c) locally by manually pressing a key on the Series 2000. The calibration box should be mounted as close to the sensor as possible. Calibration gases to be supplied by customer. Refer to spare parts section for gases stocked by Thermox for resale. Includes 25 ft (7.6 m) interconnecting cable P/N 21194 JE - (Blenden No. 9773).

PRICE ADDER: $1260.00 net each

FS recommends no, because need worker to go up to unit each day + check unit.

Sensor Mounting Configuration

Floor mounting (LIFT OFF COVER ONLY). Uses 3" 150# mounting plate

X PRICE ADDER: $530.00 net each

Remote sensor board mounting for ambient temperatures from 160°F (71°C) to 392°F (200°C). Includes remote SS junction box (A203-333-1). Maximum distance sensor to box is 20 ft (6.1m). Includes 20 ft (6.1m) high temperature cable P/N 71971.

X PRICE ADDER: $525.00 net each

X **Probe/Filter Assembly Option**

48" (122 cm) Ceramic to 2800°F (1530°C)

PRICE ADDER: $505.00 net each

Options for Series 2000 Control Unit

X Wall-mount Nema 4

PRICE ADDER: $200.00 net each

X Wall-mount Nema 4X (stainless steel)

PRICE ADDER: $600.00 net each

X 60W heater and thermostat

PRICE ADDER: $210.00 net each

INTERCONNECTING WIRING

X **Control Unit to Sensor Unit**

P/N 21185 JE - (Belden No. 9774)
6-twisted pair 18 AWG each pair individually shielded and 20 AWG drain wire w/ PVC jacket. For use up to 1000' (304). Maximum temperature 176°F (80°C). (25 ft (7.5 m) of cable is included with sensor).
PRICE: $ 2.20/ft

Only 10 feet from sensor to control unit

X **Control Unit to Remote Calibration Unit**

P/N 21194 JE - (Belden No. 9773)
3-twisted pair, 18 AWG. Each pair individually shielded and 20 AWG drain wire. PVC jacket. For use up to 1000 ft. (304 m). Maximum temperature 176°F (80°C). (25 ft (7.5 m) of cable is included with calibration unit).
PRICE: $ 1.45/ft.

220 V / 50 Hz

SPARE PARTS

Sensor Unit

Part #70409SE Furnace Assembly
PRICE: $250.00 net each
Part #71697KE Type "K" Thermocouple
PRICE: $125.00 net each
Part #80418SE Sensor Board
PRICE: $215.00 net each
Part #71063SE Zirconium Oxide Cell
PRICE: $435.00 net each
Part #72396KE Thermostat (lift-ff enclosure)
PRICE: $170.00 net each
Part #72326KE Thermostat (hinged enclosure)
PRICE: $170.00 net each

Remote Calibration Unit

~~$1368~~ 1025

Part #39003JE Air Regulator
PRICE: $110.00 net each
Part #37013JE Regulator Gauge
PRICE: $ 25.00 net each
Part #36023JE Calibration Gas Solenoid Valve
PRICE: $ 65.00 net each
Part #37020JE Flowmeter
PRICE: $120.00 net each

Series 2000 Control Unit

Part #90219VE Display Module
PRICE: $1215.00 net each
Part #90253VE Power Supply/Keypad Module
PRICE: $370.00 net each
Part #80436SE Calibration Card
PRICE: $225.00 net each
Part #80449SE Combustibles Card
PRICE: $885.00 net each
Part #80439SE Backplane Assembly
PRICE: $165.00 net each
Part #80445SE Wiring Board
PRICE: $375.00 net each
Part #80440SE Processor Board
PRICE: $810.00 net each
Part #42373JE Display
PRICE: $290.00 net each

$4935

TELEDYNE ANALYTICAL INSTRUMENTS

BAKER INDUSTRIAL EQUIPMENT, INC.
2475 State Road • P.O. Box 1208
Cuyahoga Falls, Ohio 44223-0208
Phone: 216-928-8877
Fax: 216-923-0615

APPLICATION INFORMATION

Please supply complete answers to the following questions so that Teledyne Analytical Instruments can correctly evaluate your application and propose instrumentation best suited to solve your analysis problem.

INQUIRY FROM: DATE 13 Jan 1994

Name FRANK C. STEVENS
Title President
Company Stevens Consulting Co
Address 13620 Oak Park Rd
Lakeside Calif 92040
Telephone Number 619-390-4033

SEND RESPONSE TO: FRANK C. STEVENS
and Gordon Mitchell
World Environment Center

PURPOSE OF INQUIRY: FAX 619-390-4031

Feasibility of Application ☐ Budget Estimate ☐ Quote for Possible Purchase ☒

PROCESS CONDITIONS:

1. Nature of Process Wet Process Cement Kiln, Sample feed end of K
2. Number of Sample Streams to be Monitored One
3. STREAM COMPOSITION(S): (List Everything)

COMPONENT	TO BE MEASURED	REQUIRED ACCURACY	RANGE	CONCENTRATION UNITS	MAXIMUM	NORMAL	MINIMUM
O_2	O_2	0.5 to 1.0% of Scale	0-5%	Percent	10%	2.65%	0.0%
			0-10%				
CO	CO		0-2000	ppm	2000 ppm	200 ppm	0.0%
			0-2000	ppm	2%	2000 ppm	

4. STREAM OPERATING CONDITIONS: VACUUM -4" H_2O -3" H_2O -2" H_2
   a. Physical Properties
      Temp.: °F ☐ °C ☒ Max. 400°C Normal 300°C Min. 200°C
      VACUUM ~~Press.~~: psig ☐ psia ☐ Inches of H_2O ☐ Max. -4" H_2O Normal -3" H_2O Min. -2" H_2O
      Phase: Vapor ☐ Liquid ☐ Mixed ☐ Contains Solids? Yes ☒ No ☐ Describe PORTLAND CEMENT DUST, HEAVY CONCENTRATION
      Amount and Particle Size 2-2 grams/cubic meter minus 100 mes
   b. Chemical Properties
      Corrosive? Yes ☐ No ☒ Acid ☐ Basic ☒ Neutral ☐
      What materials withstand contact with sample? STAINLESS STEEL
      Stability HYDROSCOPIC, CONTAINS CAO AND MOISTURE
      Polymerizing Tendency No

METHODS OF ANALYSIS:

1. What methods of lab analysis are used to measure component(s) of interest? ORSAT, TESTOTER
2. What TAI instrument or literature prompted inquiry? TA!

APPLICATION DATA AVAILABLE

1. Are samples available for evaluation by TAI? Yes ☒ No ☐ If so, please describe TYPICAL FEED END CEMENT KILN GASES AND DUST
2. Are spectrograms of sample available? Yes ☐ No ☒ If so, please attach. WET CHEMICAL ANALYSES ARE AVAILABLE
3. Please attach any other data that might be useful, such as sketch of sample system, etc. WILL USE TYPICAL CEMENT PLANT SAMPLE SYSTEM FOR FEED WET PROCESS KILN

BAKER

BAKER INDUSTRIAL EQUIPMENT, INC., • 2475 STATE RD. • P. O. BOX 1208 • CUYAHOGA FALLS, OH 44223 (216) 928-8877
FAX: (216) 923-0615

December 16, 1994

Malcolm Pirnie, Inc.
445 Hutchinson Avenue
Columbus, OH 43235

Attention: Mr. Harry Bhatt - Project Manager

Gentlemen:

Subject: Teledyne Analytical Instruments Cement Kiln Sample Systems and Analyzers

Teledyne has been very successful in providing kiln sampling and gas measuring systems. Essroc Cement located in Poland, Ohio has been using a Teledyne cement kiln sampling system with oxygen and carbon monoxide analyzers for a number of years with success. I am gathering a list of other installations and will forward them in another correspondence.

We discussed a wet cement manufacturing process in which your customer would like to monitor oxygen and carbon monoxide. The Teledyne Model 9300 combines oxygen and carbon monoxide analyzers with a relatively simple maintenance-free sampling system. A budgetary cost for analyzers, sample system and probe is $24,128.00.

In the price, we have included a water-cooled and water-washed probe for temperatures up to 3,000°F (1,650°C), and an air blowback system to purge the probe and sample lines. Temperatures below 2,100°F (1,150°C) may allow us to use a dry type probe with water-wash.

Because cement kiln sampling systems are so critical, I have included several application bulletins and cut sheets on Teledyne's Model 9300 oxygen and carbon monoxide analyzer and flue gas probes.

Please free to contact me if you have any questions. Also, have your customer fill out our application data sheet so that we may provide a quote.

Sincerely,

BAKER INDUSTRIAL EQUIPMENT

Richard F. Werren
Sales Engineer

MlcmPrRF.doc
Enclosures

RECEIVED
DEC 20 '94
ACTION PRIOR
COMMENTS
DATE
JOB #
FILE:

102

VII. Pyrometer Comparison

1. The Davis M-400D unit is suspect regarding durability and application to constant cement kiln conditions. It's use is not advised without further information obtained from Davis, plus references from cement plant users.

2. The Everest 4000B and the Quantum Logic QL 3200F-3A units both should serve well as intermediate investment equipment selection. Use of these units requires understanding their operation, understanding their limitations, frequent parts cleaning and replacement, plus frequent visual inspection of the kiln flame to coordinate correctness of flame temperature readings (i.e., to make sure that it is the flame temperature that is being monitored, and not the side was (clinker) temperature). Frequent mechanical checks, calibration, and parts replacement is to be expected.

While the Quadtek Spyrometer is markedly higher in cost than non-scanning, non-imaging pyrometers, it is clearly the instrument of choice for advanced burner control / performance information. One distinct advantage is that if process changes should occur that would interfere with accurate temperature measurement, these changes would not only be displayed on the monitor, but remote repositioning of the pyrometer to the correct measuring point could be accomplished. Another advantage is the display of temperature measurement from up to six selectable points in the field of vision. The size of each of these six points is programmable, plus the system (unit) can determine the average temperature, peak (maximum) temperature, and minimum temperature within each region. Wide angle viewing of the field of interest is allowed.

Installation and application of this unit is not advised without employing either a Quadtek service professional, or WEC consultant familiar with the installation, operation and trouble-shooting of the Quadtek unit.

Appendix D-8

Waste Minimization Committee/Consultant Reports

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A/S "BROCENI" consultant, Dr.Sc.Ing. Karlis Roze's

REPORT

of fulfiled works in WEC co-ordinated program in wastes minimization.

The works had been started in May, 1994 with introduction of WEC activities in Latvia and instructions in seminar in Jurmala, which was organized by WEC. After formation the community of wastes reduction,A/S"BROCENI"had been rendered the consultation by working out the program of wastes reduction.The first stage of the project envisages to reduce the dust quantity,which have formed during the burning process into rotary kiln.This problem was foreseeing to resolve by kiln working in optimal regime,which can be reached with constant control of exit gas structures by stationary gas-analizer.At now this project is practicaly realized,the gas-analizer is established and regulation of kiln parametrs had improved appreciably.

In future the program of wastes reduction foresees burning of hard and liquid production wastes into rotary kiln.For solution of this problem decision in July between ZRF"Termolat"and A/S "BROCENI" had been concluded agreement about attracting specialists for program realization.Plan of the agreement's work fulfilment foresees inspection and integrated research of production wastes of Latvia as well as technology elaboration and necessary equipment choice.There had been taken the integrated research of the oil-production wastes in August. The material had been summaried into the report and had been passed to A/S "BROCENI"leaders.Such production wastes as filter opoka,which is polluted with mineral oil, contains from 15% to 20% of mineral oil.Using of such production wastes in cement production is convenient by two reasons:

- during burning process of absorbability oil has been got additional warmth of 2000kcal/kg
- restoration opoka flow into the clincer's part very well.

Burning 3-4t/day of the wastes, including the wastes from Riga oil plant, in addition we get from 6 to 8 Ggal of warmth.What'll give the possibility to 0,6-0,8 ton of heavy oil economy, and the economy of 60-80 USD/day and appreciably reduce the environmental pollution.Because at present the oil plant's wastes are wiped out partly or they are taken away to the sity dust-heap.

At present the firm "Termolat" continues work at working out wastes burning technology and equipment's choice. This firm has investigated also possibilities of burning the other wastes types in rotation kiln, tires burning, wastes from oil products transportation and storage,wastes from chemical filament's production.

ZRF "Termolat" technical manager K.Roze

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A/S "BROCENI" consultant, firm "Termolat" technical manager, Dr.Sc.Ing.Karlis Roze's production plan for WEC co-ordinate program of wastes minimization to 1994.

N.p.	Current work	Term
1.	Introduction with WEC program during participation in seminar in Jurmala.	May
2.	Consultation in wastes reducing program appearance.	June
3.	Consultation in working out project of the cement dust quantity reduction in clincer burning process.	July
4.	Summing up of information about using into cement production the liquid and hard production wastes.	August
5.	Determination of perspective wastes types and working out its burning technology	September
6.	Integrated research into the oil production wastes and working out of burning technology	September
7.	Consultation in working out of tires burning technology and equipment's choice.	October
8.	Consultation and technical help for wastes burning into cement kiln.	November
9.	Processing of results, reports, recommendation and technical documentation working out and passing to A/S "BROCENI"	December

Dr.Sc.Ing. K.Roze

October 12,1994

A/S "Brocēni" konsultanta, Dr. inž. Kārļa Rozes

A T S K A I T E

par izpildītajiem darbiem WEC koordinētajā atkritumu samazināšanas programmā

Darbi tika uzsākti 1994.g. maijā ar iepazīšanos ar WEC darbību Latvijā un apmācībām WEC rīkotajā seminārā Jūrmalā. Pēc atkritumu samazināšanas komitejas izveidošanas A/S "Brocēni" tika sniegtas konsultācijas atkritumu samazināšanas programmas izstrādāšanā. Projekta sākuma posms paredzēja samazināt putekļu daudzumu, kas veidojas klinkera apdedzināšanas procesā rotējošajā krāsnī. Šo problēmu bija paredzēts atrisināt, krāsnij strādājot optimālā režīmā, ko var panākt, nepārtraukti kontrolējot dūmgāzu sastāvu ar stacionāru gāzu analizātoru. Pašlaik projekts praktiski realizēts, gāzu analizātors uzstādīts un krāsns parametru regulēšana jūtami uzlabojusies.

Tālāk atkritumu samazināšanas programma paredz dažādu cieto un šķidro rūpniecības atkritumu sadedzināšanu rotējošajā krāsnī. Šo problēmu risināšanai jūlijā starp ZAP "Permolat" un A/S "Brocēni" tika noslēgts līgums par firmas speciālistu piesaistīšanu programmas realizēšanā. Līguma darbu izpildes plāns paredz Latvijas rūpniecības atkritumu apzināšanu un komplekcu izpēti, ka arī sadedzināšanas tehnoloģijas izstrādāšanu un nepieciešamo iekārtu izvēli.

Augustā veikta eļļas rūpniecības atkritumu kompleksā izpēte un atskaitē apkopotais materiāls iesniegts A/S "Brocēni" vadībai. Šie ražošanas atkritumi - ar minerāleļļām piesārņota filtrējošā opoka - satur I5 - 20 % minerāleļļas. Šo ražošanas atkritumu izmantošana cementa ražošanā ir izdevīga no diviem viedokļiem - sadegot absorbētajām eļļām tiek iegūts papildus siltums ~2000 kkal/kg, bet regenerētā opoka labi iekļaujas klinkera sastāvā.

Sadedzinot dienā 3 - 4 t atkritumu, t.i. daudzumu, kas rodas tikai Rīgas eļļas rūpnīcā, tiks papildus iegūts 6 - 8 Gkal siltuma, kas ļaus ietaupīt 0,6 - 0,8 t mazuta un dos ekonomiju $ 60 - 80 dienā, kā arī ievērojami samazināt apkārtējās vides piesārņošanu, jo patlaban eļļas rūpniecības atkritumus nepilnīgi iznīcina vai pat nogādā pilsētas izgāztuvē.

Pašlaik firmā "Termolat" turpinās darbs pie atkritumu sadedzināšanas tehnoloģijas izstrādāšanas un iekārtu izvēles, kā arī tiek pētītas citu veidu atkritumu sadedzināšanas iespējas rotācijas krāsnī, kā ~~arī~~ nolietotu autoriepu sadedzināšana, naftas produktu transporta un uzglabāšanas atkritumi, ķīmiskās šķiedras ražošanas atkritumi u.c.

ZRP "Termolat" tehniskais direktors, Dr. inž.

K.Roze

I994.g. I2. novembrī

A/S "Brocēni" konsultanta, zinātniskāa un ražošanas firmas "Termolat" tehniskā direktora, Dr. inž. Kārļa Rozes darba plāns WEC koordinētajā atkritumu samazināšanas programmā 1994. gadā

N.P.K.	Veicamie darbi	Izpildes termiņš
1.	Iepazīšanās ar WEC programmu, piedalīšanās seminārā Jūrmalā	maijs
2.	Konsultācijas atkritumu samazināšanas programmas izstrādāšanā	jūnijs
3.	Konsultācijas projekta izstrādē par cementa putekļu daudzuma samazināšanu klinkera apdedzināšanas procesā	jūlijs
4.	Informācijas apkopošana par šķidro un cieto rūpniecības atkritumu izmantošanu cementa ražošanā	augusts
5.	Perspektīvāko atkritumu veidu noteikšana un to sadedzināšanas tehnoloģijas izstrādāšana	septembris
6.	Eļļas rūpniecības atkritumu kompleksā izpēte un sadedzināšanas tehnoloģijas izstrādāšana	septembris
7.	Konsultācijas riepu sadedzināšanas tehnoloģijas izstrādāšanā un iekārtu izvēlē	oktobris
8.	Konsultācijas un tehniskā palīdzība atkritumu sadedzināšanā cementa krāsnī	novembris
9.	Rezultātu apkopošana, atskaites, rekomendāciju un tehniskās dokumentācijas izstrādāšana un nodošana A/S "Brocēni"	decembris

Dr. inž. K.Roze

1994.g. 12. 10.

1994 SEP 14 AM 9:03

BROCĒNI

ADRESE
A/S Brocēni
Saldus rajons
Latvija LV 3851

TELEFONI
371 38 69216
371 38 65886
371 38 65075
371 2 458 203
371 2 212 587

TELEFAX
371 38 65087
371 9 348058

Rīga, Tirgoņu iela 4
Latvija LV 1050

TO : W E C

ATT : Gretchen Mikaska

FAX : 212 683 5053

FROM : Janis Klavins A/S BROCENI

DATE : 13.09.94

R E P O R T

of JSC "Broceni" consultant, Dr.ing. Kārlis Roze about completed work in WEC coordinated waste reducing program.

Work have began in May 1994 with acknowledging of WEC activities in Latvia and teaching in WEC organized seminar in Jurmala. After organization of waste reducing committee have been given consultations to JSC "Broceni" in working - out of waste reducing program. In initial stage project foresee to reduce quantity of dust, which formed in rotating kiln at clinker burning process. This problem have been intended to solve, for kiln working in optinal regime, what is achievable continiously controlling flue gas content with stationary gas analyzer. At this time project is practically realized, gas analyzer settled and regulation of kiln parameters is considerably improved.

BROCĒNI
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Rīga, Tirgoņu iela 4
Latvija LV 1050

Further waste reducing program foresee liquid and solid production waste burning in rotating kiln . For solution of these problems in Yuly have been signed contract between SIF "Termolat" and JSC "Broceni" about involving specialists of firm in realization of program. Project of contract works foresee acknowledging and complex investigation of Latvian industry waste and also working - out of burning technology and choice of necessary equipment.

In August have been completed investigation of oil industry waste and report of summarized material was presented to manager board of JSC "Broceni". These waste - with mineral oils wasted filtering opoka - contains 15 - 20% mineral oil. Using these waste in cement producing is advantageous for two reasons - absorbing oils in process of burning produce additional heat ~ 2000 Kkal/kg, but regenerated opoka is used in content of clinker.

With burning daily 3 - 4 t waste (it means quantity which is produced in Riga oil factory alone), we obtained additional 6 - 8 Gkal of heat, which allows to save 0,6 - 0,8 t mazut oil and will give economy of 60 - 80 $ daily, and also considerably reduces environment pollution, because at this time waste of oil industry is exterminated only partly or even delivered to city dump - ground.

BROCĒNI
AKCIJU SABIEDRĪBA

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Saldus rajons
Latvija LV 3851

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371 38 65006
371 38 65076
371 2 459 203
371 2 212 587

TELEFAX
371 38 65007
371 9 348050

Rīga, Tirgoņu iela 4
Latvija LV 1050

At this time firm "Termolat" continues to work on waste burning technology elaboration and choice of equipment as well as research for possibilities to burn in rotating kiln another type of waste as - used tyres, waste of transportation and storage of oil products, chemical fibre production waste and others.

SIF "Termolat" technical director, Dr. ing.

K. Roze

12th september 1994.

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BROCĒNI
AKCIJU SABIEDRĪBA
ADRESE
A/S Broceni
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Latvija LV 3851
TELEFONI
371 38 65216
371 38 65886
371 38 65076
371 2 459 203
371 2 212 687
TELEFAX
371 38 65087
371 9 348058
Riga,Tirgoņu iela 4
Latvija LV 1050

Working plan of Dr. ing. Kārlis Roze consultant of JSC "Broceni" and technical director of firm "Termolat" in WEC coordinated waste reducing program in 1994.

No.	Planned works	Terms of completing
1.	Acknowledging with WEC program, participation in seminar in Jurmala.	May
2.	Consultations in waste reducing program working - out.	June
3.	Consultations in working - out project about dust quantity reducing in clinker burning process.	July
4.	Summarizing of information about liquid and solid industry waste in cement producing.	August
5.	Determination of perspective waste types and working - out of their burning technology.	September
6.	Oil industry waste complex research and working - out of burning technology.	September
7.	Consultations in tyre burning technology working - out and equipment choice.	October
8.	Consultations and technical help in waste burning in cement kiln.	November
9.	Summarizing of results, working - out reports, recommendations and technical documentation and delivering it to JSC "Broceni".	

Dr. ing. K. Roze

12th september 1994.

TO :Grethen Mikeska.
FAX :212-683-4745
FROM :J.Klavinsh, K.Roze.
FAX :011-371-9-348058
SUBJECT:Consultant report.
DATE :December 5,1994.

Dear Gretchen!

I received your fax of 21/11/94 from Mr.Klavinsh. I would like to explain following details.
The work in my company "Termolat" is very serious and that means I am not able to do full time service for WEC - I must either do it after my working hours or besides my daily work.
I hope our cooperation satisfies needs of WEC. Mr.Klavinsh have no of pretensious to my activities too.
In addition to my October report I would like to explain, that comlex analisis of oil refinery plant wastes, carried out in August and including chemical, x- ray, DTA, computing takes for us all together more than 10 days work. The date collection involved also other specialists of our company. If you are interested in this material it should be presented to Mrs.Ladutko (in Latvia).
Regulary 2 times every month I arive JSC Broceni to solve various technological and other problems together with plant specialists. It takes 2 extra full time days for me to work for WEC every month.
In November we perfomed combustion of old times, we are looking for new technologies an working on collection, transport and storage the tires at JSC Broceni until availability of new technology.
I would like to see you in January, too.

Sincerely yours

K.Roze.
06.12.94.

Appendix D-9

Stack Emissions Test on Kiln #4

115

FCS Ltd
17 Jan 1995
No 4 Kiln
Appendix D

Latvian Republic
Ministry of Environment and Regional Development

LATVIJAS REPUBLIKAS
VIDES AIZSARDZIBAS UN REĢIONĀLAS ATTĪSTĪBAS MINISTRIJA

21A

Latvijas Vides datu centra LABORATORIJA

Laboratory of Latvian Environmental Data Center

GĀZU ANALIŽU REZULTĀTI

Tērauda Broceni No 4 Kiln Latvia FCS

1 September 1994

Norīkojuma-akts Nr. _____

Paraugu noņemšanas datums, laiks 14 - 18^{00}

Šifrs 1.09.94.

Objekta nosaukums a/s "Brocēni"

Adrese, telefona Nr.

MPI/LSI izstrādes laiks 1990

Atļaujas terminš nav apstiprin.

Izmešu avota nosaukums, invent.Nr. un darbības ies raksturojums:
Krāsns Nr.4, pēc filtriem

KATLU MĀJAS DARBA REŽĪMA PARAMETRI PĒC UZŅĒMUMA DATIEM

Slodze

Kurināmais mazuts

Gaisa pārpilnības koeficients

Kurināmā patēriņš

Dūmgāzu temperatūra,°C 227

METEOROLOĢISKIE APSTĀKĻI

Gaisa temperatūra,°C 20

Atmosfēras spiediens, kPa 101,3

Slēdziens
MPI normatīvi izstrādāti 1990.g., pieņemot, ka kā kurināmo izmanto gāzi. Pašlaik cementa klinkera apdedzināšanai izmanto mazutu, tāpēc MPI vērtības nav salīdzināmas.

Paraugu noņēmēji un komisija
Ventspils RVAK vec inspekt. M.Maulipš
(amats, uzvārds)
"Brocēni" tehn.direkt.vietn.dabas aizsardz. E.Laurinoviča
VDC speciālisti V.Vaivada
G.Jansons
V.Zilinskis

Atbildīgie par analīzēm
VDC speciālisti M.Vaivada
(amats, uzvārds, paraksts)
G.Jansons
V.Zilinskis
V.Spince

Laboratorijas vadītāja
(paraksts, uzvārds)

Datums

116

(22) Latvian Brocni Stack Testo No 4 Kiln

Kiln Testo / Sept 1994

	Reģ. Nr. _____ Pirms attīrīšanas	Reģ. Nr. _____ Pēc attīrīšanas
Izmešu avota diametrs (vai malu garumi) mēr.vietā,m		2,20 x 2,60
Izmešu avota izplūdes diametrs, m		
Izmešu avota augstums, m		
Izmešu temperatūra,°C		227
Izmešu plūsmas ātrums, m/s		18,60
Izmešu plūsmas apjoms, m3/s		57,90

Brocni Stack Emission Testo on No 4 Kiln

Note: O_2 Content of Kiln gases at stack conditions of testing is 7 to 8% O_2

Viela	Analīzes metode	Mērvienība	Pirms attīrīšanas	Pēc attīrīšanas	MPI (LSI)
NO_x	ppm system gāzu anal.	mg/m3	ppm	273	
		g/s	gram/second	15,81	
SO_2	-"-"-	mg/m3		0	
		g/s			
CO	-"-"-	mg/m3		101	
		g/s		5,85	
DUST putekļi	gravim.	mg/m3		213	
		g/s		12,33	
V	atom absorbo.	mg/m3	Zem noteikšanas robežas		Less than lowest detection
		g/s			
Pb	-"-"-	mg/m3		0,031	
		g/s		0,0018	
Cr	-"-"-	mg/m3		0,102	
		g/s		0,0059	
Mn	-"-"-	mg/m3		0,046	
		g/s		0,0027	
Fe	-"-"-	mg/m3		3,225	
		g/s		0,1867	
Zn	-"-"	mg/m3		0,118	
		g/s		0,0068	
Ni	-"-"-	mg/m3		0,072	
		g/s		0,0042	
Cu	-"-"	mg/m3		0,022	
		g/s		0,0013	

GAI efektivitāte %

Calcu

Appendix D-10

Fuel Composition Report

Brocni 18 Jan 1995

Heavy Oil From Lithuania.

Mažeikių VNPI "Nafta"

PASAS NR. 85
PASSPORT NO.

Produkto pavadinimas: LABAI SIERINGAS, MAŽAI PELENINGAS, 100 MARKĖS MAZUTAS
Production: HIGHLY SULPHUREOUS, LESS ASHY FUEL OIL 100

Kodas: OKP 0252110208 GOST 10585-75 su 3,4 pakeitimu
Code:

Rezervuaro Nr. 11
Tank No

Rezervuaro lygis 681
Level

Pagaminimo data:
Manufacturing date:

Kokybės rodikliai Property	Norma Norm	Faktiškai In fact
1. Klampumas, esant 80°C, ne didesnis sąlyginis, SK laipsniais relative viscosity, at 80°C, degrees VU, max	16.0	6.6
atitinkantis jam kinematinis, (cST) kinematic viscosity, cST	118.0	48.4
2. Peleningumas, %, ne didesnis Ash, wt.%, not more than	0.05	0.05
3. Mechaninių priemaišų kiekis, %mas., ne didesnis Sediments, wt.%, not more than	1.0	1.0
4. Vandens kiekis, %mas., ne didesnis Water, wt.%, not more than	1.0	pėdsa
5. Vandenyje tirpių rūgščių ir šarmų kiekis Alkali, acid content dissolved in water	nėra is not found	nėra
6. Sieros kiekis, %mas., ne didesnis Sulphur, wt.%, not more than	3.5	2.1
7. Pliūpsnio temperatūra atvirame tiglyje, °C, ne žemesnė Flash point, °C, min	110	111
8. Stingimo temperatūra, °C, ne aukštesnė Pour point, °C, max	25	+16
9. Mažiausia sudegimo šiluma, perskaičiuota sausam kurui (ne brokuota) kJ/kg (kcal/kg), ne mažesnė Net heat of combustion, kJ/kg (kcal/kg), not less than	39900 (9520)	9530
10. Tankis esant 20°C, kg/m3, ne didesnis Density at 20°C, kg/m3, not more than	nenormuojamas no norm	967

STANDARTINIS
GOSTAS
laboratorijos virėjokas

Prekinės laboratorijos viršininkas
Head of laboratory
Vyr. laborantas
Chief laboratory assistant
Pasas išdavimo data: 94.11.05
Date:

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Новокуйбышевский ордена Ленина
нефтеперерабатывающий завод
г. Новокуйбышевск

Цистерна №...

ПАСПОРТ № 1572

Наименование нефтепродукта: Топливо нефтяное мазут топочный 40 ОКП 02 5211 010 7
ГОСТ 10585-75 с изм. № 1, 2, 3, 4 + сернистый в/пар. м/зольн.
Номер резервуара 45 Замер
Дата изготовления продукта 05.06.93г

Наименование показателей	Норма по ГОСТ	Фактически
2. Вязкость при 80°С, не более		
условия, С° ВУ	8,0	2,5-16,2
соответствующая ей кинематическая, (сСТ)	59,0	
4. Зольность, %, не более Мало Зольного	0,04	0,031
Зольного	0,12	
5. Массовая доля механических примесей, %, не более	0,5	0,5гар
6. Масовая доля воды, %, не более (WATER)	1,0	отс
7. Содержание водорастворимых кислот и щелочей	отсутствие	отс
8. Массовая доля серы, не более для мазута (Sulfur cont)		
Низкосернистого	0,5	–
Малосернистого (Low S)	1,0	
Сернистого (Mid S)	2,0	1,11
Высокосернистого (High S)	3,5	–
11. Температура вспышки в открытом тигле в °С, не ниже (Flash point)	90	177
12. Температура застывания в °С, не выше (Solidifie point (Pour))	+10	–
для (High paraffinic S) из высокопарафиновых нефтей, не выше	+25	+18
13. Теплота сгорания низшая в пересчете на сухое топливо (не браковочная), кдж/кг, для малосернистого и сернистого, не менее (Low S)	40740	40740гар
высокосернистого, не менее (high S)	39900	–
14. Плотность при 20°С, кг/м3, не более (density)		925,7

к/заявление-декларация № 5 зарегистрирована ЦСМ 31.05.93г

Стандартный

М. П.

Начальник ОТК Никова

Старший лаборант

Дата выдачи паспорта 05.06.93г

Копия верна: Мариинская

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Appendix D-11

The Use of Alternative Fuel in the Cement Industry

SEMINAR

THE USE OF ALTERNATIVE FUELS IN THE CEMENT INDUSTRY IN LITHUANIA

AKMENES CEMENT PLANT
AKMENE, LITHUANIA
OCTOBER 10, 1994

PRESENTED BY WEC VOLUNTEER CONSULTANTS

FRANK C. STEVENS
AND
FRANKLIN A. PHILLIPS

A TECHNICAL ASSISTANCE PROJECT OF
WORLD ENVIRONMENT CENTER
NEW YORK, N.Y. 10016

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EXECUTIVE SUMMARY

Innovative ideas and new technologies are continually needed to manage hazardous waste. At present, one of the more controversial options in waste management is the burning of hazardous waste in cement kilns. This practice can result in the following benefits:

- energy recovery from combustible wastes with a high energy, low chlorine, and low metals content
- conservation of fossil fuels, such as coal and oil
- reduction in cement production costs
- destruction of hazardous organic waste.

The issues associated with burning hazardous waste in cement kilns are not generally reported in publicly accessible literature. This document has been written as a resource to help answer many of the questions that arise when evaluating this technology.

In presenting a comprehensive overview of the technical and regulatory issues surrounding the use of hazardous waste as a supplemental fuel in cement kilns, this document addresses the following topics:

- the cement production process
- restrictions on the wastes that can be used by the cement industry
- characteristics of a cement kiln that make it a suitable combustion device for the treatment of hazardous waste
- federal regulations that govern cement production facilities burning hazardous waste
- the fate of the constituents in the hazardous waste fuel
- the potential for adverse human health effects.

This analysis concludes that the organic and metal emissions of a well-designed and properly operated cement kiln burning hazardous waste are not substantially different from the emissions of a cement kiln burning only conventional fuel. In addition, the byproduct of the production process (i.e., cement kiln dust) and the final product (i.e., cement) do not appear to differ substantially as a result of burning hazardous waste as a supplemental fuel.

Because no substantial increases in organic and metal components have been observed in emissions, in cement kiln dust, or in cement when hazardous waste is burned as a supplemental fuel, no increases in adverse health effects due to the use of hazardous waste are expected. Assessments of health risks from emissions and cement kiln dust from kilns in the U.S. have supported this conclusion. Thus, properly operated cement production facilities under current (1991) regulations do not pose a greater risk to public health when a portion of the conventional fuel is replaced by hazardous waste.

THE USE OF ALTERNATIVE FUELS IN THE CEMENT INDUSTRY IN LITHUANIA

F.S. 1. THE CEMENT INDUSTRY

Overheads 1-6

F.S. 2. ALTERNATIVE FUELS HISTORY IN CEMENT PLANTS

Overheads 1-3

F.S. 3. TYPES OF WASTE STREAMS AVAILABLE, AND THEIR SOURCES

Overheads 1-8

A. Tires: Municipalities, landfills, neighborhoods, import from U.S.A.

B. Used oil: Vehicle maintenance and service, hydraulic systems

C. Flammable solvents: Line flush material, tank cleaning, off-specification material, adhesive manufacturers, paint and coatings formulators, furniture manufacturing, laboratories, waste ink and printing, solvent still bottoms, rubber cements, marine glues, epoxies

D. Chlorinated solvents: Vapor degreasers, carburetor cleaner, paint remover, laundries, dry cleaning

E. Industrial sludges and filter cakes: Oil refineries, metal plating

F. Contaminated soils: spills, releases, refineries

G. Polychlorinated biphenyl (PCB) containing oil: Transformers and capacitors from electric power equipment

S. 4. BENEFITS OF BURNING WASTE MATERIAL AS FUEL

Overhead 1

A. Savings on fuel costs

B. Conserve coal supply

C. Clean up contaminated areas and waste materials from your facility

D. Help prevent soil contamination by decreasing indiscriminant dumping by waste generators

E. Help prevent aquifer contamination (ground water and water wells)

F. Help prevent air pollution from evaporating liquids

P. 5. CONTROLLED VS. UNCONTROLLED CLINKERING PROCESS

Overheads 1-3

A. Elevated temperature plus mixing action and residence time

B. Large heat mass in the clinker in kiln

C. Limit the percent of excess oxygen to 1-2%

D. Use continuous kiln emission monitoring instruments

E. Process analyzer

F. Process control computers for kiln operation

G. Automated controls

P. 6. COMBUSTION PRODUCTS AND CLINKERING ACTION

Overheads 1-3

A. $CaO + Al_2O_3 + Fe_2O_3 + SiO_2 \longrightarrow$ Cement compounds

B. Organic hydrocarbons $+ O_2 \longrightarrow CO_2 + H_2O$

C. Organics containing nitrogen $\longrightarrow NO_x$

D. Organics containing sulfur $\longrightarrow$ SO_x

E. Organics containing halogens $\longrightarrow$ HCl , However, there are no HCl vapors emitted from cement kilns since they are absorbed by the alkali atmosphere in the kiln.

F. Organics containing metals

Metals + O_2 + SiO_2 $\longrightarrow$ metal silicates

Toxic metals are lost in the large mass of produced clinker

F.P. 7. REQUIREMENTS FOR USING ALTERNATIVE FUELS

A. Destruction and removal efficiency (DRE) of 99.99% for RCRA hazardous wastes

B. Demonstrate 99.99% DRE while burning principal organic hazardous constituents (POHCs)

C. Particulate matter emissions are limited to 0.08 Gr/DSCF, corrected to 7% oxygen

F.P. 8. PUBLIC RELATIONS

Overheads 1-2

F.P. 9. AGREEMENTS WITH GOVERNMENT, SUPPLIERS, AND TRANSPORTERS

Overhead 1

F.S. 10. SAFE TRANSPORTATION

A. Trucks are properly designed, inspected, and maintained

B. Drivers are trained in hazardous materials

C. Drivers are trained in spill and fire response

F.P. 11. PROTECTION OF EMPLOYEES

A. Proper personal protective equipment is worn whenever needed: Splash protection, eye protection, hand protection

B. A respiratory protection program is developed and implemented at the plant

P. 12. PREQUALIFICATION OF WASTE SUPPLIERS AND THEIR WASTE STREAMS

A. Obtain a representative sample of the waste stream from the prospective supplier

B. Analyze the waste stream for standard parameters:

1. Specific gravity

2. pH

3. Thermal energy content (KCal/kgm, or BTU/lb)

4. Water content

5. Halogen content

6. Toxic metals content

Perform an extractable metals analysis to determine if the waste stream is regulated as a hazardous waste or not. An extractable metals analysis is also performed on the kiln dust occasionally to verify that toxic metals are not being emitted from the stack

Perform a total metals analysis to determine the metals (waste stream) feed rate into the kiln

C. Sample and analyze the blended waste stream prior to feeding it into the kiln

S. 13. PLANT FACILITIES MODIFICATIONS FOR USING ALTERNATIVE FUELS

Overheads 1-2

S. 14. CONTROL OF CEMENT QUALITY DURING WASTE BURNING

S. 15. AIR EMISSIONS AND CONTROL DURING BURNING

A. Accomplished through continuous emission monitoring (CEM) data to help control combustion conditions

P. 16. HEALTH AND SAFETY OF ALL PLANT WORKERS

A. Establish safe working conditions

B. Train workers in the principles of safe work practices

F.P. 17. HEALTH AND SAFETY OF ALTERNATIVE FUELS HANDLERS

A. Training of waste fuel site workers

1. Principles of safety applied to unloading. storing, transferring, and injecting into the kiln

2. Hazardous characteristics of wastes:

Ignitability

Corrosivity

Reactvitiy

Toxicity

B. Training of the emergency response team members

1. Spill response principles, techniques and equipment

2. Fire response principles, techniques, and equipment

C. Secondary containment requirements for storage areas and material off-loading areas

D. Site security for waste storage and handling areas

E. Preparedness and Prevention Plans and required safety equipment

F. Contingency Plans for hazardous wastes incidents

F.S. 18. IMPORT AGREEMENTS

F.S. 19. TIME FRAME TO IMPLEMENT WASTE PROGRAMS

F.S. 20. INITIAL CAPITAL INVESTMENTS REQUIRED

A. Engineering

B. Purchasing

C. Construction

D. Training

F.S. 21. SUMMARY

CEMENT INDUSTRY

- Manufacturing is energy intensive
  - Electricity used for operating process equipment and controls
  - Fuels used for firing cement kilns
  - Cost of energy 60 to 70 per cent of manufacturing cost

Table 1	Cement Industry Energy Efficiency
Table 1.1	Average Energy Intensities of Building Materials
Table 1.2	Comparison of Energy Intensities in End Products
Table 2.1	Energy Consumption by Manufacturing steps
Table 3.1	Comparative Thermal Energy Consumption in Various Pyroprocessing systems
Table 3.2	Comparative Features of Different Cement Producing Technologies
Diagram 1	Dry and Wet Process Flows
Diagram 2	Precalciner Process Flow

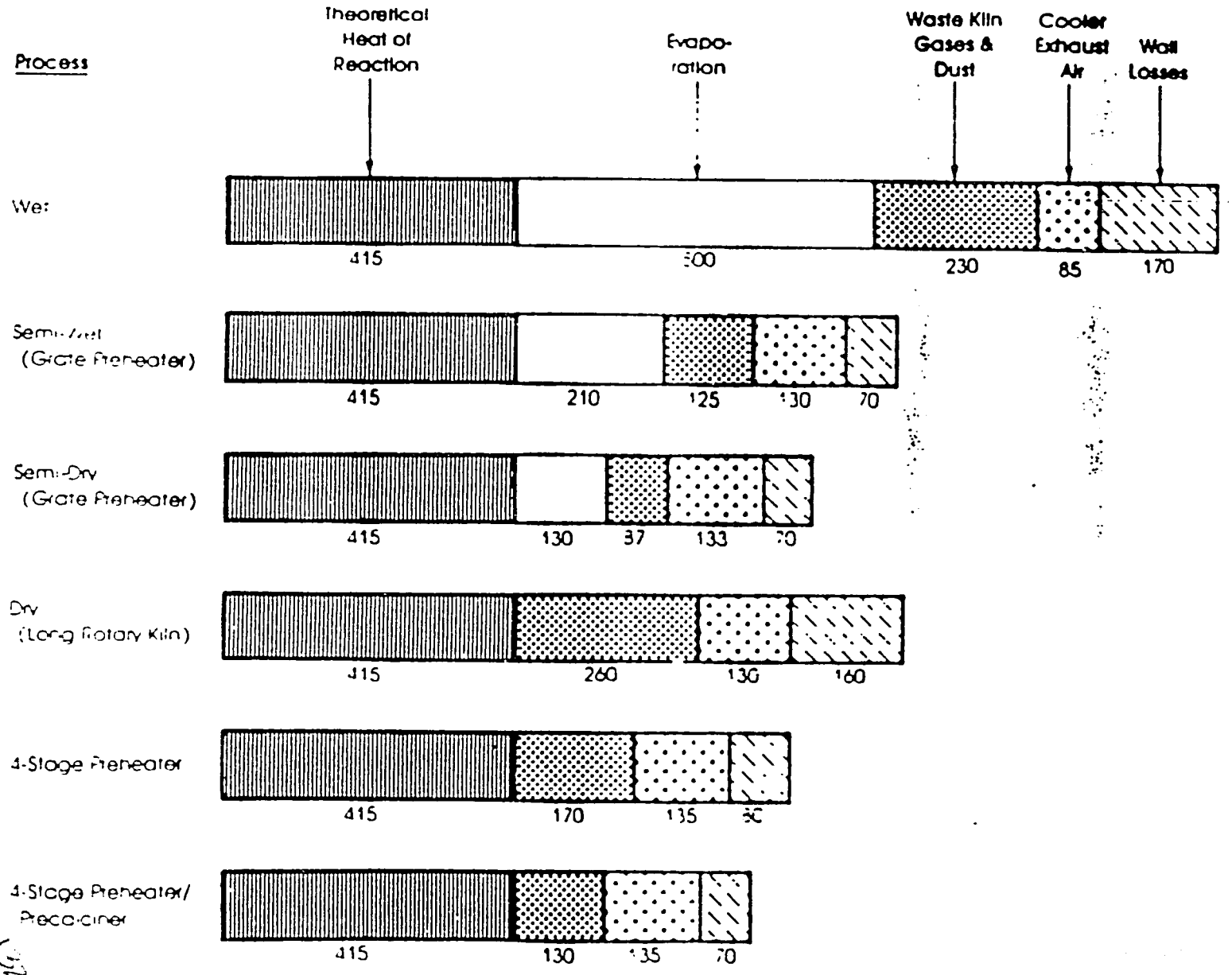
- Fuel Costs are Expensive
  - Fuel for cement kilns
  - Fuel for electric power generating plants
  - Cogeneration plants using process heat

- Use of energy is 1000 to 2000 megacalories per ton of cement

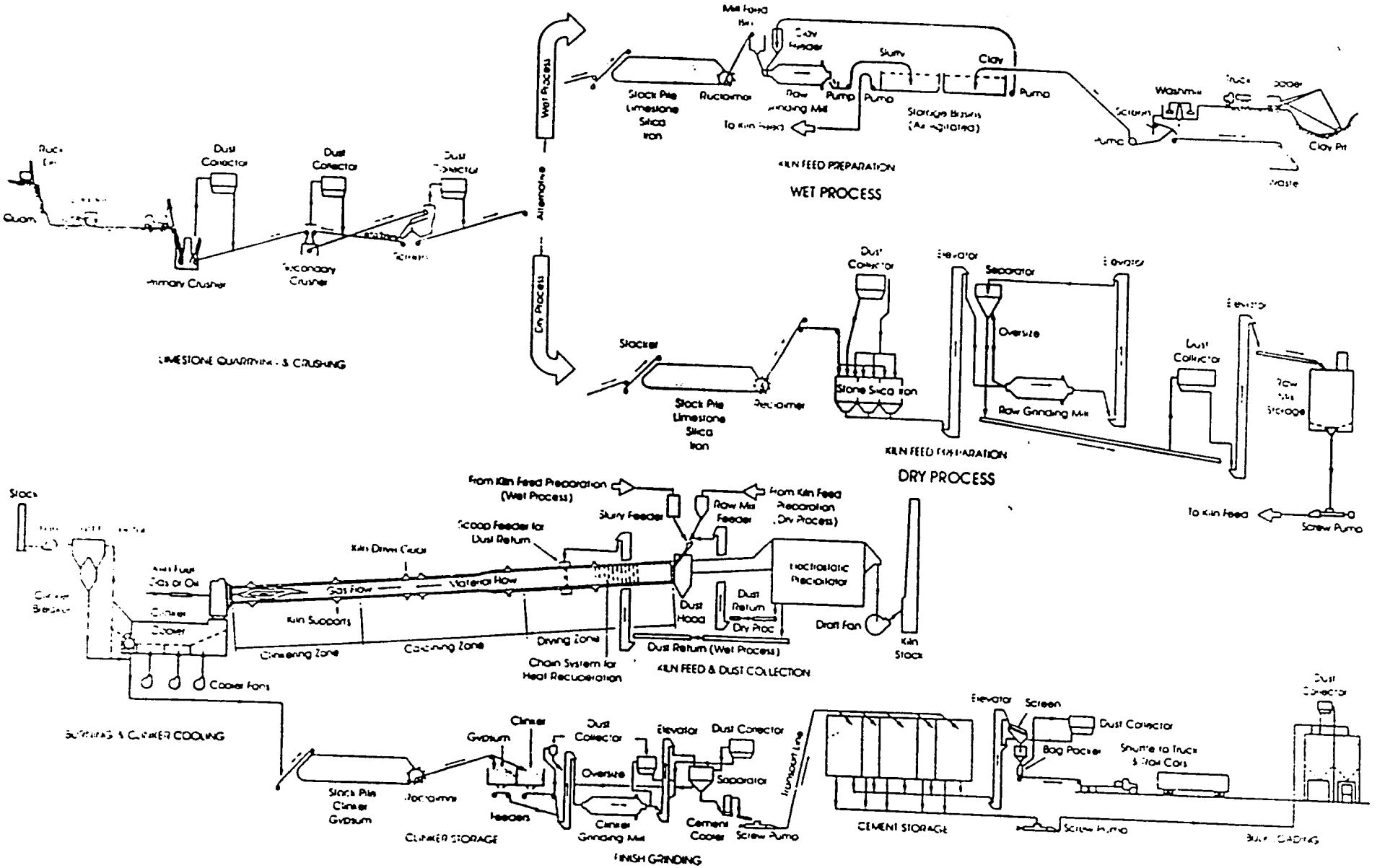
  - Electricity 90 to 140 kWh / ton cement

  - Fuel 800 to 1500 kcal/kg clinker

Comparative Thermal Energy Consumption in Various Pyroprocessing Systems (kcals/kg of clinker)



Dry and Wet Process Flows



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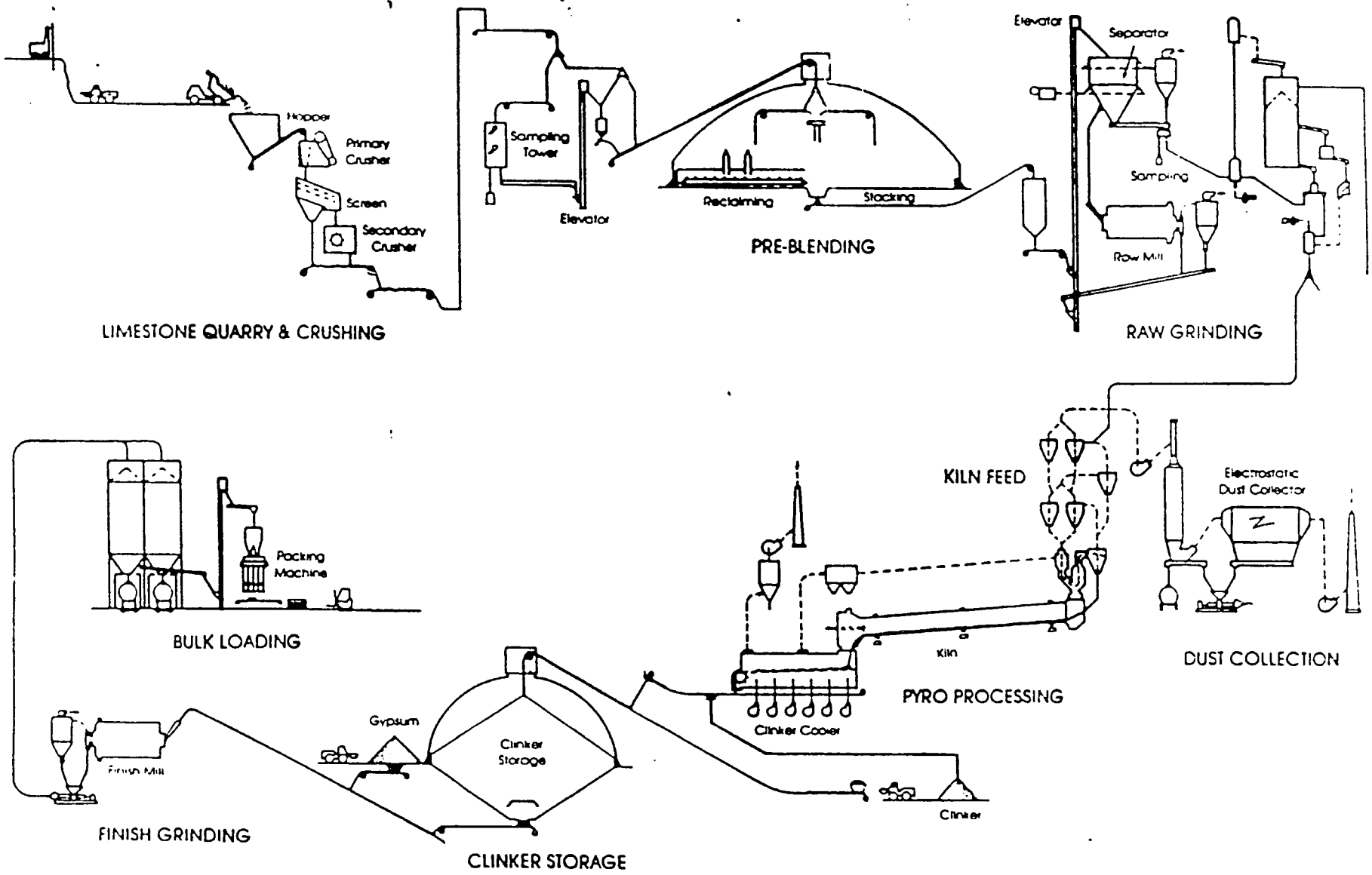
Precalciner Process Flow



ALTERNATIVES FUELS HISTORY IN CEMENT PLANTS

- Year 1973. OPEC Nations. High Fuel Costs
- Change to alternative fuels
  - Types and sources, typical history
  - Specifications - Chart
- Operating history of cement kilns, chart
- Updates on cement kilns using alternative fuels
- Definition of alternative fuels picture
  - Ignitability
  - Corrosivity
  - Reactivity
  - Toxicity
- Described as hazardous only if the alternative fuel exhibits one or more of the characteristics

- World Wide Usage by Many Cement Companies:
  - Holderbank
  - Lafarge Copee
  - Italcement and Ciments Français
  - Cementos Mexicanos
  - Blue Circle
  - CBR and Heidelburg
  - Ask Grove
  - Unincem and River Cement
  - Scancen and Continental Cement
  - Onada Cement and other Asian Countries
- Alternative fuels include organic liquids, sludges and solids. Rubber tires usage in cement kilns is expanding

Summary:

- Use of hazardous wastes as fuel substitutes in cement kilns is a "fundamentally sound" technology
- Preferred alternatives to incineration
- Long residence times and high temperatures in cement kilns maximing combustion efficiencies. At hottest point 99.9999 to efficiency
- Available data on cement kilns very complete
- Produces quality product not harmful to health of public and environment

USE OF TIRES AS AN ALTERNATIVE FUEL

1. USED IN :

- CEMENT KILNS
- PULP AND PAPER MILLS
- ELECTRIC UTILITIES
- DEDICATED TIRE TO ENERGY FACILITIES
- ENVIRONMENTALLY ACCEPTABLE
- ECONOMICALLY FEASABLE

II. SCRAP TIRES ARE RESOURCE

- BETTER HEAT CONTENT THAN COAL
- LOWER NITROGEN AND SULFUR CONTENT
- LOWER GAS EMISSIONS

III. TIRE CHARACTERISTICS

- PHYSICAL, CHEMICAL

IV. COMBUSTION PROCESS IN CEMENT KILN

- SHREDDED OR WHOLE
- AIR QUALITY

V. CEMENT KILN USAGE

- U.S
- EUROPA
- ASIA
- MOROCCO AND OTHER COUNTRIES

VI. AVAILABILITY FOR EXPORT TO [redacted] THE BALTIC STATES

CEMENT FACILITIES WHICH HAVE TEST–BURNED OR ARE BURNING TIRES

MPANY NAME	PLT/MILL	CITY	STATE	APPX. SIZE TIRE BURNED
ona Portland Cement Co.	Rillito	Rillito	Arizona	2" X 2"
Grove Cement West, Inc.	Durkee	Durkee	Oregon	2", wire free
e Circle, Inc	Atlanta	Atlanta	Georgia	
Crow Cement Co.	Boxcrow	Midlothian	Texas	2" X 6"
lfornia Portland Cement	Mojave	Mojave	California	2.5" X 2.5"
R Cement–Calaveras Cement Co.	Redding	Redding	California	shredded
ndee Cement		Dundee	Michigan	
roc Materials, Inc.		Nazareth	Pennsylvania	
rida Crushed Stone Co.		Leesburg	Florida	
nt Resource Recovery		Harleyville	South Carolina	
ord Hill Cement Co		Harleyville	South Carolina	whole
ord Hill Cement Co.		Midlothian	Texas	
LNAM, Inc.	Main office	Dundee	Michigan	
LNAM, Inc. for Ideal Basic Ind., Inc.		Dundee	Michigan	2" X 2"
al Cement		Seattle	Washington	2", wire free
ois Cement Co.		LaSalle	Illinois	
mos Cement Co.		Kosmosdale	Kentucky	shredded
Farge Corp.	Main ofc.	Dallas	Texas	
Farge Corp.	Balcones	New Braunfels	Texas	2", wire free
High Portland Cement Co.		Allentown	Pennsylvania	
dusa Cement		Charlevoix	Michigan	
dusa Cement Co.		Cleveland	Ohio	
dusa Concrete		Clinchfield	Georgia	
march Cement Co		Humboldt	Kansas	
Marys Peerless Cement		Detroit	Michigan	
ver Cement Co.	Selma	Festus	Missouri	
MC Lone Star		Davenport	California	
anoke Cement Co.		Roanoke	Virginia	whole
uthdown, Inc. (Southwestern)	Lyons	Lyons	Colorado	3" x 3"
uthwestern Portland Cement Co.		Fairborn	Ohio	whole–36"
REIGN FACILITIES:				
idelberger Cement Plant			W. Germany	
ue Circle Dry Process Cement Works		Hope	England	whole
mitomo Cement Co.			Japan	
ada Cement Co.			Japan	
ichibu Cement Co.			Japan	
aka Cement Co.			Japan	

May 3, 1991

ANALYSES OF VARIOUS TIRES

TIRE TYPE	SOURCE	ENERGY CONTENT (BTU/LB)	COMPONENTS, PERCENT BY WEIGHT						
			MOISTURE	ASH	SULFUR	CARBON	HYDROGEN	NITROGEN	OXYGEN
FIBERGLASS	POPE, 1991	13,974	0.00	11.70	1.29	75.80	6.62	0.20	4.39
STEEL-BELTED	POPE, 1991	11,478	0.00	25.20	0.91	64.20	5.00	0.10	4.40
NYLON	POPE, 1991	14,908	0.00	7.20	1.51	78.90	6.97	< 0.10	5.42
POLYESTER	POPE, 1991	14,752	0.00	6.50	1.20	83.50	7.08	< 0.10	1.72
KEVLAR-BELTED	POPE, 1991	16,870	0.00	2.50	1.49	86.50	7.35	< 0.10	2.11
UNSPECIFIED TIRE	HALEY, 1984	16,146	0.00	1.50	1.80	89.20	7.30	0.20	NR
UNSPECIFIED TIRE	RYAN, 1989	15,550	0.50	5.70	1.20	83.20	7.10	0.30	2.50

NR - NOT REPORTED

May 3, 1991

TYPICAL COMBUSTIBLE WASTES

- Halogenated solvents (e.g., tetrachoroethylene)
- Non-halogenated solvents and the still bottoms from the recovery of such solvents (e.g., acetone, benzene, MIBK, cresols, toluene, isobutanol, etc.)
- Distillation bottom tars from the production of phenol/acetone from cumene
- Slop oil emulsions, tank bottoms, and sludges from the petroleum refining industry
- Distillation bottoms from the production of chlorobenzenes, trichloroethane, etc.
- Used or contaminated organics (e.g., aldehydes, alcohols, aromatics, cutting oils, lubricating oils, engine oils, lacquers, varnishes, etc.)
- Herbicides, pesticides, and insecticides
- Gasoline, kerosene, diesel, fuel, oil sludges, and API wastes
- Light fractions of petroleum refinery products contaminated with water, dirt, and organic wastes
- Pulverized plastics from the packaging industry
- Carbon black and activated carbon

Examples of Hazardous Waste Generated by Businesses and Industries

Waste Generators	Waste Type
Chemical Manufacturers	Strong Acids and Bases Spent Solvents Reactive Wastes
Vehicle Maintenance Shops	Heavy Metal Paint Wastes Ignitable Wastes Used Lead Acid Batteries Spent Solvents
Printing Industry	Heavy Metal Solutions Waste Inks Spent Solvents Spent Electroplating Wastes Ink Sludges Containing Heavy Metals
Leather Products Manufacturing	Waste Toluene and Benzene
Paper Industry	Paint Wastes Containing Heavy Metals Ignitable Solvents Strong Acids and Bases
Construction Industry	Ignitable Paint Wastes Spent Solvents Strong Acids and Bases
Cleaning Agents and Cosmetics Manufacturing	Heavy Metal Dusts Ignitable Wastes Flammable Solvents Strong Acids and Bases
Furniture and Wood Manufacturing and Refinishing	Ignitable Wastes Spent Solvents
Metal Manufacturing	Paint Wastes Containing Heavy Metals Strong Acids and Bases Cyanide Wastes Sludges Containing Heavy Metals

SPECIFICATIONS OF SUPPLEMENTAL FUEL[1]

Heat Content	8,000 Btu/lb. minimum (5,000 Btu/lb. with supplemental fuel) 12,000 Btu/lb. preferred
Viscosity	Less than 3,000 centipoise
Odor	Characteristic of solvents Reference ASTM 1296-69
Suspended Solids[2]	30% maximum
Sulfur	3% maximum
Nitrogen	1% maximum
Halogens	10% maximum (normally 2 - 4%)
Inorganic Acids & Bases	Extractable pH of 4 - 11
Water	20% maximum (10% as separated phase)

SPECIFICATIONS OF SUPPLEMENTAL FUEL[1]

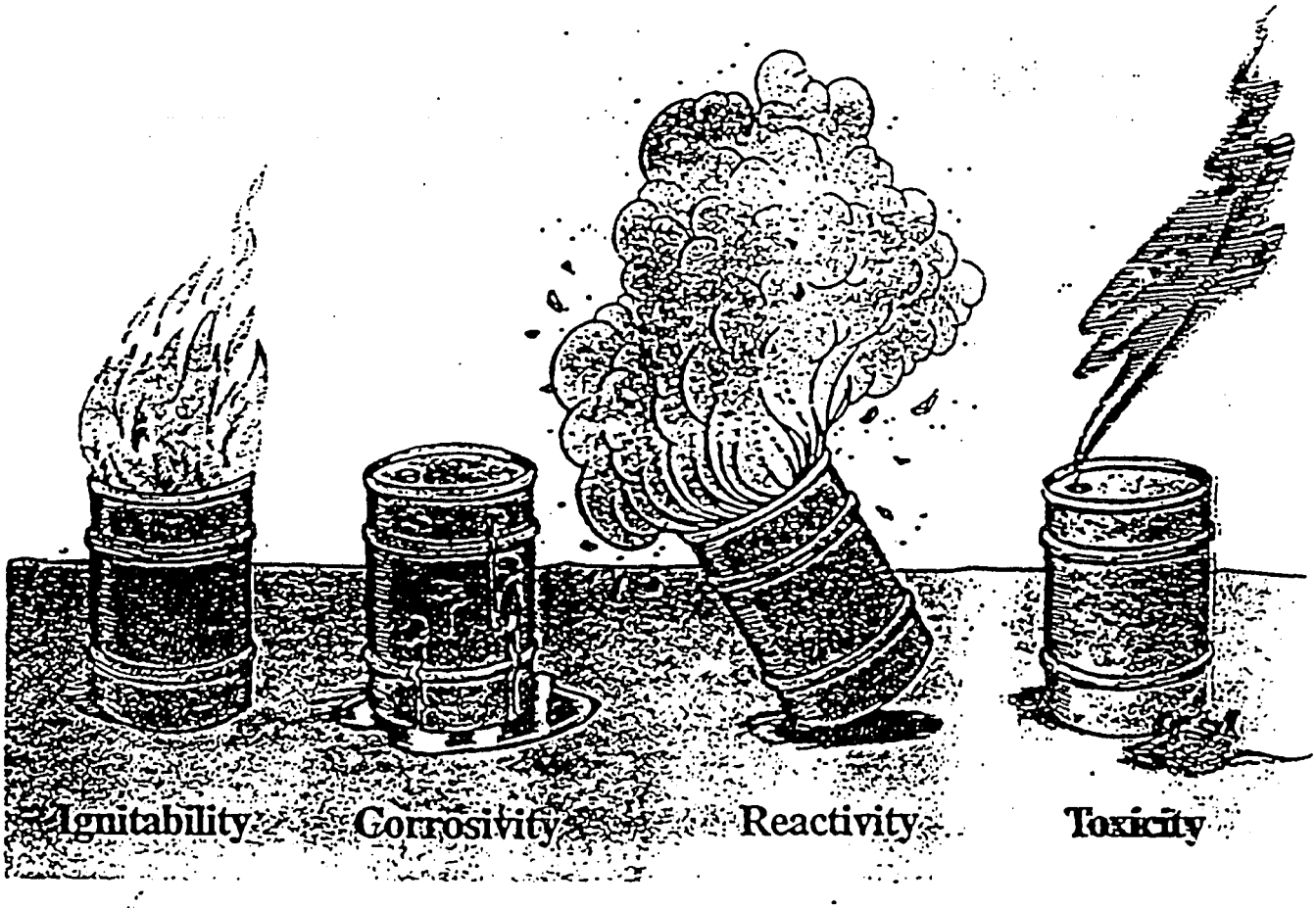
(continued)

Ash content	30% maximum	
Heavy Metals (barium, chromium, lead, zinc)	Barium	1,000 ppm
	Cadmium	300 ppm
	Chromium, total	2,000 ppm
	Lead	750 ppm
	Mercury	1.0 ppm
	Zinc	3,000 ppm
	Beryllium	0.4 ppm
	Silver	5.0 ppm
	Arsenic	5.0 ppm
	Selenium	1.0 ppm
PCB	Less than 50 ppm	
Benzene	Exclusion Level maximum 3	

1. All standards contained in this schedule are subject to change in the light of regulatory requirements.

2. Materials otherwise meeting the requirements for Acceptable Materials under this Agreement will be deemed to be Acceptable Materials with regard to size or particulates and solids if they have been pre-screened by a screening device, owned and maintained by Continental Cement and located at the plant, which has screening holes no larger than 1/8" in diameter.

3. In the absence of an Exclusion Level for Benzene, the maximum level shall be 0.5%.



A waste is hazardous if it exhibits any of these four characteristics.

- Reduction of energy usage and cost
  - Better housekeeping and pollution controls
  - Preventive maintenace and production procedures
  - Operations improvements
  - Personnel training and supervision
  - Improved monitoring and controls
    - Control room automation
    - Laboratory automation
  - Capital investments for modifications to existing plant and equipment
  - Capital investments (large) for more energy efficient processing and equipment
  - Use of blended cements with slag, fly and/or pozzolan
  - Use of lower cost alternative fuels instead of coal, oil, and/or gas.

CONTROLLED VERSUS UNCONTROLLED CLINKERING WITH ALTERNATIVE FUELS

- Has to be controlled
  - High temperatures
  - Mixing and long gas residence time
  - Heat mass 900°C to 1500°C
  - Excess air, to 2 per cent oxygen
  - Sufficient burning zone temperatures for good quality clinker, with less than 2% Free lime
  - Continuous emission monitors for O2, CO, SOx NOx, NH4CL, H2O, CO2 and THC

- Controls include
  - Process control computers
  - Quality control laboratory
  - Microscopie analyses
  - Manufacture quality controlled and acceptable clinker and cement all the time
- Results
  - Good quality clinker
  - Better production
  - Lower operating costs
  - Longer refractory life
  - Lower fuel usage and costs

Data pertinent to incineration of chemical wastes

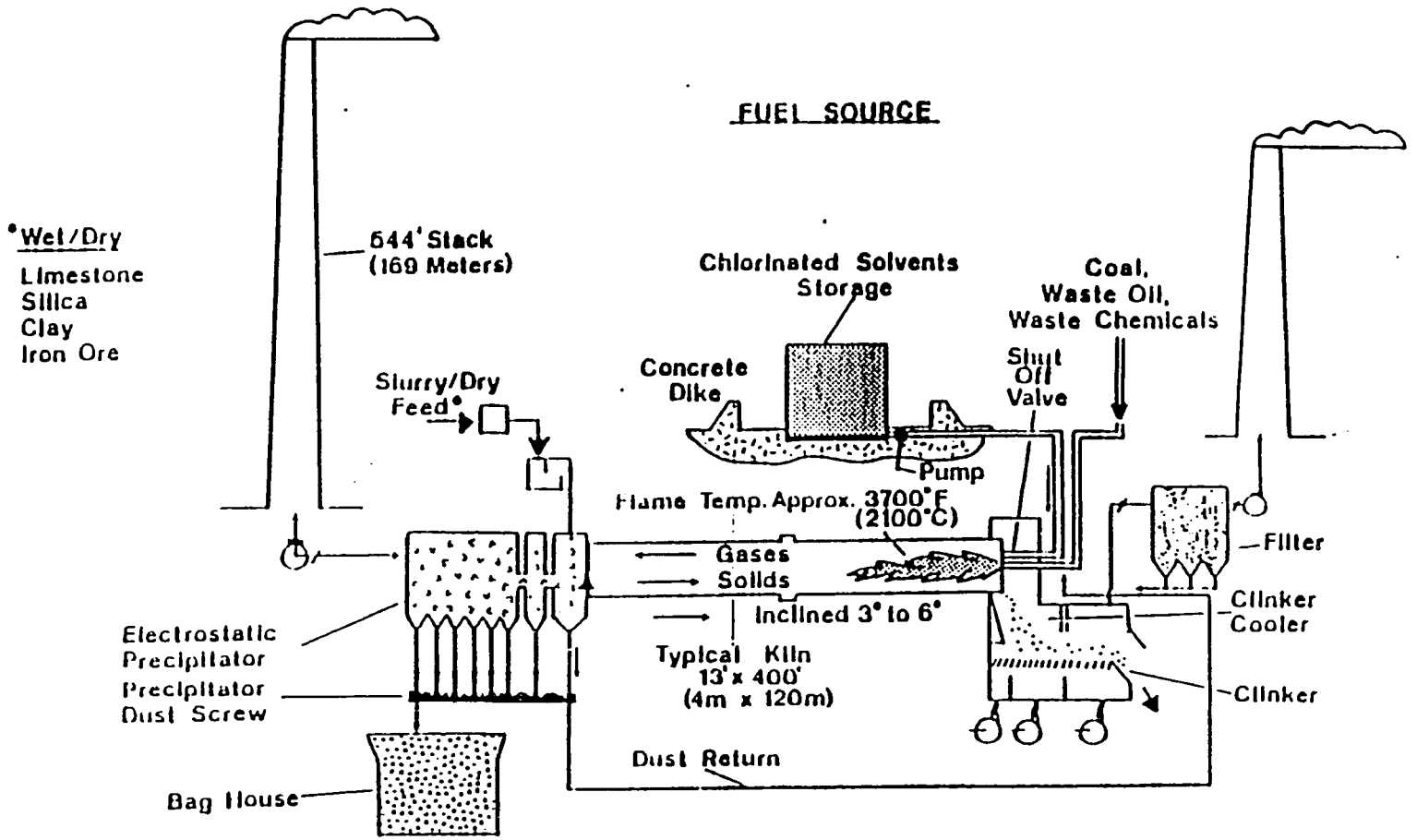
Critical waste incineration parameters	Physical and chemical properties
Ultimate analysis	C, H, O, N, S, ash, and moisture
Metals	Ca, Na, K, Cu, V, Ni, Fe, Pb, Hg, Cr, Cd, As, etc.
Halogens	Chlorides, bromides, fluorides
Heating value	Btu/lb or cal/gram
Solids	Size, form, and quantity to be received
Liquids	Viscosity, specific gravity and impurities, H_2O
Gases	Density and impurities
Organic portion	Percent total organic carbon
Special characteristics	Corrosiveness, reactivity, flammability
Toxicity	TLV (Toxic Limit Value), carcinogenicity, aquatic toxicity, etc.

Sources: Lauber (1982).
Branscome et al. (1985).

COMBUSTION, PRODUCTS AND CLINKERING ACTION

High temperatures, long residence times, excess oxygen, 1 to 2 per cent, mixing action, and excess heat mass yields complete organic and metal destruction

- Organic hydrocarbons ⟶ CO_2 + H_2O
- Nitrogen in organics ⟶ NO_x
- Sulfur in organics ⟶ SO_x
  (Note: Less than 0.5 % S in most waste fuels)
- Halogens in organics ⟶ HCl
  + Ca, Na and K in cement
  Yield $CaCl_2$, NaCl and KCl
- Metals in organics ⟶ Metal silicates
  as part of C_3S, C_2S, C_3A and C_4AF
- Plastics and other organic products ⟶ CO_2



Schematic drawing of a typical cement kiln (Source: Lauber 1982. Reprinted by permission of the publisher.)

PUBLIC RELATIONS

- Cement plant must be neighbor friendly
- Good housekeeping, neat and green appearance, minimum fugitive, dust and clean stack emissions
- Must answer immediatly concerns of employees, neighbors, customers, share-holders and government officials
- Plant must have acceptances of alternatives fuels program before, during, and after start of program
- Criteria are what the public perceives, sees, hears, understands and believes
- Company must tell, explain, show and demonstrate credibility

- Right of refusal must be obtained by cement plant if alternative fuel does not meet chemical and physical test requirements
- Generator, supplier, blender, and transporter must retain full ownership and responsibility of alternative fuel until sampled, tested, and accepted by cement plant
- Generator, supplier, blender and transporter must have financial responsibility and insurances to handle their responsibilities in cases of misrepresentation, accident, liability and/or contamination
- Testing by generators, suppliers, and transporters must be performed by accredited and qualified personnel and laboratories

AGREEMENTS WITH GOVERNMENTS, GENERATORS, SUPPLIERS, AND TRANSPORTERS

- Must be excellent legal document giving full protection to the cement plant
- Terms and conditions must give the cement plant flexibility to meet changing requirements in plant operations, government restrictions, quantities, and revenues
- Full insurance coverage must be obtained to protect plant and personnel against fire hazards accidents and other liabilities

PLANT FACILITIES

- Unloading alternative fuels at plant
  - Concrete pad and containment area
  - Sampling station
  - Fire protection
  - Venting of vapors to thermal oxydizer, kiln burner, or carbon canisters
  - Covering
  - Filters, pumps, and unloading equipment
  - Use of containers from suppliers and generators
- Laboratory
  - Complete, testing equipment and trained personnel
  - Audit and control of sampling testing and storage of alternative fuel samples, kiln feed samples, clinker samples and cement samples

- Fire and safety protection
  - Adequate fire fighting equipment, water storage, foam generators and fire extinguishers
  - Trained personnel in alternative fuels facility and plant
  - Safety equipment, protective clothing and trained personnel
- Processing and blending
  - Liquids and sludges. Filters, screens, schredders, grinders, and conveying facilities, storage tanks, venting
  - Solids Unloading equipment, conveying, screening, shredding, Vented storage buildings
  - Blending for alternative fuels
  - Volumetric metering and controls for liquids and sludges
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  - Fail safe controls for alternatives fuels and kiln systems
  - Cut-off alternatives fuels when kiln operating parameters are not met
  - Operating procedures and combustion controls

Appendix D-12

Air Emissions Associated with the combustion of Scrap Tires for Energy Recovery

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OHIO AIR QUALITY
DEVELOPMENT AUTHORITY

AIR EMISSIONS ASSOCIATED WITH THE COMBUSTION OF SCRAP TIRES FOR ENERGY RECOVERY

MALCOLM PIRNIE, INC.
6161 Busch Blvd.
Columbus, Ohio 43229

May, 1991

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OHIO AIR QUALITY DEVELOPMENT AUTHORITY
AIR EMISSIONS ASSOCIATED WITH THE
COMBUSTION OF SCRAP TIRES FOR ENERGY RECOVERY

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ACRONYMS AND ABBREVIATIONS (Continued)

Acronym	Term
km	Kilometer
lb	Pound
m	Meter
M	Million
Mn	Manganese
MW	Megawatt
N_2	Nitrogen
ng	Nanogram, one-billionth of a gram ($1x10^{-9}$ g)
ng/dscm	Nanograms per dry standards cubic meter
NH_3	Ammonia
Ni	Nickel
NIOSH	National Institute for Occupational Safety and Health
NO	Nitric Oxide
NO_x	Nitrogen Oxides
O_2	Oxygen
OEPA	Ohio Environmental Protection Agency
PAH, PNA	Polynuclear Aromatic Hydrocarbons
Pb	Lead
PCB	Polychlorinated Biphenyls
PCDD	Polychlorinated Dibenzo (p) Dioxins
PCDF	Polychlorinated Dibenzofurans
PM	Particulate Matter
PM-10	Particulate Matter with an aerodynamic diameter less than 10 microns
ppb	Parts per billion
ppm	Parts per million
ppmdv	Parts per million in dry volume
ppmv	Parts per million on a volume basis
psig	Pounds per square inch - gauge
RCRA	Resource Conservation and Recovery Act
RDF	Refuse-Derived Fuel
Sn	Tin
SNCR	Selective Noncatalytic Reduction
SO_2	Sulfur Dioxide
SO_3	Sulfur Trioxide
sq. in.	Square Inch
SWMP	Solid Waste Management Plan
TCDD	All isomers of tetrachlorodibenzo-p-dioxin
TCLP	Toxicity Characteristic Leaching Procedure
TDF	Tire-Derived Fuel, exclusive of whole tires

ACRONYMS AND ABBREVIATIONS

Acronym	Term
ACFM	Actual Cubic Feet Per Minute
As	Arsenic
B(a)P	Benzo-a-pyrene
BACT	Best Available Control Technology
Be	Beryllium
Btu	British Thermal Unit
°C	Degrees Celsius
CAA	Clean Air Act
$CACO_3$	Limestone (Calcium Carbonate)
$CaSO_3$	Calcium Sulfite
$CaSO_4$	Calcium Sulfate
Cd	Cadmium
CEM	Continuous Emission Monitoring
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Cr	Chromium
Cu	Copper
DNR	Department of Natural Resources
EPRI	Electric Power Research Institute
ESP	Electrostatic Precipitator
°F	Degrees Fahrenheit
ft	Feet
FGD	Flue Gas Desulfurization
g	Gram
gr/dscf	Grains Per Dry Standard Cubic Foot
H	Hydrogen
HB	House Bill
HCl	Hydrogen Chloride
HF	Hydrogen Fluoride
Hg	Mercury
HHV	Higher Heating Value
H_2O	Water
H_2SO_4	Sulfuric Acid
hr	Hour
kcal	Kilocalorie
kg	Kilogram

ACRONYMS AND ABBREVIATIONS (Continued)

Acronym	Term
THC	Total Hydrocarbons
TPD	Tons Per Day
TPY	Tons Per Year
TSP	Total Suspended Particulate Matter
TWA	Time-Weighted Average
ug	Microgram, one-millionth of a gram ($1x10^{-6}$ g)
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
ug/m^3	Micrograms per cubic meter
VOC	Volatile Organic Compounds
yr	Year
Zn	Zinc
ZnO	Zinc Oxide

GLOSSARY AND DEFINITION OF TERMS

Ash Residue:

A mixture of bottom ash and fly ash.

Baghouse:

Air pollution control equipment used for removing particulates from the flue gas stream by means of filtration through tubular fabric filters (bags).

Bottom Ash:

Ash and unburned material remaining on grates (stoker) after the waste is combusted in the furnace.

Dry Scrubber:

Air pollution control equipment that injects a lime slurry into a flue gas stream containing acid gases, producing a neutralized dry residue that can then be removed by a particulate control device. They are also commonly called spray dryer absorbers.

Electrostatic Precipitator:

An air pollution control device which removes particulates from the flue gas stream by charging the particulates and collecting these particles on an oppositely charged plate. The particulates are then removed from the plate by a mechanical rapper and collected as fly ash for disposal.

Flue Gas Desulfurization:

The operation of removing sulfur oxides from exhaust gas streams of a boiler or industrial process.

Fly Ash:

Airborne combustion residue collected in the steam generator economizer, dry scrubber and the fabric filter system. This includes excess lime and acid gas reaction products.

PCDD:

Short for polyclorinated dibenzo-p-dioxins (dioxins), a family of chemical compounds whose molecular structure consists of three rings, two of which are benzene rings connected by a pair of oxygen atoms, with from one to eight chlorine atoms attached to the benzene rings in any of 75 different combinations (isomers) in a number of groups (homologs).

Homolog defines a group of isomers with the same number of chlorine atoms. Homolog nomenclature is as follows:

T_4CDD	tetrachlorodibenzo(p)dioxin containing four chlorine atoms
P_5CDD	pentachlorodibenzo(p)dioxin containing five chlorine atoms
H_6CDD	hexachlorodibenzo(p)dioxin containing six chlorine atoms
H_7CDD	heptachlorodibenzo(p)dioxin containing seven chlorine atoms
O_8CDD	octachlorodibenzo(p)dioxin containing eight chlorine atoms

An isomer is defined by the arrangement of chlorine atoms within the homolog. Isomer nomenclature is as follows:

2,3,7,8-T_4CDD: 2,3,7,8-Tetrachlorodibenzo(p)dioxin, that is, an isomer with a chlorine atom at the 2,3,7, and 8 lateral ring positions

PCDF:

Short for polychlorinated dibenzofurans (PCDFs) (furans), a family of 135 possible isomers that are structurally similar to the dioxins, containing two benzene rings attached to a central furan ring. The PCDF nomenclature is as described under dioxins.

PM-10:

Particulate matter including only those particles with aerodynamic diameters less than or equal to a nominal 10 micrometers and representing that fraction of total suspended particulates (TSP) available for bio-uptake and retention via inhalation.

Polynuclear Aromatic Hydrocarbons (PAH, PNA):

A group of chemicals that may be formed during the incomplete combustion of coal, oil and gas, garbage, or other organic substances. PAHs can be derived from both man-made and natural sources. The structure of PAH compounds are based on multiple benzene rings. The compounds range in complexity from naphthalene, consisting of two benzene rings, to benzo(a)pyrene, consisting of five benzene rings. Naphthalene is the lightest of the PAHs and is one of the lease toxic, whereas benzo(a)pyrene is one of the heaviest PAHs and is the most hazardous. Benzo(a)pyrene is a known carcinogen.

Solid Waste Management:

The systematic administration of activities which provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of solid waste.

Ton:

A "short ton" equal to 2,000 pounds.

Waste Management:

The total process of the collection of waste at its point of generation, transportation, treatment and final disposal in an acceptable manner.

EXECUTIVE SUMMARY

An estimated 2 to 3 billion scrap tires are presently stockpiled in numerous locations around the United States, and at least 170 million tires are added to these storage piles or landfilled each year. As more scrap tires are added to unregulated dumpsites, they present a solid waste management problem. Scrap tires create potential fire hazards as they accumulate in stockpiles, as well as contributing to environmental, public health, and safety problems. Legislation governing scrap tire disposal has been enacted in over half of the states to regulate/ban landfilling of tires.

A number of technically feasible alternatives exist to utilize scrap tires other than landfilling or stockpiling. In particular, scrap tires have an attractive heat content, and as a result, are a potential energy resource. Tires generally have more heat energy by weight than coal and have the highest heating value per pound of any potential waste fuels of interest today. In addition, combusting tires or tire-derived fuel (TDF) is relatively inexpensive compared to coal.

Under the appropriate operating conditions, feed rates and pollution control equipment configurations, scrap tires have a significant potential as a supplemental or dedicated fuel source. Four types of combustion facilities which can substantially decrease the number of tires disposed in landfills and stockpiles are cement kilns, pulp and paper mills, electric utilities, and dedicated tire-to-energy facilities. Although published air emissions data regarding the combustion of scrap tires are limited, compared to the available literature for municipal wastes, biomass, and coal combustion, these four combustion sources have the potential to be operated in an environmentally acceptable and economically sound manner.

This report presents a compilation of available air emissions data from sources which combusted scrap tires as a fuel source. Air pollution control equipment requirements and air emissions testing protocols vary from state to state, resulting in a wide range in reported emissions. Although this air emissions data base is limited, enough information is available to suggest that scrap tires for energy recovery be explored as a possible solution to the scrap tire management problem.

As a result of reviewing the available literature of air emission data associated with the combustion of scrap tires for energy recovery, several conclusions are possible:

1. Scrap tires should be considered a resource rather than a waste material;
2. Scrap tires in either a shredded, chipped, or whole condition have been combusted in an environmentally sound manner; and
3. Scrap tires have a significant heat content, and under controlled conditions this heat can be extracted for a beneficial use.

Several other issues, however, must be addressed concerning the use of scrap tires for heat recovery. These include the issues of chipping or shredding technology reliability, regulatory review, uniformity of air emissions data and test methodologies, and ash characteristics.

1.0 INTRODUCTION

This document addresses the final disposition of automotive tires which have been discarded (scrap tires). Adverse environmental effects and threats to public health and safety may develop if scrap tires are not properly managed. A number of technically feasible alternatives exist for disposing of scrap tires, other than landfilling or illegal dumping. Table 1-1, for example, lists various potential uses for scrap tires in Illinois.

Some options for the more than 240 million tires discarded in the U.S. each year include: resale, exporting, retreading, and processing into products such as remanufactured tires, reclaim rubber, industrial floor mats, and railroad crossings. Tires can also be burned for energy recovery, shredded or chipped for use as fill or road surfacing material, and melted to allow recovery of the metal in steel-belted tires. Only about 35 million, or approximately 15% of the scrap tires generated each year, are retreaded (Pope, 1991). Rubber reclamation operations consume 12 million tires per year, and 13 million tires per year are used as supplemental fuel (Pope, 1991). Tires are utilized in asphalt production, as railroad ties, and as artificial reefs when tied together to form groin/dock bumpers.

In addition, various technologies, which utilize these scrap tires, also exist. For example, melting scrap tires and separating the residue to reclaim the ingredients for recycling have been previously studied, as the technology is not new (Haas, 1990). Although these options may be technically feasible, the economic viability of any alternative is the ultimate factor which determines its success. For example, studies have shown that rubberized asphalt has a greater degree of integrity than conventional asphalt. However, processing costs to produce rubberized asphalt, which can potentially be doubled, have limited the expanded use of the rubberized asphalt (Burger, 1991).

Haas (1990) indicates that it is time that scrap tires be used as a source of energy recovery in addition to recycling or reclaiming tire parts. Assessing the feasibility of energy recovery through the use of scrap tires as a fuel is an area of interest to industry and policy makers. A study on scrap tire management by the Illinois Department of Energy and Natural Resources (IDENR) concluded that a "cost effective method of utilizing scrap tires in large volumes in the near term is to use scrap tires as fuel" (Burger, 1991). Other authors concur with this conclusion that energy recovery from scrap tires is a viable alternative (Pope, 1991).

A recent article in Scrap Tire News (January, 1991) describes a Japanese facility which incinerates tires. In Japan, approximately 35 percent of all scrap tires are burned for

fuel. Figure 1-1 illustrates Japan's use of scrap tires and the extent that each option is used. Japan is currently looking at alternative fuel sources due to the ongoing unrest in the Middle East, which is the source of approximately 60 percent of the country's energy requirements. As a result of the oil crisis in the 1970's, a Japanese tire company, Yokohama Rubber Company, Ltd., installed a tire incinerator at its Mie Plant. This incinerator has been in operation since November, 1974, and provides eight percent of the facility's energy requirements.

The tires are burned whole at Yokohama and range from minimum vehicle to truck size tires. Depending on the tire size, an average of 10,000 tires are burned each month. The use of these tires results in a considerable savings in fuel consumption. The company has estimated a savings of 18,850 tons of petroleum which is equivalent to $439,000. The scrap tire supply at the Mie plant comes from the plant itself, which produces truck tires. Tires are also transported from two other Yokohama plants, which provide a total of 75 percent of the supply. Six percent of this supply is from racing tires. Although a Yokohama engineer, Osuke Kojima, cites that the system is old and generates too much smoke for today's environmental standards, he estimates that the cost to update the facility would be three times the cost to build the incinerator in 1974 (original construction cost: $950,000).

The chamber burns tires at approximately 900°C (1600°F) within the current incinerator, and generates 10,240 cubic meters of gas per hour. This gas flows into an adjacent boiler and then to an economizer or heat exchanger, where it is desulfurized and goes up the stack. The system is computer-controlled.

The availability of scrap tires for energy recovery appears not to be a concern. In addition to the 240 million tires scrapped each year in the U.S., 2 to 3 billion scrap tires are estimated to be presently stockpiled at disposal sites, a majority of which are illegal sites. As these tires are awaiting some removal/disposal action, a great potential exists that the tire pile will catch fire.

According to several sources, only 25 to 30 percent of the waste tires discarded each year are used productively, i.e., either re-used or re-processed (McGowin, 1991). Approximately 10 percent of the scrapped tires are landfilled, with the remaining 60 to 65 percent stockpiled and/or dumped. Thus, at least 150 million tires are made available each year for energy recovery.

Reliability of a continuous tire supply can be a concern, especially for facilities located in remote areas (e.g., Midlothian, Texas). For these facilities, scrap tires are not as easily accessible, and/or have higher transportation costs compared to facilities located in

large, metropolitan communities. Thus, if the reliability of a long term tire supply decreases, the risk of recovering capital investment required for permit and feed system modifications increases. Because many pulp and paper mills are located at or near raw material supplies, these mills are at long distances from metropolitan cities, where tire generation is most common. Transportation costs are a price disadvantage.

The primary reason for burning waste tires is to save fuel costs. Burning tires as an alternative fuel will only be feasible if it is economically competitive with the other fuels. The feasibility of co-firing tires/TDF is dependent on various factors, particularly the degree of processing/fuel specifications. Substituting tires for coal can decrease the cost of fuel substantially. For example, if the relative cost of coal, the primary fuel, is assumed to be 1, then according to Juell (1984), the relative costs of the other fuels are as follows:

Natural gas	-	2.5
Rice hulls	-	0.9
Wood shavings	-	0.7
Coke	-	0.6
Chipped tires	-	0.6

The use of TDF could potentially reduce the cost of fuel by as much as 40 percent.

The cost to produce 2 inch tire fuel is relatively low compared to processing tires into new products. However, the energy required to reduce the size of the tire chips increases dramatically as the size of the tire chip decreases. Thus, the smaller a tire chip size is needed, the more expensive the price is to obtain it. Approximately 40 Btus are expended to produce one pound of 6" x 6" tire shreds, whereas 750 Btus are required to produce one pound of 1" x 1" tire chips (Burger, 1991). Boilers requiring wire-free crumb rubber material, 20-30 mesh, may pay an average of $160/ton (Scrap Tire News, March, 1988, from Burger, 1991). However, 2" TDF with steel may only cost $20/ton. Boiler types can determine the tire chip size requirement. Co-firing pulverized coal or cyclone-fired boilers require 1" x 1" or less TDF, whereas stoker-fired and fluidized-bed boilers can accept 2" x 2" to 4" x 4" size shredded tires (McGowan, 1991). Burning tires in pulverized coal or cyclone-fired boilers may not be cost-effective, whereas burning tires in stoker-fired or fluidized bed boilers may result in a cost savings. Keystone Cement Company in Bath, PA, currently has a permit to burn scrap tires; however, the tire shred must be less than 1/8" and Keystone has not found a supplier who can grind tires small enough and keep it cost-effective for Keystone to utilize tires as a fuel (Luybli, personal communication).

For a cement kiln to burn scrap tires economically, the cost to obtain the tires must be less than $45.00 per ton (Kearney, 1990). An initial cost of $60,000 to $500,000 for modification of the feed system must be invested prior to burning scrap tires. Additional costs for test burns are required for permitting. Thus, for a facility to recover some of the investments, the cost for TDF must be considerably less than coal to be economically viable.

According to the Scrap Tire Use/Disposal Study by Kearney (1990), the typical cost of coal for cement kilns is $38 - $48 per ton and for TDF, $30-50 per ton. However, because TDF has a higher Btu content, TDF can generally be cheaper per MBtu than coal ($1.10-$1.80 per MBtu for TDF vs. $1.60-$2.00/Mbtu for coal). However, initial capital costs and costs for shredding and transportation may increase the net cost for TDF. Blue Circle Cement, Inc. in Hope, England has demonstrated a 15 percent savings in primary fuel cost for one kiln without noticeable production loss nor adverse effects on the quality of the cement.

Costs for shredding tires range from 27 to 37 cents per tire. Pulp and paper mills require tires to be wire-free prior to burning. Dewiring increases the cost of TDF by 25-50 percent. Additional costs for dewiring TDF range from $1.00 to $1.70 per Mbtu.

A scrap tire management study in Illinois found that one facility using existing boilers and four processing sites had total collection, transportation and processing costs of $1.19 per tire (Burger, 1991). The facility could maintain economic viability if the combined income from the tipping fee and sale of tire fuel would be at least $1.19 per tire. If tire fuel suppliers charge tipping fees comparable to landfills ($1 - $5 per tire), the suppliers could offer the fuel to customers for approximately $1 per tire or less. Thus, tire fuel could be approximately $20 per ton, assuming tire chip sizes are between 1.5" and 2".

The town of Manitowoc, Wisconsin has offered to provide shredded tires to Manitowoc Public Utilities (MPU) and would pay $3 for each ton of tires burned by MPU. The disposal fee of + $3 per ton for tires when compared to the costs of coal ($35 - 48/ton) and coke ($26/ton) presents a compelling economic argument for burning scrap tires.

The states of Minnesota, Wisconsin, and Illinois have initiated programs which subsidize some of the costs of burning TDF, thus, encouraging the use of TDF as a supplemental energy source. Specifically, the Wisconsin Department of Natural Resources (DNR) will pay for stack test during source test-burns to obtain quality emissions data and for permitting. The Wisconsin DNR has contributed monies for environmental testing to Nekoosa Packaging and Wisconsin Power and Light. In addition, the Wisconsin Waste Tire Management and Recovery Grant Program will fund projects intended to research new uses

and expand existing uses for scrap tires. Wisconsin's grant program is funded by monies generated from a $2 per tire fee on vehicle titles.

The state of Minnesota requires a $4 tax on vehicle title transfers to fund a stockpile cleanup and a grant/loan program. The Minnesota Pollution Control Agency will provide grants and loans to facilities recycling, reusing, or processing tires. These grants and loans help companies that use tire-derived material, such as crumb rubber, to manufacture products incorporating these waste tire products.

Illinois also funds TDF test-burns and provides low interest loans to industries planning to burn scrap tires. These loans allow the industries to retrofit existing equipment or make improvements to facilitate the use of TDF. Illinois is currently funding five TDF test-burns in 1991. This fund is supported by a $0.50 revenue received per vehicle title, and is used to establish the Used Tire Management Fund.

Other states which provide grants/loans to industries, or subsidize markets for waste tires or TDF, include Arizona, California, Missouri, and Oregon. Virginia is currently planning to implement a program to subsidize costs for burning TDF in cement kilns and pulp and paper mills.

The purpose of this study is to compile and analyze available air emissions data on the use of scrap tires as a fuel source for combustion. The consequences of scrap tire combustion on air quality, and the identification of areas in which additional information is necessary are presented in this document. This report does not address potential associated issues, including shredding or chipping technology, economics, ash handling, transport or storage issues. A comprehensive understanding of the impact on air quality resulting from burning scrap tires is required so that industry, policy makers and the general public can make informed decisions on this topic.

Published air emissions data regarding the combustion of scrap tires are limited compared to available literature for municipal wastes, biomass, and coal combustion. Literature which is available concentrates primarily on the methods and feasibility of the processes. Unfortunately, data available regarding air emissions associated with scrap tire combustion are widely scattered and inconsistent. Since few data associated with scrap tire combustion are readily available, there is a relatively low level of understanding regarding use of scrap tires as a fuel source. Information that is available is highly variable. Air emission testing methods are not standardized, and air emission limits vary from state to state.

TABLE 1–1 (Page 1 of 2)

POTENTIAL USES FOR SCRAP TIRES IN ILLINOIS

POTENTIAL USES	Est. % of IL Tires Use	ADVANTAGES	DISADVANTAGES	MARKETABLE PRODUCT
Artificial Reefs	5	Increases Fish Habitation Long Life Ease of Configuration	Costly to Install May Move	Reefs
Breakwaters	1–2	Perform Well Durable Low Cost	Limited Number of Tires Used	Breakwater
Construction	5	Perform Well Low Cost	Limited Number of Tires Used	Retaining Walls Erosion Control Crash Attenuation Structrual Fill Material
Crumb Rubber	Up to 100%	Marketable Commodity Reclaims Raw Material Marketable Applications	High Cost	Crumb Rubber
Rubberized Asphalt	Up to 100%	Longer Wear Noise Buffer	Mixed Test Results Requires Special Equipment Not Proven Economical	Asphalt
Sealants	5	Proven Effective	Limited Number of Tires Used	Roof/Road Sealant
Railroad Crossings	5	Proven Effective Reduces Supply	Limited Number of Tires Used	Railroad Crossings
Sport Surfaces	1–2	Better Surface Lessens Impact	Limited Number of Tires Used	Running Tracks Playgrounds
Stampings	1–2	Proven Effective	Limited Number of Tires Used Not Economical Fragmented Market	Dock Bumpers Farm Machinery Rollers Pipe Rollers
Soil Additives	1–2	Improves Soil Quality Improves Air Circulation	Limited Number of Tires Used Fixed Sales for Compost	Tire Chips
Sheet Goods	1–2	Proven Effective	Limited Number of Tires Used Limited Uses	Floor Mats, Carpet Pads Mud Guards

(From Burger, 1991)

TABLE 1–1 (Page 2 of 2)

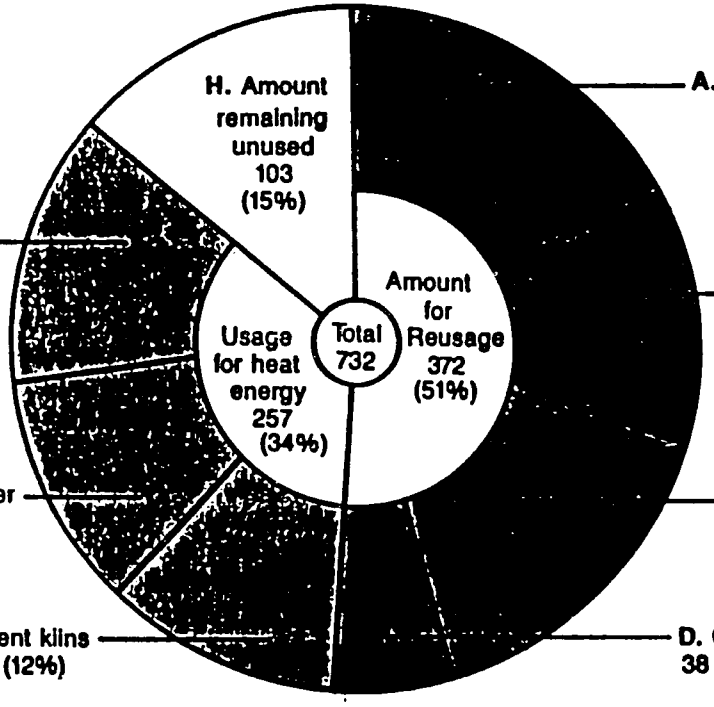
POTENTIAL USES FOR SCRAP TIRES IN ILLINOIS

POTENTIAL USES	Est. % of IL Tires Use	ADVANTAGES	DISADVANTAGES	MARKETABLE PRODUCT
Molded Products	5–10	Wide Variety of Uses	Saturated Market	Truckbed Liners Pots, Buckets, Etc.
Tire Retreading	10	Historically Proven Reduction of Supply	Declining Market	Retreaded Tires
Dedicated Whole Tire Boilers	90–100	Completely Disposes Tire Produces Energy Appears Environmentally Clean	Long Pay–back Period Community Acceptance New Boiler Construction Requires Large Stockpile for Continued Use	Energy
Municipal Solid Waste to Energy	50–80	Reduction of Supply Compatible with Existing Fuel Can Boost Btu Content	Limited Use Tires My Burn Too Hot Limited MSW WTE Facility	Energy
Pulp/Paper Plants	Unknown	Reduction of Supply Compatible wiht Existing Fuel Can Boost Btu Content	Limited Use in Illinois Increases Air Emissions Required Stockpiles	Energy
Utility Boilers	10–20	Reduction of Supply Compatible with Existing Fuel	Requires Stockpiles Increases Air Emissions	Energy
Cement Kilns	Unknown	Reduction of Supply Compatible with Existing Fuel	Requires Clean TDF	Energy
Fluidized Bed Boilers	50–100	Reduction of Supply Compatible with Existing Fuel	Requires Clean TDF Requires Stockpiles Increases Air Emissions	Energy
Pyrolysis	Unknown	Minimal Environmental Impac Anticipated	Unproven Markets Requires Stockpiles	Oil & Combustible Gas Carbon Black

(From Burger, 1991)

Japan's Use of Scrap Tires

(unit: 1,000 tons)



Source: JATMA

MALCOLM PIRNIE	1737-01-1	Japan's Use of Scrap Tires (From Scrap Tire News, Jan., 1991) Rev. 2, May 3, 1991	FIGURE 1-1

2.1 PHYSICAL

Although automobile and truck tires manufactured today are primarily steel-belted radial ply type, other types of tires are available. Some tires are made with Fiberglas, Aramid, and/or Rayon. Table 2-1 lists five different types of tires and their properties. Most modern tires have a complex composition of natural and synthetic rubbers, other chemicals, minerals, and metals. Steel-belted radial ply tires may also contain polyester, steel, or nylon cords.

Some radial tires have a fine carcass wire, whereas bias ply tires do not. Radial and bias ply tires contain bead wire. The bead wire in these tires consists of numerous strands of high tensile strength steel. This steel is used to assure that the tire remains on the rim. In the past, both auto and truck tires have been either radial or bias ply type. Some bias ply tires are still manufactured in the U.S., but they are primarily truck tires. Approximately one-half of the truck tires present in the market today are radial and one-half are bias ply types.

2.2 CHEMICAL

Table 2-2 lists properties of various sizes and qualities of tire-derived fuel (TDF). In general, tires have more heat energy by weight than coal (8970 kcal/kg vs. 6500 kcal/kg). Tires have the highest heating value per pound of potential waste fuels of interest today (Howe, 1991). The average higher heating value of tires is 14,000 Btu/lb. One average tire contains over 300,000 Btu of heat energy. Discarded tires, however, can lose their volatility, dropping from as high as 50 percent to as low as 20 percent, as they age in a scrap tire pile (Granger & Clark, 1991). This finding is disputed by the tire industry. As an example, tires do not volatilize at highway or ambient temperatures and, (J. Zimmer, personal communication, 4/18/91) therefore, it is unlikely to occur from pile storage. In general, the heating value of TDF generally decreases with increasing steel content (Table 2-2).

The main constituents of rubber in tires are carbon and oil (hydrocarbons), hence

the combustible nature of tires. When tires burn in uncontrolled environments, the black smoke that escapes contains fine particles of carbon. Carbon and hydrogen can make up as much as 96.5 percent of the tire. However, the percentage of ash can be as high as 25 percent, especially if the rubber contains steel (Granger & Clark, 1991). Although tires contain a significant amount of sulfur, they are generally lower in sulfur than oil and U.S. coal (except low-sulfur coal). In addition, coal generally has a higher percentage of ash than TDF. Table 2-3 lists various types of U.S. coal and their properties. The ash resulting from burning coal or TDF is comprised mainly of metals. Zinc is the main constituent in TDF fly ash, but lead, arsenic, chromium, and cadmium are also present (Granger & Clark, 1991). Table 2-4 lists the major chemical elements in ashes of coal and TDF and their concentrations.

TABLE 2-1

ANALYSES OF VARIOUS TIRES

TIRE TYPE	SOURCE	ENERGY CONTENT (BTU/LB)	COMPONENTS, PERCENT BY WEIGHT						
			MOISTURE	ASH	SULFUR	CARBON	HYDROGEN	NITROGEN	OXYGEN
FIBERGLASS	POPE, 1991	13,974	0.00	11.70	1.29	75.80	6.62	0.20	4.39
STEEL-BELTED	POPE, 1991	11,478	0.00	25.20	0.91	64.20	5.00	0.10	4.40
NYLON	POPE, 1991	14,908	0.00	7.20	1.51	78.90	6.97	< 0.10	5.42
POLYESTER	POPE, 1991	14,752	0.00	6.50	1.20	83.50	7.08	< 0.10	1.72
KEVLAR-BELTED	POPE, 1991	16,870	0.00	2.50	1.49	86.50	7.35	< 0.10	2.11
UNSPECIFIED TIRE	HALEY, 1984	16,146	0.00	1.50	1.80	89.20	7.30	0.20	NR
UNSPECIFIED TIRE	RYAN, 1989	15,550	0.50	5.70	1.20	83.20	7.10	0.30	2.50

NR - NOT REPORTED

TABLE 2–2

ANALYSES OF VARIOUS TIRE–DERIVED FUELS (TDF)[7]

TDF TYPE	SOURCE	ENERGY CONTENT (BTU/LB)	COMPONENTS, PERCENT BY WEIGHT								
			MOISTURE	ASH	SULFUR	CARBON	HYDROGEN	NITROGEN	OXYGEN	CHLORINE	VOLATILES*
CRUMB RUBBER	EIRSCHELE, 1991	16,300	0.20	4.20	1.90	**28.90	NR	NR	NR	NR	64.80
1/2" "FUZZ"	GRANGER & CLARK, 1991	13,813	2.26	16.48	1.30	69.74	6.30	0.45	3.40	0.07	64.66
1/2" X 1/2" W/O STEEL	EIRSCHELE, 1991	15,560	0.80	9.50	1.50	**27.30	NR	NR	NR	NR	60.90
1" X 1" W/ STEEL	EIRSCHELE, 1991	14,860	2.40	13.20	1.30	**22.40	NR	NR	NR	NR	60.70
1" X 1" W/O STEEL	EIRSCHELE, 1991	15,690	1.30	6.80	1.40	NR	NR	NR	NR	NR	NR
1" X 1" W/O STEEL	MC GOWIN, 1991	12,572	8.55	14.76	1.19	NR	NR	NR	NR	NR	NR
2" SHREDDED W/ STEEL	PHALEN ET AL., 1991	15,787	0.39	8.32	1.62	77.37	6.81	0.37	5.12	NR	62.72
2" RUBBER W/ METAL	GRANGER & CLARK, 1991	13,362	0.75	23.19	1.33	67.00	5.81	0.25	1.64	0.03	54.23
2" RUBBER W/O METAL	GRANGER & CLARK, 1991	14,019	1.02	8.74	1.23	72.15	6.74	0.36	9.67	0.09	67.31
1-1/2" UNSPECIFIED TDF	HOWE, 1991	12,572	8.55	14.76	1.19	62.02	5.96	0.25	7.27	NR	54.33
UNSPECIFIED TDF	POPE, 1991	14,500	0.00	4.81	1.24	84.40	7.13	0.24	2.18	NR	NR
UNSPECIFIED TDF	BURGER, 1991	14,500	0.80	10.00	1.40	78.00	NR	0.02	NR	0.15	65.00
UNSPECIFIED TDF	SCHREURS, 1991	14,500	1.00	5–22	1.60	NR	NR	NR	NR	NR	NR
SHREDDED TDF	GAGLIA ET AL., 1991	16,250	0.62	4.78	1.23	83.87	7.09	0.24	2.17	NR	NR

NR – NOT REPORTED

* – PROXIMATE ANALYSES

** – FIXED CARBON ONLY

TABLE 2–4

MAJOR CHEMICAL ELEMENTS IN ASH OF COAL AND THREE RUBBER SAMPLES

ASH ANALYSIS (%)	COAL	RUBBER 1/2" "FUZZ"	RUBBER 2" W/O METAL	RUBBER 2" W/METAL
Silicon as SiO_2	47.98	18.21	22.00	5.16
Aluminum as Al_2O_3	20.70	6.99	9.09	1.93
Iron as Fe_2O_3	18.89	30.93	1.45	0.35
Titanium as TiO_2	0.82	6.01	2.57	0.14
Calcium as CaO	3.30	5.99	10.64	0.56
Magnesium as MgO	0.79	0.73	1.35	0.10
Sodium as Na_2O	0.48	1.07	1.10	0.13
Potassium as K_2O	2.06	0.55	0.92	0.14
Sulfur as SO_3	4.33	8.35	15.38	0.99
Phosphorous as P_2O_5	0.62	0.56	1.03	0.10
Zinc as ZnO	0.02	20.60	34.50	5.14
Metal				85.28
Total	100.00	100.00	100.00	100.00
Base/Acid Ratio	0.37	1.26	0.46	*11.98

* Counting metal as Fe_2O_3

All values normalized to 100%

Ash and coal samples laboratory–prepared.

(From Granger and Clark, 1991)

TABLE 2-3

ANALYSES OF VARIOUS SOURCES OF COAL

COAL TYPE	SOURCE	ENERGY CONTENT (BTU/LB)	COMPONENTS, PERCENT BY WEIGHT								
			MOISTURE	ASH	SULFUR	CARBON	HYDROGEN	NITROGEN	OXYGEN	CHLORINE	VOLATILES
UTAH COAL	CALIFORNIA AIR RESOURCES BOARD, 1984	12,771	3.59	8.44	0.79	71.45	5.00	1.37	9.64	0.04	NR
UNSPECIFIED WESTERN COAL	CALIFORNIA AIR RESOURCES BOARD, 1984	12,000	18.00	9.00	1.00	54.50	4.00	1.00	12.50	NR	NR
WYOMING SUB-BITUMINOUS COAL	CALIFORNIA AIR RESOURCES BOARD, 1984	6,900	26.95	11.00	0.37	30.68	5.04	0.34	25.63	NR	NR
WEST VIRGINIA BITUMINOUS COAL	MC GOWIN, 1991	11,680	6.60	16.04	0.85	NR	NR	NR	NR	NR	NR
CLINTWOOD BED VIRGINIA COAL	VIRGINIA POLYTECHNIC INSTITUTE, 1990	14,120	2.00	6.70	1.30	78.80	5.20	NR	6.40	NR	31.90
NORTH DAKOTA LIGNITE	SCHREURS, 1991	6,100	40-43	9.00	0.85	NR	NR	NR	NR	NR	NR
UNSPECIFIED COAL	BURGER, 1991	12,400	6.30	8.00	2.70	77.00	NR	1.50	NR	0.01	37.00
UNSPECIFIED COAL	HALEY, 1984	11,700	2.60	15.20	0.40	69.00	4.00	1.30	NR	NR	NR
UNSPECIFIED COAL	TRAVERSE CITY LIGHT & POWER, 1984	11,800	11.39	8.13	0.92	66.10	4.49	1.35	7.62	NR	NR
UNSPECIFIED COAL	GRANGER & CLARK, 1991	12,148	7.76	11.05	2.30	67.69	4.59	1.13	5.47	0.01	34.05
UNSPECIFIED COAL	GAGLIA, ET AL., 1991	NR	6.50	14.00	2.30	70.50	4.00	1.30	1.40	NR	NR
UNSPECIFIED COAL	PHALEN, 1991	10,527	9.76	18.02	2.08	60.71	3.64	1.50	4.29	NR	20.97

NR - NOT REPORTED

review, could result in potential health problems. The residue resulting from the combusting of tires was 100 feet thick, and composed of char, carbon black, metal and some remaining rubber. Another major fire in Ontario burned at least 13 to 14 million tires. This uncontrolled fire, which began on February 12, 1990, is considered the largest fire in North America (Tire Business, 1/26/90).

The effect of open, uncontrolled scrap tire fires on air quality has become a major concern as more uncontrolled fires occur. To determine air emissions from open combustion of scrap tires, a small scale study guided by USEPA was conducted by Acurex (Ryan, J.V., 1990). During this study, more than 50 volatile organic compounds (VOCs) were identified. Results indicated that the main emission products identified due to incomplete combustion were mono and polyaromatic hydrocarbons. At least one of these compounds, benzo(a)pyrene, is a known carcinogen. Data also indicate that approximately 12-50 grams of semi-volatile organics can be emitted for every kilogram of tire burned. In addition, zinc was identified to comprise nearly 50 percent of the total ash residue.

3.3 TIRES AS BREEDING GROUNDS FOR INSECTS

In addition to creating potential fire hazards, stockpiles and dumps of tires are ideal breeding places for rodents and insects, especially mosquitos. The water that collects in the tires is warmed by the sun's rays which are absorbed by the dark surface of the tire. These conditions create an excellent habitat for mosquitos, and when coupled with an absence of natural predators and protection from the effects of insecticides, allows mosquitos to breed up to 4,000 times faster than in their natural habitat.

The introduction and infestation of several mosquito species is directly attributed to the importation of used tires from other continents to the U.S. The invasion of the Asian Tiger Mosquito (Aedes Albopictus), for example, was caused by the presence of these insects in a shipment of used tires, as the tires were transported from Asia to the U.S. Data from the U.S. Public Health service reveal these mosquitos can transmit Dengue Fever, Yellow Fever and at least 15 other viruses. Efforts to extinguish or control the spread of the Asian Tiger mosquito have failed.

3.1 LANDFILL PROBLEMS

The accumulation of scrap tires at landfills, above ground stockpiles, and illegal dumps creates potential environmental, safety and health hazards. Air and water, which become entrapped in the tires buried in a landfill, make the buried tires buoyant. These tires rise to the top of the landfill and eventually rupture the clay cap that protects the buried refuse. A rupture in the clay cap allows landfill gases to escape and allows for infiltration of rain or surface water which may then increase the production of leachates which can contaminate surrounding soils and/or ground water. The ruptured landfill cap is a potential health risk, creating an avenue into the landfill for rodents, insects, and birds. In addition, tires take up a significant amount of volume in landfills and do not biodegrade. As few as 13 tires can occupy one cubic yard of landfill space (Culviner, 1990). Many landfill owners refuse to accept scrap tires due to these various disposal problems. Those landfill owners who do accept tires usually charge a higher disposal fee due to increased handling requirements. For example, a survey revealed that 12 of the 35 landfills in Illinois would not accept tires, and the average cost to dispose of tires in Illinois landfills in July, 1990 was $2.32 per tire (Burger, 1991).

3.2 TIRE FIRES

As scrap tires accumulate at stockpiles and dumps, they create potential fire hazards. Arson is the number one cause for tire fires (Blumenthal, personal communication). On October 31, 1983, a fire began in Winchester, Virginia and burned for nearly nine months. This fire began in a dump containing approximately 5 million truck and automobile tires. On November 4, 1983 air samples were collected in the fire smoke plume, and analyzed to determine the types and magnitude of contaminants and other emissions comprising the smoke. Samples were analyzed for nitrosamines, metals, total particulates, polynuclear aromatic hydrocarbons (PAHs), and other organic vapors. Results indicated that potentially hazardous levels of carbon monoxide (CO) and PAHs were present in the fire smoke plume. CO levels ranged from 15 to 65 ppm above the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit for a 10-hr time-weighted average (TWA) (NIOSH, 1984). At least seven PAH compounds were detected at concentrations ranging from 3 to 461 ug/m^3. These concentrations, which may require additional regulatory

3.4 RODENTS

Tires also supply a warm, dark harbor for rodents. For example, tires with an adequate water supply are an ideal habitat for Rattus norvegicus (Norwegian Rat). These rats either burrow under scrap tires or breed within the tires. The Norwegian Rat is the most common species of rats in landfills and can have as many as 12 offspring in one litter. They can transmit diseases as they are omnivors and feed on either dead or live animals.

3.5 WASTE TIRE LEGISLATION

Legislation governing used tire disposal has been enacted in many states (Pillsbury, 1991, personal communication). Table 3-1 lists these states and a summary of their applicable waste tire regulations. Minnesota currently bans whole as well as cut tires from disposal at landfills. Illinois passed the Vector Control Act in 1989, which places a ban on land disposal of whole tires, effective July 1, 1994. According to this law, whole tires can only be accepted at landfills which have the capabilities to shred, chop, or slit the tires, and which have implemented programs to actively seek other disposal options for the processed tire material (Burger, 1991). A discussion of legislative activities in the state of Ohio is contained in Section 7.

3.6 TIRES AS A FUEL SOURCE

The major reason for combusting tires is to decrease the number of waste tires disposed of in landfills and dumps, thereby reducing the potential for fires, and environmental, health, and safety hazards. However, other reasons exist for combusting tires or tire-derived fuel (TDF) for energy recovery. First, combusting tires or TDF would reduce the dependency on oil for fuel. When comparing the heating value of tires to gasoline, Pope (1991) concludes that one tire has the energy equivalent of approximately 2.4 gallons of gasoline. If a car is assumed to get 25 miles per gallon of gasoline, then one tire has enough energy to move the car 60 miles. Although tires cannot be used to run cars, tires are a valuable fuel when burned completely in the proper environment. Tires can be combusted to generate electricity, steam or hot gases. Other methods of reusing tires for purposes such as an asphalt-reducing admixture in road construction can save millions of barrels of imported oil. According to one rubber industry source, approximately 63 million

barrels of oil could be saved as well as 440 million scrap tires used when incorporating scrap tires in asphalt paving (Culviner, 1990). Note: Rubber is used as an asphalt extender or aggregate replacement, but it does not replace asphalt cement (Chapman, personal communication).

STATE	FUNDING SOURCE	STORAGE REGS	PROCESSOR REGS	HAULER REGS	LANDFILL RESTRICTIONS*	MARKET INCENTIVES
AZ	2% sales tax on retail sale		✓		bans whole tires	
CA	$.25/tire disposal fee	✓	✓			grants
CO		✓	✓			
CT		✓				
FL	$1/tire retail sales	✓	✓	✓	tires must be cut	R&D grants
IL	$.50/vehicle title	✓	✓	✓		grants/loans
IN	permit fees/tire storage sites	✓			tires must be cut	grants
IA					bans whole tires	
KS	$.50/tire retail sales	✓	✓	✓	tires must be cut	grants
KY	$1/tire retail sales	✓			tires must be cut	
LA		✓			tires must be cut	
ME	$1/tire disposal fee	✓	✓	draft		grants/loans
MD	state budget appropriations	✓	✓	✓		
MI	$.50/vehicle title fee	✓	✓	✓		grants
MO	$.50/tire retail sales	✓		✓	bans whole tires	funds/testing
MN	$4/vehicle title transfer	✓	✓	✓	bans whole and cut tires	grants
NB	$1/tire retail sales					grants
NH	town graduated vehicle registration fee	✓				
NC	1% sales tax on new tires	✓	✓	✓	tires must be cut	funds county tire collection
OH					tires must be cut	
OK	$1/tire surcharge new tire sales	✓	✓		tires must be cut	grants
OR	$1/tire disposal tax on new tire sales	✓	✓	✓	tires must be cut	$.01/lb.
PA		✓				R&D grants
RI	$.50/tire tax on new tire sales	✓	✓			
SD		✓	✓		tires must be cut	
TN					bans whole tires	
TX		✓			bans whole tires	
UT	graduated tax per tire size					$20/ton
VA	$.50/tire disposal fee on new tire sales					funds/testing
VT					tires must be cut	
WA	$1/vehicle registration	✓	✓	✓		grants
WI	$2/tire per vehicle title fee	✓	✓	✓	tires must be cut	$20/ton

* Majority of states have imposed regulations that require tires to be cut, sliced or shredded prior to landfilling. Some allow for above-ground storage of shreds at landfills. OH, NC, CO are considering or allowing exemptions for tire shreds. Whole tires are discouraged from landfills in most cases by law or by high disposal fees. STN – Jan. 1991

MALCOLM PIRNIE

Applicable State Laws
(From Scrap Tire News, 1991)

FIGURE 3-1

1737-01-1

REV. 2, May 3, 1991

Communications with various industries indicate that several types of combustion sources are typically used in scrap tire combustion. Table 4-1 summarizes four types of combustion facilities which are not only effective in decreasing the number of tires disposed in landfills or stockpiles, but also appear to be operating in an environmentally acceptable and economically sound manner. Some combustion sources are limited to the percent of tires that can be combusted due to limitations on emissions of VOCs, metal oxides, and SO_2. In addition, many combustion sources are operationally limited because they cannot handle the high concentration of bead wire and steel-belting in the tires due to boiler feed rates, fuel specifications and other technical reasons. Combustion sources which require shredded tires have experienced handling problems due to the poor quality of TDF. Utility facilities in particular, have expressed the need for standards in the quality of the TDF. A quality standard could avoid the handling problems many companies experience from the large TDF pieces and wire in the TDF.

In order to evaluate the suitability of TDF as a supplemental fuel with coal in a cyclone furnace, the Babcock & Wilcox Company performed chemical and physical evaluations on eastern, bituminous coal and three samples of TDF (Granger and Clark, 1991). The car and truck tires were shredded into three categories for the tests: 1/2 inch rubber "fuzz", 2 inch rubber with metal, and 2 inch rubber without metal. Results of the analyses showed that, compared to coal, the tire samples had less moisture, significantly more combustible matter, and significantly less fixed carbon. The heating content of the shredded tire samples tested was 10 to 16 percent higher than the coal alone. The most significant differences observed between combusting TDF and coal were the ash characteristics and sulfur content of the fuel. The sulfur content of the TDF samples was 1.2 percent to 1.3 percent, or approximately one-half of the sulfur content of eastern coal. However, there should be no significant change in the sulfur content when comparing TDF with low sulfur, western coals.

The ash contents from the three TDF samples were 16 percent, 9 percent, and 23 percent, respectively. The high ash percent was due to the steel content of the TDF. Combusting coal only with no TDF resulted in 11 percent ash. The ash chemistry between the TDF and coal also varied significantly. Table 4-2 shows the major constituents and concentrations, expressed as oxides, in the coal and TDF ash samples. Zinc oxide (ZnO)

is added during the rubber compounding process to control the rate of vulcanization, and appeared to be the cause of the high zinc concentration in the fly ash.

Although most combustion facilities may viably burn TDF, boiler types can also determine whether combusting tires is economically feasible. Test burns on several boiler types (pulverized coal-fired, stoker-fired, cyclone-fired, fluidized bed boilers and wet-bottom boilers) indicate that not all boiler-types combust tires with the same degree of success. The following section provides a review of these four boiler types.

4.1 BOILER TYPES

Pulverized coal-fired boilers require coal to be finely ground into the consistency of face powder. The ground coal is blown into the fire box where it is combusted. The cost to grind TDF into a similar consistency is very high and generally not considered economically feasible, (Stopek, et al.).

Stoker-fired boilers typically combust 3/4-inch minus coal and can readily burn TDF. Combusting 1-inch minus TDF in stoker-fired boilers is generally feasible up to about 10 percent TDF. Stoker-fired boilers are common in industrial applications, but are rare in utility systems.

Cyclone-fired boilers combust coal that is crushed to a size such that 95 percent of the material is less than 1/4-inch. Several utility boilers are currently undergoing studies to determine the maximum TDF size that cyclone burners, which are attached to the outside of the boiler, can effectively and efficiently combust. Coal and TDF are fed into one end of the cylindrical cyclone, and combusted at high temperatures (2500°F - 3000°F). Ottertail Power Company determined that the largest size tire shreds which can be combusted at their South Dakota facility is 2" x 2" TDF with all loose wire removed (Rolfus, 1991, Personal Communication).

Fluidized bed boilers are also capable of combusting scrap tires. The number and capacity of fluidized bed boilers for generating power have increased significantly in the past decade. Tires are shredded or chipped prior to being fed into the combustor to prevent "hot spots" that could occur if a whole tire was combusting in one small area (Pope, 1991). Fluidized bed boilers have emission control advantages as a result of more complete combustion of fuels and thus, have the flexibility of combusting various fuel types, including waste fuels. Test results indicate that the SO_2 and NO_x emissions usually decrease during

process is an efficient method of trapping the metal present in modern tires (e.g., steel-belted radials) as well as trapping ash. These by-products become a constituent of the clinker and are eventually incorporated into the finished product. As a result, this consumption of iron from combusting tires has reduced the costs for supplemental iron for some cement manufacturers. Advantages to combusting waste tires as a supplemental fuel in cement kilns are as follows:

1. Nitrogen and sulphur emissions and ash quantities are lower than typical coal values;

2. The steel content provides supplemental iron for the cement; and

3. The ash is incorporated into the product (cement) and thus, is totally consumed.

Approximately 240 cement kilns are currently in operation in the U.S. The primary requirement for a cement kiln to combust scrap tires/TDF is the installation of a separate fuel feed system. This fuel feed system introduces the tires into the process. Several different types of tire feeding systems are currently available. The type of system is generally dependent on the selected application. The purpose of this separate fuel feed system is to control the rate at which TDF is fed into the combustion system.

TDF can be fed into the combustion system using either a mechanical or pneumatic system. The configuration of the kiln determines whether whole tires or only TDF can be used as an auxiliary fuel. Larger kilns with preheaters can effectively combust whole tires. However, Ash Grove Cement, Inc. has patented a process whereby whole tires are combusted in long kilns without preheaters (E. Hansen, personal communication). Most other cement plants usually combust TDF in kilns without preheaters. The size of the TDF is generally 2" x 2" or 4" x 4". Figure 4-1 is a diagram of a waste tire combustion system in Hope, England, where whole tires are combusted.

Table 4-3 lists facilities in the U.S., Japan, and Europe which have tested or are currently combusting scrap tires in their cement kilns as a supplemental fuel, and the approximate size of tire or TDF it can combust, if known. According to Kearney (1989), over 69,000 tires are combusted in Japan each year as fuel in cement kilns. Japanese cement companies typically combust whole tires in their kilns.

An estimated 40-50 kilns in the U.S. are presently equipped with preheaters/pre-calciners, which can efficiently combust scrap tires. In general, the existing emission controls on kilns are suitable for flue gas cleaning when combusting waste tires. Emission standards

the combustion process. Emissions of dioxins and furans are also minimized due to the extremely high temperatures within the combustor.

The wet-bottom boiler has a slag layer on the bottom that keeps temperatures at about 3,000°F. This temperature is hot enough to vaporize whole tires immediately without producting environmental effects (The Herald-Star, 1990). In wet-bottom boilers, the ash-handling system can accommodate the slag produced by the steel from the tire beads and belts. Wet-bottom boiler furnaces have lower and upper sections. The lower portion of the furnace maintains a high, constant gas temperature, allowing molten slag to fall onto the floor bottom where a pool of liquid slag is maintained and trapped in a slag tank containing water. The lower temperature in the upper portion of the furnace allows gases to cool below the ash fusion point. Ohio Edison Company has test-burned whole tires (up to 32") in their 42 megawatt coal-fired, wet-bottom boiler, the only one of its kind in Ohio, with decreased air emissions (See Section 7.5).

4.2 TYPES OF COMBUSTION FACILITIES

Scrap tire combustion methods are discussed in detail in a report by the Scrap Tire Management Council (Kearney, 1990). Various barriers to the expanded use of these tire combustion methods were also discussed. The following sections summarize four of the most combustion methods.

4.2.1 CEMENT KILNS

The basic elements of cement are calcium, silicon, aluminum, and iron. Mixtures of finely ground calcareous material (e.g., limestone), argillaceous material (e.g., clay, shale), and siliceous material (e.g., sand) provide the required elements for cement. Cement is manufactured through the controlled heating of a mixture of these materials to approximately 1500°C - 1600°C (2700°F - 2900°F) in a rotary kiln. Decarbonation of lime results from the high temperature, and subsequent reaction with silica forms calcium silicates, or "clinker". The clinker is ground with gypsum to produce cement.

Combusting waste tires for energy recovery in cement kilns has been widely used in Europe and Japan since about 1974 (Haley, 1984). The cement kiln has proved to be successful for disposing of whole scrap tires or rubber dust. The extremely high temperature in the kiln allows for complete combustion of tires, as well as oxidation of the steel reinforcements. Because the steel beads/belts react as a component of the cement clinker, these wires do not need to be removed from the tires prior to combustion. This clinkering

can generally be maintained when using TDF as an auxiliary fuel, if the TDF does not exceed 20 percent of the total heat value of the fuel used in the kilns. However, according to Hansen (personal communication), Ash Grove Cement, Inc. can combust up to 40 percent whole tires of the total fuel in their kilns without preheaters when utilizing their patented process.

4.2.2 PULP AND PAPER MILLS

Hog fuel (wood waste) boilers are normally used at pulp and paper mills. These boilers generally have stoker grate feeding system designs, which can combust solid waste such as TDF. Mills combusting TDF normally mix the TDF with the hog fuel on a conveyor which feeds the furnace. The only primary equipment modification required to combust scrap tires in hog fuel boilers is the installation of a metering system capable of handling the high heat values of TDF. The TDF is generally required to be wire free to minimize potential feeding complications, especially jamming within the feed system which can result from the steel wires in the tire belts.

Hog fuel varies substantially in moisture and Btu content. Therefore, fuels with high heat values, such as coal, are often used as a supplement to hog fuel. Because scrap tires also have high heat values and essentially no moisture content, TDF has recently gained acceptance as an auxiliary fuel in this industry. Table 4-4 lists pulp and paper mills which have tested or are regularly combusting tires as an auxiliary fuel in their boilers.

4.2.3 ELECTRIC UTILITIES

Scrap tires can be combusted at electric utility plants in either wet-bottom boilers (whole tires) or cyclone boilers (wire free, 1" x 1" TDF). Table 4-5 presents a summary of experiences at electric utility facilities which have conducted test burns. Depending on the boiler size and ash-handling system, whole scrap tires or TDF can be combusted in existing U.S. utility boilers with little modification. The major modification needed to combust tires would include the construction of a secondary fuel feed system to deliver tires to the boiler.

Cyclone boilers require finely shredded TDF (1" x 1" or less), which can make combusting the TDF uneconomical. However, on a Btu basis, TDF can be cheaper than coal. The Ottertail Power Company's Big Stone Plant in South Dakota has test-burned TDF and determined that in the proper coal/TDF ratio, TDF can offer a cyclone-fired boiler improved flame stabilization compared to coal alone. The Wisconsin Power & Light

Company operates two cyclonic boilers which have test-burned TDF in Rock River, Wisconsin. Results indicate a decrease in NO_x and SO_2 emissions with only a slight increase in opacity.

4.2.4 DEDICATED TIRE-TO-ENERGY FACILITY

One tire-to-energy facility is currently operating in the U.S., and, a second facility is currently under construction in Sterling, Connecticut. The Modesto Energy Company, owned by Oxford Energy, Inc., operates two mass burn waterwall boilers in Westley, California. Oxford Energy, Inc. obtained the technology from Gummi-Mayer KG (Landau), a German tire retreader. Modesto Energy scaled up the technology developed by Gummi-Mayer to handle eight times as many tires and increased the emission control system to comply with the environmental regulations in the U.S. At this facility, whole scrap tires are fed to each boiler on a gravity roller conveyor-belt assembly. The tire feed rate is approximately 3.97 tons/hour (700 tires/hour), but it is varied to optimize the energy input rate.

Tires are fed into both boilers and combusted on a reciprocating stoker grate located in each unit. This reciprocating grate allows air to flow between the metal grate bars, and moves ash and slag down onto a conveyor, which removes the wet ash. To achieve and maintain proper combustion temperatures, several auxiliary gas-fired burners are used during periods of startup and when tire feed is interrupted. The high boiler temperature (2500°F) is designed to minimize air emissions of organic compounds.

The heat generated during the combustion process at the Modesto facility is used to convert boiler water to steam. Output from the two boilers is 125,000 pounds per hour of 930 psig steam. Hot offgases, produced during the combustion process, pass through a superheater section and then through an economizer section to preheat the water being supplied to the boiler. This steam is 930°F when it is transported to a 14 megawatt turbine generator to produce electricity. The electricity is sold to the Pacific Gas and Electricity Company and provides power to 15,000 homes in Modesto. Figure 4-2 is a schematic diagram of the Modesto Energy Company Plant.

The facility's air pollution control system consists of three stages. The first stage, ammonia injection (Thermal De-NO_x™), reduces the emissions of nitrogen oxides. Ammonia injectors, located on the boiler walls in the economizer section, mix ammonia with the hot flue gases reducing nitrogen oxides. The second stage includes a fabric filtration system (baghouse), which collects particulate matter from the flue gases in a baghouse.

Finally, after leaving the baghouse, the flue gases enter a spray tower, where a lime slurry in a wet scrubber absorbs sulfur gases and hydrogen chloride (HCl). The remaining gas is then exhausted through a 120 ft. stack. The air emissions testing at the Modesto Energy Company's tire-to-energy facility is summarized in Section 6.

All by-products and ash produced at the plant are sold for recycling. The ferrous slag goes to cement factories; the zinc is recovered from the fly ash, which is mostly zinc calcines; and gypsum is used as a soil conditioner by local farmers or sold to cement kilns.

The Modesto plant is located near the world's largest known tire dump with an estimated 40 million discarded tires. The plant charges a tipping fee for each new scrap tire received; but pays the owner of the pile for each tire withdrawn from the pile. Tires with high treads suitable for retreading with useable casings are sold to tire retreaders. The remaining tires are combusted to generate electricity which is sold to utilities.

Oxford Energy's second plant in Sterling, Connecticut is scheduled to begin combusting tires by mid-1991 (Valenti, 1991). This plant, which is anticipated to cost approximately $100 million (Oxford Energy Co., 1989 Annual Report), is designed to combust up to 11 million tires per year (compared to Modesto's 5 million tires per year). An anticipated 30 megawatts of electricity, enough to serve 28,000 homes, will be sold to Connecticut Power and Light.

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SCRAP TIRE USE

COMPANY NAME: Roanoke Cement Co.
PLANT NAME: Same
ADDRESS: PO Box 27
Botetourt VA 24175
PHONE NO.: (703) 992-1501
ENVIRONMENTAL ENGINEER/CONTACT: RANDY RAKES

OF KILNS: 5 kilns — Only 1 Burning Tires
CAPACITY OF EACH: 550,000 TPY
HEAT RATE OF EACH: 325,000,000 BTU/HR

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED (WHOLE) SLIT

MAXIMUM TIRE PIECE:
OTHER FUELS:
% TIRE OF TOTAL FUEL: 20%

POLLUTION CONTROL EQUIPMENT:
No New Equipment Required

CONTINUOUS EMISSION MONITORING EQUIPMENT:
DATA TEST Single Pass model 900-A

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
Installed Elevator + Conveyors to handle Tires

WASTE TIRE SUPPLY PROBLEMS? YES ____ (NO) ____
IF YES, PLEASE EXPLAIN:

ANY COMBUSTION/OPERATING PROBLEMS? YES ____ (NO) ____
IF YES, PLEASE EXPLAIN:

AIR EMISSION DATA:
Pending

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? (YES) ____ NO ____
IF YES, WHAT TYPE OF MODIFICATION?
Simple Feeds modification

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QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: SOUTHDOWN, INC. *
PLANT NAME: LYONS PLANT
ADDRESS: P.O. BOX 529
LYONS, COLORADO 80540
PHONE NO.: (303) 534-4206
ENVIRONMENTAL ENGINEER/CONTACT: RANDY WILEY, PLANT ENGINEER

OF KILNS: 1
CAPACITY OF EACH: 1400 TON/DAY CLINKER
HEAT RATE OF EACH 4.8 MBTU/TON

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

(SHREDDED) WHOLE SLIT

MAXIMUM TIRE PIECE: 3" X 3"
OTHER FUELS: WASTE OIL, NATURAL GAS, COAL, #6 FUEL OIL(haven't used in yrs)
% TIRE OF TOTAL FUEL: 1/2 TON/HR, @ 5%

POLLUTION CONTROL EQUIPMENT:
BAGHOUSE

CONTINUOUS EMISSION MONITORING EQUIPMENT:
OPACITY
HC MONITOR AND SO_2 – INTERMITTENTLY

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
ADDED HOPPER, SCALE, AND BELT CONVEYOR

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:
FROM DENVER, DELIVERED SHREDDED

ANY COMBUSTION/OPERATING PROBLEM: YES ____ NO X
IF YES, PLEASE EXPLAIN: SOME FEEDING PROBLEMS, PLUGGING OF RUBBER SHREDS TO HOPPER – IF SHREDS HAVE BELTS AND BEADS

AIR EMISSION DATA:
SEND WRITTEN REQUEST FOR DATA

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION?
NO FINAL PERMIT – HAVE SOME NEW LIMITS.

* Information obtained by phone.

QUESTIONNAIRE

SCRAP TIRE USE

COMPANY NAME: Southwestern Portland Cement Co.
PLANT NAME: Quarry Plant
ADDRESS: 506 E. Xenia Drive, P. O. Box 191
Fairborn, OH 45324
PHONE NO.: (513) 878-8651
ENVIRONMENTAL ENGINEER/CONTACT: Daniel A. Willis

OF BOILERS: N/A
CAPACITY OF EACH:
HEAT RATE OF EACH:

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

MAXIMUM TIRE PIECE: 36 inches diameter
OTHER FUELS: Fossil fuels, hazardous waste fuel
% TIRE OF TOTAL FUEL: 10 - 15%

POLLUTION CONTROL EQUIPMENT:

~~Fabric filter dust collectors~~

CONTINUOUS EMISSION MONITORING EQUIPMENT:
Altech system for NO, SO_2, CO_2, CO O_2, HC

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
Added conveyors, elevator, scale, double tipping valve air lock, electric eyes, misc. hardware and software

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

ANY COMBUSTION/OPERATING PROBLEMS? YES X NO ____
IF YES, PLEASE EXPLAIN: Limited to 18% of total heat input

AIR EMISSION DATA:
Bypass Stack: PM = .03 gr/dscf @ 7% O_2
Main Stack: PM = .02 gr/dscf @ 7% O_2

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION? RAPCA and OEPA require operating permit for each type of fuel burned.

7/25/91

SCRAP TIRE USE

COMPANY NAME: Wisconsin Power and Light Co
PLANT NAME: Rock River Plant
ADDRESS: 150 Townline Road
Beloit, WI
PHONE NO.: (608) 252-3084
ENVIRONMENTAL ENGINEER/CONTACT: Greg Eirschele, Chem Eng

OF BOILERS: 2; test in 1
CAPACITY OF EACH: 75 Mwatts
HEAT RATE OF EACH: 10,600 Btu/KW hr

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

(SHREDDED) WHOLE SLIT

MAXIMUM TIRE PIECE: 1" x 1"
OTHER FUELS: coal - Low sulfur western
% TIRE OF TOTAL FUEL: 7 %

POLLUTION CONTROL EQUIPMENT:
ESP - one on each unit

CONTINUOUS EMISSION MONITORING EQUIPMENT:
opacity

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
Added hopper, separate portable blending conveyor, and scale

WASTE TIRE SUPPLY PROBLEMS? YES _____ NO ✓
IF YES, PLEASE EXPLAIN: 100% of tire supply provided by WI, pays $20.00-25.00/ton

ANY COMBUSTION/OPERATING PROBLEMS? YES _____ NO ✓
IF YES, PLEASE EXPLAIN: Fuel Feed system problems = ① too much volume of rubber at one time ② bad quality of TDF - TDF not w/in specifications: larger size than requested and bad out of TDF ma wires stick out + jams coal feed system.

AIR EMISSION DATA:
Not available yet - plan to receive 3/31/91

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES _____ NO X
IF YES, WHAT TYPE OF MODIFICATION? WE DNR - exempt modific under definition - considers tires as minor modification as "test phase". Will pursue permanent operating perm if results are good.

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TABLE 6–12A

MODESTO ENERGY COMPANY
SUMMARY OF MEASURED EMISSIONS, 1988

PARAMETER	ACTUAL EMISSIONS	LB/DAY	PERMIT LIMIT
PCDD	0.515 ng/sec	9.81E–08	**** TCDD = 2.60×10^{-7} g/sec
PCDF	1.692 ng/sec	3.22E–07	–
PAH	61.6 ug/sec	1.17E–02	**** 9.42×10^{-5} g/sec
PCB*	3 ug/sec	5.71E–04	**** 1.93×10^{-5} g/sec
THC**	0.239 ppmv @ 12% CO_2	0.646	148.4 lb/day
NH_3	63.9 ppmv @12% CO_2	181.8	50 ppmv
NOx	49.54 ppmv @ 12% CO_2	384.3	500 lb/day
SOx –			250 lb/day
– SO_3 (CCS)	4.5 ppmv @ 12% CO_2	55.4	
– SO_2 (Method 8)	4.2 ppmv @ 12% CO_2	45.4	
– SO_2 (CEM)	3.76 ppmv @ 12% CO_2	40.6	
HCl	< 3.5 ppmv @ 12% CO_2	< 22.3	–
CO	52.59 ppmv @ 12% CO_2	247.8	346.4 lb/day
PM –			
– FRONT HALF	0.00190 grains/dscf	25.5	
– BACK HALF	0.000418 grains/dscf	5.7	
– TOTAL	0.0023 grains/dscf	31.2	113 lb/day
TOTAL METALS***	48.4 mg/sec	9.2	--
Al***	1,464 ug/sec		2.02×10^{-3} g/sec
As***	13.7 ug sec		4.61×10^{-4} g/sec
Ca***	609 ug/sec		NR
Cd***	9.38 ug/sec		2.22×10^{-3} g/sec
Cr***	6.00 ug/sec		8364×10^{-5} g/sec
Cu***	77.8 ug sec		2.30×10^{-3} g/sec
Hg***	<0.17 ug/sec		5.76×10^{-4} g/sec
Mg***	122 ug/sec		2.30×10^{-3} g/sec
Na***	655 ug/sec		$<2.88 \times 10^{-4}$ g/sec
Pb***	138 ug/sec		1.15×10^{-3} g/sec
Fe***	3,244 ug/sec		2.24×10^{-2} g/sec
K***	1,341 ug/sec		$<2.88 \times 10^{-4}$ g/sec
Zn***	40,706 ug/sec		2.10×10^{-1} g/sec

NOTE: 1 mg = 0.001 g; 1 ug = 1×10^{-6} g; 1 ng = 1×10^{-9} g

* Data obtained from Engineering–Science.

** Expressed as parts per million methane.

*** Estimated based on inlet concentrations and particulate reduction.

**** Permit Limit obtained from Modesto Tire Incinerator Health Risk Assessment.

NR – Not Reported

(Data from Radian Corporation, 1988)

1737–01–1

REV. 2, May 3, 1991

TABLE 6–11

SUMMARY OF AVERAGE AIR EMISSIONS RESULTS FROM STUDY I
UNITED POWER ASSOCIATION, ELK RIVER, MINNESOTA

POLLUTANT*	TEST DAY 1 100% COAL	TEST DAY 2 6.3% TDF	TEST DAY 3 10.4% TDF	EMISSION LIMIT (lb/MBtu)
PARTICULATE MATTER**	0.021	0.015	0.009	0.6
SO_2	1.41	1.8	1.53	4
SULFURIC ACID (SO_3 & H_2SO_4)	0.015	0.014	0.012	NOT LISTED
NOx	0.78	0.58	0.3	NOT LISTED
Cl^- ***	0.029	0.029	0.027	NOT LISTED

* All emission rates in lb/MBtu
** Includes back–half catch
*** Average from inlet

(From O'Brien, M.V., and Hanson, W.C., 1983)

TABLE 6–9B

EMISSION RATES OF MATERIALS MEASURED IN TESTS
CHAMPION INTERNATIONAL, BUCKSPORT, MAINE

TEST TYPE	UNITS	TDF FEED RATE			
		1.5 TPH	2.5 TPH	3.5 TPH	0 TPH
TOTAL PARTICULATE MATTER	LB/MBTU	0.054	0.047	0.056	0.053
SULFUR DIOXIDE	LB/MBTU	0.466	0.483	0.510	0.508
METALS: BERYLLIUM	LB/MBTU	0.00000111	0.00000087	0.00000073	0.00000106
CADMIUM	LB/MBTU	0.00000149	0.00000084	0.00000078	0.00000060
CHROMIUM	LB/MBTU	0.0000147	0.00000667	0.00000636	0.0000121
LEAD	LB/MBTU	<.000010	<.000010	<.000010	<.000010
ZINC	LB/MBTU	0.000981	0.001380	0.002560	0.000260
HYDROCARBONS AS PROPANE	LB/MBTU	0.00118	0.00118	0.00118	0.00117
OXIDES OF NITROGEN	LB/MBTU	0.273	0.280	0.273	0.274

TPH – Tons per hour

(From Woodman Engineering, Inc., 1989)

TABLE 6–10

AVERAGE EMISSION TEST RESULTS
SMURFIT NEWSPRINT, NEWBERG, OREGON

POLLUTANT	TEST DAY 1 WOOD ONLY	TEST DAY 2 1% TDF	TEST DAY 3 1 1/2% TDF	EMISSION LIMIT
PARTICULATE MATTER gr/scfd @ 12% CO_2	0.022	0.0374	0.0459	0.04 gr/scfd
VOLATILE ORGANIC COMPOUNDS (VOC) tons/yr @ 8760 hr/yr	110	35.1	306	189 tons/yr

(From Horizon Engineering, 1987)

TABLE 6–8

AVERAGE EMISSION DATA FROM BURNING TDF AND COAL*
WILLAMETTE INDUSTRIES, INC., PORTLAND, OREGON

POLLUTANT	UNITS	HOGGED FUEL ONLY	HOGGED FUEL WITH 6% TDF	HOGGED FUEL WITH 13% COAL
PARTICULATE MATTER	gr/sdcf	0.0328	0.0692	0.0339
OPACITY (pre–drier)	%	36	40	22
SO_2	ppm**	0	16	6
ZINC	lb/day	7.3	114.9	26.3

* All values adjusted to a steaming rate of 160,000 lb/hr.
** parts per million

(From Vosler, 1985)

TABLE 6–9A

SUMMARY OF AVERAGE AIR EMISSIONS FOR EACH TEST CONDITION CHAMPION INTERNATIONAL, SARTELL, MINNESOTA

TEST TYPE	UNITS	TEST 1 0% TDF	TEST 2 15% TDF	TEST 3 30% TDF	EMISSION LIMIT (LB/MBTU)
PARTICULATE MATTER	LB/MBTU	0.05	0.09	0.22	0.1
SULFUR DIOXIDE	LB/MBTU	0.25	0.33	0.45	1.2
NOx	LB/MBTU	0.64	0.67	0.47	0.7
METALS: CADMIUM		0.000005	0.000015	0.000026	NONE
CHROMIUM		0.000023	0.000005	0.00024	NONE
LEAD		0.000071	0.00022	0.00032	NONE
ZINC		0.00025	0.039	0.086	NONE
TOTAL HYDROCARBONS	ppm* – (AS CARBON)	959	16	3	NONE
	LB/HR – (AS CARBON)	165	2.7	0.6	NONE
PAH**	–	–	–	–	–

* ppm – parts per million
** PAH – All polynuclear aromatic hydrocarbons were below detection levels.

(From Pace Laboratories, 1988)

TABLE 6–7

SUMMARY OF AIR EMISSIONS FROM BURNING TIRES
CROWN ZELLERBACH PULP MILL

POLLUTANT	TIRES, OIL, AND WOOD FIRED	OIL AND WOOD FIRED	DIFFERENCE WITH TIRES	LIMIT
PARTICULATE MATTER (@ 12% CO_2)	0.056 GR/DSCF	0.03 GR/DSCF	0.026 – INCREASE	0.10 GR/DSCF @ 12% CO_2
ZINC (@ 7% O_2)	28400 ug/m3	3600 ug/m3	14800 – INCREASE	NOT LISTED
ARSENIC (@ 7% O_2)	11.3 ug/m3	4.5 ug/m3	6.8 – INCREASE	NOT LISTED
PNA	–	–	– NO DIFFERENCE	NOT LISTED

(From Washington Department of Ecology, 1986)

TABLE 6–6

SUMMARY OF EMISSIONS FROM THE TDF–SLUDGE TEST–BURN
INLAND–ROME, INC., ROME, GEORGIA

POLLUTANT	DATE	TDF FEED RATE (TONS/DAY)	HEAT RATE (MBTU/HR)	EMISSIONS*
TOTAL SUSPENDED PARTICULATES (TSP)	8/5/89	0	810	33.76 lb/hr
	8/11/89	**25	754	36.76 lb/hr
NOx	9/11/87	0	NOT AVAILABLE	315.3 mg/m^3
	1/31/89	**25	NOT AVAILABLE	338 mg/m^3

* Emissions are combined rates from two boilers.
** Approximately 25 tons of sludge and 25 tons of TDF were fed concurrently to each boiler.

(From Georgia Department of Natural Resources, 1991)

TABLE 6–5

SUMMARY OF AIR EMISSION RATES FROM BURNING TIRES
GREAT SOUTHERN PAPER COMPANY

POLLUTANT	DATE	POWER BOILER #	TDF FEED RATE (LB/HR)	EMISSION RATE (LB/MBTU)	EMISSION LIMIT (LB/MBTU)
PARTICULATE MATTER	11/89	1	2585	0.14	0.30
	10/90	1	4480	0.14	0.30
	11/89	2	2584	0.08	0.29
	10/90	2	4870	0.15	0.28
NOx	3/88	1	0	0.67	NONE
	10/90	1	4837	0.20	NONE
	10/90	2	6480	0.29	NONE

(From Georgia Department of Natural Resources, 1989 and 1990)

TABLE 6–4

EMISSIONS OF PNAs AND METALS FROM BURNING AUXILIARY FUELS PORT TOWNSEND PAPER COMPANY

(Measured in ug/m^3 at 7% O_2)

POLLUTANT	BURNING TIRES	BURNING OIL	DIFFERENCE WITH TIRE BURNING	
ZINC	274000	16700	257000	INCREASE
VANADIUM	10	1017	−1007	DECREASE
NICKEL	65	778	−713	DECREASE
LEAD	145	681	−536	DECREASE
PHENANTHRENE*	846	473	373	INCREASE
CHROMIUM	38	62	−24	DECREASE
CADMIUM	34	48	−14	DECREASE
ANTHRACENE*	29	11	18	INCREASE

* Polynuclear Aromatic Hydrocarbons (PNA)

(From Washington Department of Ecology, 1986)

TABLE 6–3

SUMMARY OF AIR EMISSION RESULTS FOR NEKOOSA PACKAGING

POLLUTANT	UNITS	WITH TIRES	WITHOUT TIRES	LIMIT
Particulate Matter	lb/Mbtu	0.092	0.082	0.38
SO_2	lb/Mbtu	1.13	1.1	5.5
NO_x	lb/Mbtu	0.49	0.5	NL
NO_x	lb/hr	221	230	720
CO	lb/hr	301	223	1155
THC	lb/hr	8.89	3.23	NL
Arsenic	lb/yr	43.8	52.6	25
Cadmium	lb/yr	<43.8	<35	25
Lead	lb/hr	0.037	0.038	0.00349
Nickel	lb/yr	<158	<140	250
Zinc	lb/yr	15234	12553	NL
Mercury	lb/hr	0.0012	0.001	0.017
Chromium VI	lb/yr	649	227	2
Chromium VI	lb/hr	0.0741	0.0259	0.017
HCl	lb/hr	3.63	1.95	1.368
Benzene	lb/yr	<978	<843	300
PCB	lb/yr	0.159	0.098	0.1
PAH	lb/hr	0.017	0.012	17.472
Dioxins	lb/yr	0.00009	0.00013	0.0001

(From Wisconsin Department of Natural Resources, 1990, and Clean Air Engineering, 1989)

TABLE 6–2

SUMMARY OF RETURNED QUESTIONNAIRES FROM COMPANIES WHICH HAVE TEST–BURNED OR ARE BURNING SCRAP TIRES

COMPANY NAME	LOCATION	# BLRS KILNS	CAPACITY	HEAT RATE	TIRE SIZE	OTHER FUELS	% TIRE	POLL. CONTROL EQUIPMENT	CONT. EMISSION MONITORING
Arizona Portland Cement	Rillito, AZ	1			2" X 2"	coal	5–20	fabric collectors	opacity
Ash Grove Cement West, Inc.	Durkee, OR	1	500,000 ton/yr				10	ESP*	opacity, CO, O_2, NOx
Boxcrow Cement Co.	Midlothian, TX	1	3100 tons/day	3.5 MBtu/ton	2" x 6"	coal	10–12	baghouse	SO_2, NOx, opacity
Calif. Portland Cement Co.	Mojave, CA	1	3250 tons/day	3.3 MBtu/ton	2.5" x 2.5"	coal	30	filter baghouse	opacity
Calaveras Cement Co.	Redding, CA	1	650,000 tons/yr		shredded	coal	20	baghouse	NOx, CO, O_2
Champion International	Bucksport, ME	1	500,000 lb/hr	814 MBtu	2" X 2"	oil, coal, biomass, sludge	10	ESP	opacity, CO_2, SO_2, NOx
Fort Howard Corp.	Green Bay, WI	5			1" x 1"	coal, pet. coke, RDF	3	baghouse	opacity, SO_2
Georgia Pacific	Cedar Springs, GA	2	690 x 10^6 Btu/hr	22,000 Btu/hr/ft^3	1.5" x 1.5"	coal, woodwaste, peanut hulls, No. 6 oil, gas	5	multicyclones followed by venturi scrubbers	no gas analyzers
HOLNAM, Inc.	Seattle, WA	1	1500 stpd**	5.3 MBtu/st	2" x 2"	coal	15	ESP	O_2, opacity, CO
				6.0 MBtu/st	2" x 2"	gas	20	ESP	O_2, opacity
Kosmos Cement Co.	Louisville, KY	1	2160 tons/day	302,650,000 Btu/hr		coal	12	baghouse	opacity
Roanoke Cement Co.	Roanoke, VA	***5(1)	550,000 tons/yr	325 MBtu/hr	whole		20		
Southdown, Inc	Lyons, CO	1	1400 tons/day	4.8 MBtu/ton	3" x 3"	waste oil, gas, coal	5	baghouse	opacity
Southwestern Portland Cem. Co.	Fairborn, OH				wh–36"	fossil, haz wst.	10–15	fabric filter dust collector	NO, SO_2, CO_2,
Uniroyal Goodrich	Eau Claire, WI	1	100,000 lb/hr		3 sq. in.	coal	5	particle collectors on stack	O_2
Willamette Industries	Albany, OR	1	180,000 lbs/hr	3,400 MBtu/day	2" X 4"	hog fuel	2 by wt	wet scrubber	opacity
Wisconsin Power & Light	Beloit, WI	2(1)	75 Mwatts	10,000 Btu/kwhr	1" x 1"	coal	7	ESP	opacity

* ESP = electrostatic precipitator

** stpd = standard tons per day

*** Number in parentheses indicates number of boilers burning tires.

TABLE 6-1 (Page 8 of 8)

CEMENT COMPANIES LISTED IN
"THE AMERICAN CEMENT DIRECTORY, 1990"

	Contacted?	Burn Tires?
Kosmos Cement Company		
Kosmosdale, Kentucky;	Yes	Test Burned
Pittsburgh, Pennsylvania	No	
Texas Industries, Inc.		
Midlothian, Texas;	Yes	No
Artesia, Missouri;	Does not own.	
New Braunfels, Texas	Yes	No
Texas-Lehigh Cement Company		
Buda, Texas	Yes	Yes - Test-burned
Texas Sunbelt Cement (Distribution Only)		
Corpus Christi, Texas	Yes	No - Distribution only

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CEMENT COMPANIES LISTED IN
"THE AMERICAN CEMENT DIRECTORY, 1990"

	Contacted?	Burn Tires?
River Cement Company St. Louis, Missouri Plant: Festus, Missouri	Yes	Yes - Test-burned
Riverton Corporation Riverton, Virginia	Yes	No
RMC Lone Star Davenport, California	Yes	Yes - Test-burned
St. Mary's - New York Cement Company, Inc. Buffalo, New York	Yes	No - No kilns
St. Mary Peerless Cement Company Detroit, Michigan	Yes	No
St. Mary's Wisconsin Cement, Inc. Detroit, Michigan	Yes	No
Santee Portland Cement Corporation Holly Hill, South Carolina	Yes	No
Signal Mountain Cement Company Chattanooga, Tennessee	Yes	No
South Dakota Cement Rapid City, South Dakota	Yes	No
Southdown, Inc. Houston, Texas;	Yes	No
Victorville, California;	No	
Odessa, Texas;	Yes	No
Lyons, Colorado;	Yes	Test Burned
Fairborn, Ohio;	Yes	Permit Expired October, 1990
Brooksville, Florida	No	
Dixie Cement Company Knoxville, Tennessee	Yes	No

TABLE 6-1 (Page 6 of 8)

CEMENT COMPANIES LISTED IN
"THE AMERICAN CEMENT DIRECTORY, 1990"

	Contacted?	Burn Tires?
Miron/U.S.A Ltd. Glens Falls, NY	Disconnected number.	
Missouri Portland Cement Company Grand Chain, Illinois; Independence, Missouri	Yes Yes	No No
The Monarch Cement Company Humboldt, Kansas; Des Moines, Iowa	Yes Yes	Yes - Test-burned No - No kilns
Mountain Cement Company Laramie, Wyoming	Yes	No
National Cement Company, Inc. Encino, California	Yes	No
National Cement Company, Inc. (Southeast Division) Ragland, Alabama	Yes	No
National Cement Company of California, Inc. Lebec, California	Yes	No
National Portland Cement Company Palmetto, Florida	Yes	No
Nevada Cement Company Fernley, Nevada	Yes	No - No Kilns
Northwestern States Portland Cement Company Mason City, Iowa	Yes	No
RC Cement Company, Inc. St. Louis, Missouri	Yes	No - No Kilns
Roanoke Cement Co. Roanoke, Virginia Test Burn	Yes	Yes - Preliminar
Rinker Materials Corporation Miami, Florida	Yes	No

TABLE 6-1 (Page 5 of 8)

CEMENT COMPANIES LISTED IN
"THE AMERICAN CEMENT DIRECTORY, 1990"

	Contacted?	Burn Tires?
Trinity Marketing Group		
Dallas, Texas		
Metaline Falls, Washington	No	
Whitehall, Pennsylvania;	No	
Alpena, Michigan;	No	
Paulding, Ohio	No	
Lehigh Portland Cement Company		
Allentown, Pennsylvania (Corp. H.Q.)	Yes	Sent request letter
Buffington-Gary, Indiana;	No	
Mason City, Iowa;	No	
Union Bridge, Maryland;	No	
Waco, Texas;	No	
York, Pennsylvania	No	
Lone Star Industries, Inc.		
Cape Girardeau, Missouri;	Yes	No
Pryor, Oklahoma;	Yes	No
Bonner Springs, Kansas;	No	
Greencastle, Indiana;	Yes	No
Nazareth, Pennsylvania;	Yes	No
Maryneal, Texas;	Yes	No
Oglesby, Illinois	Yes	No
Medusa Cement Company		
Cleveland, Ohio; (Main Office)	Yes	Yes - Sent letter.
Charlevoix, Michigan;	Yes	Yes - Test-burned
Clinchfield, Georgia;	No	Yes
Wampum, Pennsylvania;	No	No
Manitowoc, Wisconsin;	No	
Milwaukee, Wisconsin;	No	
Detroit, Michigan;	No	
Chicago, Illinois;	No	
Green Bay, Wisconsin;	No	
Toledo, Ohio;	No	
Ferrysburg, Michigan;	No	
Plover, Wisconsin;	No	
Rhinelander, Wisconsin;	No	
Doraville, Georgia;	No	
Orlando, Florida	No	

TABLE 6-1 (Page 4 of 8)

CEMENT COMPANIES LISTED IN
"THE AMERICAN CEMENT DIRECTORY, 1990"

	Contacted?	Burn Tires?
Gulf Coast Portland Cement Company		
Houston, Texas	Yes	No
Hawaii Cement		
Honolulu, Hawaii	Yes	No
Heartland Cement Company		
Independence, Kansas	No	
Hercules Cement Company		
Stockertown, Pennsylvania	Yes	No
Ideal Basic Industries, Inc.		
Fort Collins, Colorado;	Yes	Yes
Florence, Colorado;	No	
Superior, Nebraska	No	
Illinois Cement Co.		
LaSalle, Illinois	Yes	Has test-burn plannec
Independent Cement Corporation		
Catskill, New York	Yes	No
Hagerstown, Maryland	Yes	No
Kaiser Cement Corporation		
Cupertino, California	Yes	No
Keystone Cement Company		
Bath, Pennsylvania	Yes	No
Lafarge Corporation		
Reston, Virginia (Corp. H.Q.)	No	
Plants:		
Demopolis, Alabama;	Yes	No
New Braunfels, Texas;	Yes	Yes
Fredonia, Kansas	Yes	Test burn planned
Masonry Grinding and Color Blending		
Birmingham, Alabama	No	
Florida Brand		
Tampa, Florida	No	

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CEMENT COMPANIES LISTED IN "THE AMERICAN CEMENT DIRECTORY, 1990"

	Contacted?	Burn Tires?
Coastal Cement Corporation		
Boston, Massachusetts	Yes	No - Distribution Only
Continental Cement Company, Inc.		
Chicago, Illinois;	No	
Hannibal, Missouri	Yes	No
Davenport Cement Company		
Davenport, Iowa	Yes	No
Dixon-Marquette Cement, Inc.		
Dixon, Illinois	Yes	No
Dragon Products Company		
Thomaston, Maine	Yes	No
Dundee Cement Company		
Dundee, Michigan (Corp H.Q.)	Yes	Yes - Test-burned
Essroc Cement Group		
Plants:		
Egypt, Pennsylvania;	Yes	Yes - many plants burning
Nazareth, Pennsylvania (Corp. H.Q.);	Yes	Sent request letter
Frederick, Maryland;	No	
Speed, Indiana;	No	
Logansport, Indiana;	No	
Essexville, Michigan;	No	
Federal White Cement, Inc.		
Oil City, Pennsylvania	Phone # out of order.	
Florida Crushed Stone Company		
Brooksville, Florida	Yes	Yes - have test burned.
Giant Cement Company		
Harleyville, South Carolina	Yes	Yes - burn unsuccessful
Gifford-Hill and Company, Inc.		
Midlothian, Texas;	No	
Riverside, California;	No	
Oro Grande, California	No	
Dallas, Texas	No	

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CEMENT COMPANIES LISTED IN
"THE AMERICAN CEMENT DIRECTORY, 1990"

	Contacted?	Burn Tires?
BCW, Inc. Phoenix, Arizona	Yes	No Kilns
Boxcrow Cement Company, L.P. Midlothian, Texas	Yes	Yes - One Day
Calmat Company Los Angeles, California	Yes	No - No Kilns
California Portland Cement Company (Subsidiary of Calmat Company)		
Colton, California	Yes	No
Mojave, California;	Yes	Yes - Test burned.
Rillito, Arizona	No	
Capitol Aggregates, Inc. San Antonio, Texas	Yes	No
Capitol Cement Corporation Martinsburg, West Virginia	Yes	No
CBR Cement - Calaveras Cement Company Redding, California	Yes	Yes - Burns 20% tire
CBR Cement Corporation Monolith, California	Yes	No
CBR Cement, Calaveras Cement Company Sparks, Nevada	No	
CBR Cement, Tilburn Cement Company Seattle, Washington	Yes	No - Distribution On
Centex Cement Enterprises, Inc. Dallas, Texas	No	
Citadel and Florida Marketing Groups Atlanta, Georgia	No	
Citadel Brand Atlanta, Georgia	No	

TABLE 6-1 (Page 1 of 8)

CEMENT COMPANIES LISTED IN "THE AMERICAN CEMENT DIRECTORY, 1990"

	Contacted?	Burn Tires?
Alamo Cement Company San Antonio, Texas	Yes	No
Alaska Basic Industries, Inc. Anchorage, Alaska	Yes	No - No Kilns
Allentown Cement Company, Inc. Blandon, Pennsylvania	Yes	No
Arizona Portland Cement Company Rillito, Arizona	Yes	Yes - Burns 10% tires
Armstrong Cement & Supply Corporation Cabot, Pennsylvania	Yes	No
Ash Grove Cement Company Overland Park, Kansas (Corp. H.Q.)	Yes	Yes
Plants:		
Chanute, Kansas;	No	Yes
Louisville, Nebraska;	No	Can burn tires
Foreman, Arkansas	No	Can burn tires
Ash Grove Cement West, Inc.		
Plants:		
Durkee, Oregon;	Yes	Yes - test burned, in permitting process
Inkom, Idaho;	Yes	No
Seattle, Washington;	Yes	No
Clancy, Montana;	Yes	No
Leamington, Utah;	Yes	No, have discussed with state.
Blue Circle Atlantic, Inc.	Yes	Test Burned in England.
Plants:		
Ravena, New York;	Yes	No
Sparrows Point, Maryland	Yes	No kilns.
Blue Circle, Inc.		
Plants:		
Calera, Alabama;	Yes	No
Atlanta, Georgia;	Yes	Test Burned
Tulsa, Oklahoma	Yes	No - Too Expensive

control equipment, especially electrostatic precipitators and baghouses, is more effective in capturing particulate matter than scrubbers. The amount of increased efficiency of ESPs, relative to scrubbers, is not known when combusting tires. Pope (1991) states that a fluidized-bed boiler is the "best bet" for complete combustion, which is the key to efficiently converting tires into energy in a clean and environmentally sound manner. Thus, based upon these findings, it appears that the combustion technology may be the dominant factor that allows for the incineration of 100% tires in a clean and efficient manner.

from 83.0 lb/hr to 109.0 lb/hr. The increase in CO emissions is considered negligible in either case (Almega Corporation, 1991).

6.7 ADDITIONAL OBSERVATIONS

Generally, the sulfur content in tires is moderate, and co-firing with coal can result in both increases or decreases in SO_2 emissions depending on the sulfur content of the original coal or primary fuel. For example, the Big Stone Plant, operated by the Ottertail Power Company in South Dakota, combusts North Dakota lignite. An initial evaluation of the lignite reveals that it has approximately one-half the sulfur of TDF (lignite = 0.85% S; TDF = 1.6% S). However, TDF has 2.5 times the heating value per pound than lignite, and thus, TDF actually has 25 percent less sulfur than lignite on a Btu basis (Schreurs, 1991). The effect on air emissions while combusting TDF is dependent on the type of primary fuel, and is relative to the fuel compared to TDF.

Energy Product of Idaho, Inc. constructed a 3' x 3' pilot plant with a fluidized-bed combustor to test burn tires, refuse-derived fuel (RDF) and a variety of other fuels (Pope, 1991). Emission tests were conducted while combusting the tires. Results of the emission tests from combusting tires and RDF are shown on Table 6-18. Test data revealed that the emission levels of dioxins and furans were not detectable (detection limit = 25 picograms) (Pope, 1991). SO_2 gases released during the combustion process are reduced by the injection of limestone into the combustor and captures SO_2 gases. The gases are removed from the gas stream by the pollution control equipment in collected fly ash. This limestone injection method has resulted in 90% removal of SO_2 gas.

The production of Nitrogen Oxide (NO_x) emissions is low due to the extremely high temperatures in the combustor. Reduction of up to 80% NO_x emissions have been observed when operating the Selective Non-Catalytic NO_x Reduction Technology, which injects ammonia into the vapor space of the combustor. Modesto Energy Company uses this technology to control NO_x emissions at their tire-to-energy facility.

Several other factors influence air emissions when combusting scrap tires, but all of these factors have not been thoroughly studied. Drabek and Willenberg reported that PAH emissions would not increase if the combustion conditions are properly maintained. Other factors such as pollution control equipment, boiler-type, size of TDF, and quality of TDF may also influence the rate and type of air emissions. However, the amount of influence that each factor has on air emissions has not been determined. In general, modern pollution

while combusting coal-tire mixtures consisting of 0, 10, and 20 percent tire chips by weight. NOx and SO_2 emissions could not be determined due to absorption of these compounds by the gas analyzer sample train. PAHs quantified were benzene, phenol, crysene, and benzo(a)pyrene.

A summary of the air emissions testing results are provided in Table 6-16. Particulate matter emissions measured for 0, 10, and 20 percent tire mixtures were 0.88, 2.32, and 2.13 lb/MBtu, respectively. Carbon monoxide (CO) emission results were 0.17, 0.22, and 0.33 lb/MBtu for 0, 10, and 20 percent tire mixtures, respectively. Both particulate matter and CO emissions increased when combusting tires. Opacity readings taken during the testing increased to as high as 50 percent with the combustion of tires. Some of this opacity increase is thought to be due to zinc oxide emissions. Because the sulfur content in tires is generally the same as Virginia coal, the SO_2 emissions were not expected to change substantially when combusting tires. Furthermore, because tires have a higher heating value than this coal, SO_2 emissions on a lb/MBtu basis, should be less as the percent of TDF combusted increases.

Phenol and chrysene emissions increased with increasing tire percent. No trends in benzene or benzo(a)pyrene were observed for increased or decreased emissions with the amount of tire mixture.

After reviewing the test conditions of the trial burn, the Virginia Department of Air Pollution Control considers the test data inconclusive.

MONSANTO CHEMICAL

On December 18 and 19, 1990, a series of tests were conducted to determine air emissions and the operating efficiency of Boiler #8 at Monsanto Company in Sauget, Illinois. All emission test data were collected at the exhaust of the electrostatic precipitator (ESP) during 100% coal use and a 80% and 20% mixture of coal and TDF, respectively. Particulate matter emissions were also tested at the inlet to the ESP.

Table 6-17 presents a summary of the results of these tests. Metals and dioxin data are not available and are not included in Table 6-17. In summary, the coal/TDF mixture significantly reduced O_2, particulate matter, VOCs, NO_x, HCl, and HF emissions. NO_x emmisions decreased by 30 percent, particulate matter emissions decreased by 50 percent, and the accompanying ESP performance increased by 4 percent when combusting coal and TDF. Only CO and SO_2 emissions increased when combusting the coal/TDF fuel. The CO emission rate increased from 0.38 lb/hr to 0.53 lb/hr, and the SO_2 emission rate increased

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% Tire Chip Fuel	Average Opacity (%)
0	5.89%
5	6.90%
10	7.46%
15	15.80%

Table 6-14 lists the metal emission results for the four metals analyzed. The most significant change in emissions observed was zinc, which increased more than 150 times when combusting tires. Cadmium emissions increased approximately five times when combusting tires. Chromium emissions increase slightly, but were statistically insignificant. Beryllium was below detection limits in both cases.

UNIROYAL GOODRICH TIRE COMPANY

Air emission compliance testing was conducted on September 27 through 29, 1990 on the No. 2 boiler at the Uniroyal Goodrich Plant near Eau Claire, Wisconsin. Tests included particulate, carbon monoxide, trace metals, and polyaromatic hydrocarbons (PAHs) determinations. Particulate matter emissions are controlled by a Zurn mechanical collector. Air emissions were tested at two different firing conditions: 11.5% TDF and 0% TDF. The TDF consisted of a mixture of waste oil, rubber dust, and hog scrap tires.

The results of the emission tests are provided in Table 6-15. The average particulate matter emission rate when combusting coal was 0.35 lb/MBtu, whereas for coal and tires it was 0.42 lb/MBtu. The State limit for particulate matter emissions is 0.6 lb/MBtu. The emission rates of all the trace metals are quite low, except for zinc. However, the low emission rates may be due to the low volumetric flow rate of exhaust gas. Arsenic and cadmium emissions exceed the State standards. CO concentrations measured were very low. In addition, the concentrations of THC, benzene, and PAHs were extremely low. Because CO and PAHs are both byproducts of incomplete combustion, their concentrations are usually positively correlated.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Stack emissions were measured at the Virginia Polytechnic Institute on the number 6 stoker-fired boiler while firing coal and coal mixed with shredded tires. Emissions from this boiler are controlled by multicyclones. Shredded tire sizes varied from 1/4" to 8" long and 1/2" to 2" wide. Particulate matter and carbon monoxide emissions were determined

summary, NH_3 levels, which averaged 63.9 ppm corrected to 12 percent CO_2, exceeded the permitted level of 50 ppm during the 1988 emissions testing. All other test parameter results were below the levels allowed by the air permit. The average emission for dioxins (PCDD) and furans (PCDF) combined was 2.21 x 10^{-9} g/sec. This average emission rate is less than one percent of the permitted level. The average emission rate for PAHs was 6.2 x 10^{-5} g/sec. Only one species, (benzo(b)fluoranthene) of the 17 PAHs analyzed was detected. None of the 7 PCB aroclors tested were detected. The listed emission for PCB aroclors in Table 6-12A is the detection limit. PM ranged from 0.0017 to 0.0033 gr/dscf, and averaged 0.0023 gr/dscf or approximately 31 lbs/day. These emission rates are about 25 percent of the permitted level of 113 lbs/day.

6.6 AIR EMISSIONS DATA FROM OTHER INDUSTRIES

DOW CORNING

An emission study was conducted from March 9 through 29, 1989 on Dow Corning Corporation's wood-fired boiler in Midland, Michigan during a tire chip trial burn to determine the total particulate and PM-10 (particulate matter ten microns or less) emissions from the boiler. Pollution control for the boiler is an electrostatic precipitator. Tire chips are purchased in approximately 2-3 inches in diameter sizes with wires.

Samples were collected under four operating conditions: tire chips as 0%, 5%, 10%, and 15 percent of the fuel. In addition, sampling for metals (cadmium, total chromium, zinc, and beryllium) was performed during the 0% and 15% tire chip loading conditions. SO_2, NO_x, and opacity were measured using continuous emission monitors (CEMs) on the stack. Table 6-13 provides the air emission results for each of the four operating conditions. In general, particulate emissions increased with increasing tire percentage. The PM emission limit allowed by the DNR (0.035 lbs/MBtu corrected to 12% CO_2) was exceeded only when 15 percent tires of the total fuel were combusted. One sample exceeded the PM limit at 10 percent, but the average of the three samples was just below the limit.

SO_2 and NO_x emissions were below the established emission limits allowed by the air permit. SO_2 increased with an increase in tire percentage, but was still under the limit. SO_2 doubled with 15 percent tires, but were insignificant. No significant trend with NO_x was observed, but NO_x decreased by almost one-half with 15 percent tires.

Opacity increased with increasing percentage of tire chip fuel. The permit limit for opacity is 20%. Averages for test periods are as follows:

Pollutant	Allowable Limit
SO_2	1.67 lb/MBtu
Particulate Matter	0.30 lbs/1,000 lbs of exhaust gasses, corrected to 50% excess air.
Opacity	20%

Due to emission problems, no test data on air emissions was collected. The superintendent of TCL&P indicated that too many tires were combusted initially, causing the opacity monitor to increase to 80% within the first hour. They were combusting approximately 30% tires with coal. However, since their test burn, TCL&P has combusted 2% to 5% tires with wood without opacity problems. TCL&P has burned up their scrap tire pile, and has decided not to pursue combusting tires again.

WISCONSIN POWER AND LIGHT

The Wisconsin Power and Light Company test-burned TDF in one of the two boilers February through March, 1991. The shredded tires were approximately 1" x 1" in size, and were combusted to supplement low sulfur western coal, the primary fuel. Approximately 7% TDF was combusted during the test-burn. Pollution control for the boiler is an electrostatic precipitator. Air emission test results from the test-burn are currently under review by the Wisconsin DNR. The Wisconsin Power and Light Company plans to pursue an operating modification permit if the air quality results are favorable (Eirschele, personal communication).

OHIO EDISON COMPANY

See Section 7.5 for discussion.

6.5 AIR EMISSIONS DATA FROM A DEDICATED TIRE-TO-ENERGY FACILITY

Tables 6-12A and 6-12B are summaries of measured emissions at the Modesto tire-to-energy plant. The emission tests were conducted on January 9 through 14, 1988 and March 2 through 4, 1988 by Radian Corporation, and on October 9 through 10, 1990 by The Almega Corporation. Test parameters include: particulate matter (PM), dioxins and furans, polynuclear aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), ammonium (NH_3), hydrochloric acid (HCl), sulfur oxides (SO_2, SO_3), nitrogen oxides (NO_x), carbon monoxide (CO), total hydrocarbons (THC), metals and particle size distribution. In

CHAMPION INTERNATIONAL, BUCKSPORT, MAINE

Air emissions testing was performed at the Champion International Corporation Steam Plant in Bucksport, Maine during September 27 to October 3, 1989. Two tests were conducted at a feed rate of 0 tons per hour (TPH) 1.5 TPH, 2.5 TPH, and 3.5 TPH. The TDF was added to the flow of biomass entering the fuel feeders to boiler Number 8. Emission rates of hydrocarbons, SO_2, NO_x total particulate matter, and selected metals (beryllium, cadmium, chromium, lead and zinc) were measured by sampling two breechings leading from the electrostatic precipitator to the stack.

The results of the air emission tests are presented in Table 6-9B. Hydrocarbon emissions (as propane) were not affected by the combustion of TDF. Beryllium, cadmium, and chromium emissions decreased as the quantity of TDF increased. Cadmium and zinc emissions increased during all three test conditions when TDF was combusted. Zinc emissions increased almost ten-fold with the maximum TDF input of 3.5 TPH. SO_2 emissions and NO_x emissions were affected only slightly, as TDF input increased.

SMURFIT NEWSPRINT

Source tests for particulate matter and VOCs were conducted on the No. 10 boiler stack at Smurfit Newsprint's plant at Newberg, Oregon. Emissions from the No. 10 stoker-grate boiler is controlled by a multi-clone and a venturi scrubber. The tests were performed to fulfill air contaminant discharge permit requirements for annual compliance and to determine if normal wood fuel could be supplemented with rubber tire chips without violating the emission standards. On May 28, 1987, only wood was combusted, and on June 3 and July 16, 1987 tire chips were added as 1 percent and 1-1/2 percent by weight of the total fuel, respectively.

The average results from three test runs for the three testing conditions are summarized on Table 6-10. Particulate matter test results with only wood fuel were all below the emission standards. Two of the three particulate tests were below the standard at 1 percent and 1-1/2 percent tires. The average of the three tests at 1 percent tires was in compliance, but the average was not in compliance at 1-1/2 percent tires. VOC emissions from runs with 1-1/2 percent tires were also over the permitted amounts, whereas VOC emissions from the first two test conditions were below the allowable limits.

In general, decreases in NO_x and SO_2 emissions have been observed from combusting scrap tires at utility boilers (Kearney, 1990). However, opacity has been observed to increase in some utility boilers from combusting TDF (Kearney, 1990).

Overall, the compiled air emissions data from combusting scrap tires/TDF as a supplemental fuel for energy recovery does not show an adverse impact on air emissions.

UNITED POWER ASSOCIATION

United Power Association in Elk River, Minnesota conducted a study on two boilers to co-fire shredded tires and subbituminous coal. Pollution control for these two stoker-fired boilers is a baghouse. Two studies were conducted: the first used non-steel belted, two inch tire chips, and the second used mostly two to six inch shredded steel-belted radial tires.

During Study I (May, 1979), tire chips were mixed with coal at 0, 6.4, and 10.4 percent proportions, respectively. The feeders operated normally while combusting up to 10.4 percent rubber, but less fuel was fed to the boilers for the same output when the mix went to 6.3 percent rubber. the flames were longer and hotter at the 6.3 percent rubber test and more black smoke than normally for western coal was observed.

Emission rates from Study I are presented in Table 6-11. Overall, SO_2 and particulate matter emission rates remained below the emission limit. Both particulate matter and NO_x decreased as the percentage of tire chips increased.

During study II, the percentage of shredded tires in the fuel was varied for the tests, from 5% to 65% by weight, for one month to evaluate the long-term effects of combusting tires. A 50/50 mixture of coal and rubber appeared to combust the best. Once again, the particulate matter results include both the front and back-half catch.

TRAVERSE CITY LIGHT AND POWER

Traverse City Light and Power (TCL&P) received permission to combust 25 tons per day of tire chips from the Michigan Department of Natural Resources (DNR). Pollution control for the boiler includes a multiple cyclone with sidestream baghouse. Air emission limits allowed by the air permit are presented below:

After modifications of the scrubbers, changes in the air flows to the boiler, and the installation of a solid state steam control system were completed, additional trials were conducted. Trial burns determined that up to 2 percent rubber by weight would be combusted with no measurable increase in particulate matter, and that up to 5 percent rubber could be combusted with no significant increase in particulate matter emissions.

CHAMPION INTERNATIONAL, SARTELL, MINNESOTA

Emission compliance testing was conducted at the Champion International Mill in Sartell, Minnesota on October 28 through 30, 1987 for the Unit 3 stack to measure particulate matter, NO_x, SO_2, metals, PAHs, and THC for each of three test conditions. Test conditions included combusting 0, 15, and 30 percent TDF, respectively. Continuous monitoring of CO_2 and CO was also performed during testing.

Unit 3 is a stoker-fired boiler with a traveling grate. Pollution control consists of facilitated by a multi-clone as a pre-separator followed by a wet scrubber. The boiler operated at approximately 90 percent of capacity for Test Day 1 and part of Test Day 2. The load was gradually increased to 100 percent on Test Day 2.

Test results for particulate matter, SO_2, and NO_x are presented in Table 6-9A. Average particulate matter emissions increased from 0.05 lb/MBtu with no tires to 0.09 lb/MBtu with 15 percent TDF and 0.22 lb/MBtu with 30 percent TDF combusted as fuel. The particulate matter emission limit allowed by the state is 0.1 lb/MBtu. SO_2 emissions increased from 0.25 lb/MBtu to 0.33 lb/MBtu and 0.45 lb/MBtu when combusting 0%, 15%, and 30 percent TDF, respectively. Although emissions increased, SO_2 was still below the limits allowed by the state. NO_x emissions remained the same when combusting 15 percent tires, but decreased to 0.47 lb/MBtu when 30 percent TDF was combusted. All values were below the 0.7 lb/MBtu emission limit allowed by the state. Analyses of PAH samples indicate all samples were below detectable levels for Method 610 compounds. Results of the metals analyses indicate that zinc was the most significant metal emission. Zinc emissions averaged 0.08 lb/hr, 12.3 lb/hr, and 31.0 lb/hr for 0, 15, and 30 percent TDF runs, respectively. Emissions limitations are not established for PAHs, metals, and total hydrocarbons. These emissions are regulated on a case by case basis in Minnesota. In Minnesota, particulate matter compliance, by state rule, requires both the front and back-half catch to be included in the Method 5 test method results.

increased from zero percent to 13 percent with tires. Authors of this source test indicated that although opacity increased while combusting tires, opacity during previous tests (April 24, 1986) and during the first run was zero percent, and thus, this increase in opacity during the combustion of tires is not attributed to the burning of tires (Washington Department of Ecology, 1986).

Zinc emissions increased seven-fold when tires were combusted to supplement the oil. A slight increase in arsenic also occurred when tires were used. Emissions of other metals and PNAs from combusting tires as two percent of the total fuel were not measurably different than when oil was used as the auxiliary fuel.

WILLAMETTE INDUSTRIES

In order to determine the environmental impact of combusting rubber as an alternate fuel to hog fuel, source tests were conducted at the Albany Paper Mill in Oregon to analyze the hogged fuel boiler emissions. Emissions from the 185,000 lb/hr hogged fuel boiler are maintained by a series of multi-clones followed by a fuel dryer and two wet scrubbers. Emissions testing was performed when 6 percent rubber and 13 percent coal by weight was combusted as a supplemental fuel to the hogged fuel.

Table 6-8 lists emission rates while combusting the hogged fuel and rubber tires, and hogged fuel and coal. Particulate matter emissions increased by 53 percent when combusting tires. According to Vosler (1985), the maximum rate of particulate matter discharged occurred while combusting tires, but was only 84 percent of the permitted discharge rate. The opacity did not exceed the limit of 20 percent after the wet scrubbers at any time. The rate of zinc discharges increased by 108 lbs/day, and SO_2 emissions increased from zero to 16 ppm when combusting tires.

When coal was combusted with hogged fuel, the only significant increase was in SO_2 emissions (from zero to 6 ppm). In addition, the rate of zinc discharges increased slightly, and particulate emissions remained essentially the same. Opacity decreased by 39 percent when coal was combusted.

Permit limits were not exceeded at any time during the test burns. However, an increase of 113 tons/year in particulate matter emissions were determined when combusting 6 percent rubber. Guidelines state that a significant increase in particulate emissions is more than 25 tons/year. Thus, particulate matter emissions when combusting 6 percent rubber were well in excess of these guidelines. Increases in SO_2 emissions while combusting 6 percent rubber or 13 percent coal were both considered insignificant.

as TDF feed rate increased. Although Georgia does not have a standard for NO_x, comparison of NO_x emissions from combusting coal and coal with TDF indicated that NO_x emissions did not increase when combusting TDF.

INLAND-ROME, INC.

The Inland-Rome paper mill test-burned TDF-sludge fuels in two of its four boilers. TSP emissions were measured on August 11, 1989 and NO_x emissions were measured on January 1, 1990. The purpose of these test-burns was to determine if a significant increase in emissions would occur when combusting tires. The pollution control equipment for all four boilers is an ESP.

The results of the TDF-sludge test are listed in Table 6-6. A feed rate of 25 tons per day of TDF was measured during the test burns. Increases in TSP and NO_x were measured when combusting the TDF. However, according to calculations from 40CFR60, Appendix C by the Georgia Department of Natural Resources, no significant increases in TSP or NO_x emissions were detected due to the combustion of the TDF-sludge fuel. In addition, 25 tons per day of sludge were also fed into the boilers concurrently with the TDF. Thus, the increase in the emissions may be partially or solely due to the sludge. The increase in the air emissions caused by the TDF alone cannot be determined from these tests.

CROWN ZELLERBACH

On June 10 and 11, 1986, hog fuel and oil and hog fuel, oil, and tires were combusted, respectively, at Crown Zellerbach's Port Angeles, Washington facility. The purpose of the test-burn was to measure particulate emissions from the #8 wood-fired boiler. The #8 boiler was originally designed to combust oil, but was converted to combust hog fuel with oil used as an auxiliary fuel to increase combustion efficiency. Tires have been used at Crown Zellerbach as an alternate fuel to supplement the oil. Approximately 2 percent of the total heat input on June 11 was contributed by tires and 11 percent of heat input was contributed by oil. Pollution control equipment consists of a multi-clone followed by a venturi scrubber. Table 6-7 presents air emission results from the combustion of tires. Average measured concentration of particulate matter increased from 0.030 gr/dscf to 0.056 gr/dscf when tires were combusted. Both were below the allowable emission of 0.10 gr/dscf. All measurements were corrected to 12 percent CO_2. On a lb/hr basis, emissions increased from 9.9 lb/hr (0.069 lb/MBtu) to 16.3 lbs/hr (0.14 lbs/MBtu) with tires. Opacity

NEKOOSA PACKAGING

On August 4 through 11, 1989 Nekoosa Packaging conducted air emissions testing at their Tomahawk Mill in Tomahawk, Wisconsin. The purpose of the tests was to determine differences in air emissions from combusting coal and bark versus combusting coal, bark, and rubber in the form of scrap tires (TDF). Emissions from boilers are controlled by an electrostatic precipitator. A summary of the air emission results is provided in Table 6-3.

Test results indicated increased emissions in SO_2, CO, HCl, polychlorinated biphenyls (PCBs), total hydrocarbons (THC), zinc, and hexavalent chromium. Decreased emissions were observed in particulate matter and NO_x. Arsenic, lead, chromium (as chrome VI), and benzene were high for both conditions. Dioxin emissions were nearly the same for both conditions.

PORT TOWNSEND PAPER COMPANY

Air emissions were measured from power boiler No. 10 at the Port Townsend Paper Company Kraft Pulp Mill in Port Townsend, Washington. On February 25, 1986, tires and hog fuel were combusted, and on March 5, oil and hog fuel were combusted. Pollution control equipment consists of a multi-clone followed by a venturi scrubber.

The average measured particulate concentration emitted when tires were combusted was 0.149 gr/dscf. The average concentration on the day when tires were not combusted was 0.117 gr/dscf. Both measured emissions were above the allowable emission of 0.1 gr/dscf. All measurements were corrected to 7% O_2.

Emissions of PNAs and metals were measured when tires were combusted as an auxiliary fuel and when only oil was used as the auxiliary fuel. Table 6-4 presents the results of the air emission tests. A large increase in zinc emissions resulted when combusting tires. Emissions of lead, nickel, and vanadium increased when oil was combusted. Slight increases in emissions of PNAs, phenanthrene and anthracene, and decreases in chromium and cadmium were observed when tires were combusted.

GREAT SOUTHERN PAPER COMPANY

Results from air emission testing at Great Southern Paper Company in Georgia are presented on Table 6-5. In general, particulate matter increased, but the emission rates were all below the emission limit stated in the air permit. NO_x levels were more than one-half the emission rate of NO_x from combusting coal. In addition, NO_x emissions decreased

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percent increase in particulates was observed from combusting tires with gas (from 0.037 gr/dscf corrected to 10% O_2 to 0.058 gr/dscf corrected to 10% O_2). Although the measured emissions increased when combusting tires as a co-fuel, the emission rates were still below the allowable limit of 0.067 gr/dscf corrected to 10% O_2 (Drabeck, 1986).

6.3 AIR EMISSIONS DATA FROM PULP AND PAPER MILLS

Air emissions from combusting scrap tires at pulp and paper mills have generally resulted in mixed data. Increased particulate emissions of 38 percent - 93 percent have been observed while combusting TDF in hog fuel boilers (Kearney, 1990). Hog fuel, or wood waste, is considered a "clean fuel". Increased emissions would not be unexpected when adding TDF due to the relative characteristics of tire material versus wood. Data has revealed increases in zinc by 1500 percent (Kearney, 1990). No significant differences have been observed with polynuclear aromatic hydrocarbons (PAHs).

Lower emissions of several metals including chromium, cadmium, and lead have been observed. Lower emissions in SO_2 and NO_x have been observed when the primary fuels at these pulp and paper mills are coal or oil. Again, because of the relative characteristics of TDF versus coal, decreases in emission in SO_2 and NO_x would be expected.

Air emissions testing was conducted at a stationary grate, wood-fired boiler to measure VOC emissions. The location of the wood-fired boiler is not specified by Caron (1985). During the test, 10 percent of the total heat input was shredded rubber tire chips. The results indicate that emission rates were essentially the same as those measured when no rubber chips were combusted (Caron, 1985). At another site, CO emissions were measured from a boiler combusting shredded rubber tire chips. Emissions were essentially the same as those measured when rubber chips were not combusted. Because both CO and VOCs are by-products of incomplete combustion, emissions of these pollutants should follow the same trend when combusting tires.

Some wood-residue fired boilers can combust controlled amounts of rubber tire chips without increasing VOC emission rates. However, the feed rates of tires which can be combusted without influencing emissions of VOCs need to be established. It would be expected that these levels would vary from boiler to boiler and depend on flexibility in the control of primary to secondary air to the unit, as well as grate design.

6.0 SUMMARY OF AIR EMISSIONS DATA BY COMBUSTION SOURCE

6.1 SOURCES OF INFORMATION

All cement kilns listed in "The American Cement Directory" (1990) were contacted to determine whether their facility had experience in combusting scrap tires. Table 6-1 is a list of all the cement companies contacted in the U.S. with information on their level of experience with combusting scrap tires. Several state agencies were also contacted to obtain names of other companies that have test-burned or are currently combusting tires.

Each company that indicated they had test-burned or are combusting tires was requested to complete a questionnaire to obtain some information regarding their facility and conditions when combusting scrap tires. In addition, air emissions data was requested from each company. A copy of this questionnaire is provided in Appendix A; the request letters and a list of recipients is provided in Appendix B; and completed questionnaires are included in Appendix C. Table 6-2 is a list of companies which returned questionnaires and a summary of their responses. No air emissions testing information was received with questionnaires from the cement companies listed in Table 6-2. Some of the questionnaires have some air emission data, however, no air emission limits were included for comparison. In addition, no information regarding the testing conditions during the collection of air emissions data were provided and thus, were not included in the following section.

6.2 AIR EMISSIONS DATA FROM KILNS

According to Kearney (1990), combustion of scrap tires in cement kilns reduces NO_x by approximately 10 percent. In general, the nitrogen (N) content is much lower than in coal (TDF = 0.24 percent N versus coal = 1.76 percent N). SO_2 and CO emissions on the average do not show significant changes.

BOISE CASCADE

Boise Cascade's plant in Wallula, Washington is a pulp and paper mill; however, a source test was conducted on their lime kiln on May 20-21, 1986. Particulate matter emissions were measured when combusting natural gas and with natural gas supplemented with approximately 15 percent heat input from shredded tires (approximately 87 Mbtu/hr). Pollution control equipment consists of an Air Pol variable throat venturi scrubber. A 64

Fuel characteristics, such as ash, chloride and metals, affect the characteristics of fly ash formed. Large fluctuations in the quantity and type of fly ash significantly affect the resistivity and the ESP collection efficiency. A high concentration of fine particulates reduces the corona discharge which reduces the overall collection efficiency. Reductions in ESP collection efficiencies occur in the submicron particle size range.

Flue gas stream characteristics (such as temperature, moisture content, and volumetric flow rate) affect the resistivity and performance of the ESP. At high flue gas temperatures, resistivity is more predictable. Moisture can encapsulate fly ash particles, significantly altering electrical characteristics resulting in a reduction of collection efficiency. High flue gas flow rates reduce the residence time of the fly ash in the ESP thereby reducing the collection efficiency.

5.3.5 Selective Non-Catalytic Reduction

Selective Non-Catalytic Reduction (SNCR) is a system used to control NO_x emissions. It is based on the gas phase homogeneous reaction between NO_x in the flue gas and NH_3, which produces innocuous nitrogen and water. This reaction is effective to varying degrees within the temperature range of 1300°F to 2200°F. At high temperatures, additional NO_x may form, while at lower temperatures the reaction falls off drastically. In practice, the optimal temperature for NO_x reduction is 1750°F, with an effective temperature range for NO_x reduction of 1600°F to 2000°F. In general, NH_3 is injected into the hot flue gas by means of either air or steam (carrier gas) at a zone in the flue gas path specifically selected to provide optimum reaction temperature and residence time. Typically, injection will be carried out by wall injectors, usually arranged in multiple zones in the furnace.

There are two known patented processes of SNCR available for resource recovery facility applications. The first process is called Thermal De-NO_x and is licensed by Exxon Research and Engineering. The second, called the NO_x-OUT process, was developed under EPRI sponsorship, and is now licensed by Fuel-Tech. The former process utilizes ammonia injection into the flue gas stream and the latter process utilizes aqueous urea injection. The Modesto Energy Company's tire-to-energy facility is the only tire combusting facility that uses this Thermal De-No_x process.

because any unspent sorbent will coat the bags and absorb acid gas not absorbed in the dry scrubber. Thus, the fabric filter has a greater capability of handling peaks in acid gas concentrations since the efficiency of reagent utilization is increased. In addition, the fabric filter will remove a greater percentage of heavy metals in the low temperature environment.

5.3.4 Electrostatic Precipitators

Electrostatic precipitators are designed to remove particulate matter from gas streams. An electrostatic precipitator collects particulates by producing an electrical charge on the particles and then attracting the particles to collection surfaces of opposite polarity. A typical ESP consists of an alternating array of negatively charged wires or grids and positively charged collection plates. The incoming particles are given an electrical charge through contact with gas ions produced by a high voltage corona discharge. The charged particles pass through a strong electric field causing migration of particles to a collection electrode of opposing polarity. The particulates are dislodged periodically by rappers and fall by gravity into hoppers.

The discharge electrodes are usually small metal wires tensioned by weights or by rigid frames. Collection electrodes are usually flat plates. The electrical system consists of high voltage components used to control the strength of the electric field between the discharge and collection electrodes.

The collection efficiency of an ESP system is affected by several factors. These include the following:

- Collection plate area per unit gas flow;
- Gas velocity through collectors;
- Particle size distribution and properties of the particles;
- Number, width and length of gas passages;
- Electrical field strength;
- Particle in-field residence time; and
- Resistivity of fly ash.

ESP performance is highly dependent on the electrical characteristics of fly ash particles. The critical property affecting ESP performance is the resistivity of the particle. Particles with very low resistivities give up their charge and are re-entrained in the flue gas. Particles with very high resistivities will adhere to the collection plates making them difficult to dislodge. The three major factors that affect the resistivity of the fly ash are: (1) fuel characteristics, (2) particle size distribution and (3) flue gas stream characteristics.

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technology of wet scrubbers at utility facilities is a forced oxidation process. During this process, sulfur oxidizes to calcium sulfate or gypsum.

Existing wet scrubber installations in Europe and Japan which have demonstrated good acid gas removal capabilities have used an ESP/wet scrubber combination, with addition of alkaline reagent (CARB, 1984). Corrosion and scaling have been the major problems encountered in wet scrubbers using alkaline reagents. These problems can be minimized by special design measures and by constructing the scrubber with special corrosion resistant materials.

5.3.3 Fabric Filters (Baghouse)

Fabric filters are typically highly efficient particulate control devices. Collection of particles is accomplished through filtration by fabric filter media. The basic components of a baghouse include a filter medium (tubular bag), a cage to support the bag, a gas-tight enclosure, and a mechanism to remove accumulated particulates. In one typical baghouse design, gases enter the lower portion of the baghouse near the collection hoppers. The gases enter one of a number of separate baghouse compartments where they are directed upward through a cell plate, a sheet of perforated metal with the thimbles protruding from each cell, and into contact with the tube-shaped bag, or fabric filter. The tubular bags are contained in multiple modular units comprising the total baghouse system. When the particulate laden gas reaches the filter medium, the gases pass through while greater than 99 percent of the particulate matter is collected on the filter medium. Initial collection forms a thick porous cake of collected particulate on the bags. The cake then acts as the filtration medium while the bags support the cake.

Periodically the accumulated dust cake layer is removed from the bags. Baghouses are categorized according to the method used for cleaning the bags: shaker, reverse-air and pulse jet. The reverse-air baghouse uses an external centrifugal blower. A large volume of gas from the blower is introduced through a reverse gas damper. This gas gently collapses the bags, cracking the dust cake, and blows it down into the hopper. The pulse jet baghouse uses high-pressure compressed air. The short (50-100 milliseconds) pulse of compressed air forms an energy bubble that travels down the bag, rapidly distending the bag and dust cake. When the fabric reaches its stretch limit, its motion abruptly stops and the dust cake, which has been cracked and broken during transition, is thrown from the fabric and falls into the hopper below.

When used with a dry scrubber, the baghouse also serves as an "acid gas reactor"

moisture content of the flue gas.

Drabek and Willenberg (1987) suggest that the efficiency of the air pollution control equipment be reviewed prior to combusting tire chips as a supplemental fuel. In general, wet scrubbers are not as efficient in collecting fine particulate matter as electrostatic precipitators when combusting scrap tires (Hope, 1991). Other emissions such as VOCs are usually not dependent on the pollution control equipment. VOC emissions are usually a function of the combustion process (Hope, 1991).

Ultimately, the state agency determines what emission rates the pollution control equipment must achieve for a facility. Environmental, energy, and economic impacts of the pollution control equipment are factors which must be considered when determining the appropriate type of pollution control equipment for a facility.

5.3.1 Dry Scrubbers

The flue gas containing fly ash and acid gases (SO_2, HCl, HF, and CO) enters the dry scrubber and is contacted with a finely atomized lime slurry. The slurry can be injected into the dry scrubber through dual phase nozzles or mechanical atomizers. Acid gases rapidly dissolve into the liquid phase of the droplets and react with the absorbent to form solid phase salts. Simultaneously, the solid particles are dried by the heat of the flue gas. During the approximate 10 second residence time in the scrubber, the flue gas is cooled as the water in the lime slurry is evaporated.

5.3.2 Wet Scrubbers

If wet scrubbers are applied for acid gas control, a high-efficiency particulate control device usually precedes the scrubber to ensure compliance with the particulate matter emission standards applicable to new facilities. Electrostatic precipitators have been used in combination with wet scrubbers as flue gas desulfurization (FGD) systems for coal-fired utility boilers. The most widely used scrubber in these applications is an open spray tower using limestone as the absorbent. Removal efficiencies equivalent to those of dry scrubbers have been achieved.

In an ESP/wet scrubber system, the particulate-laden gases first pass through an ESP designed to meet the required particulate matter limitations. The cleaned gases then enter the wet scrubber where SO_2 and HCl are absorbed from the gas stream. The overall reactions of gaseous SO_2 with limestone ($CaCO_3$) as the absorbent results in the formation of calcium sulfite ($CaSO_3$) with some oxidation to calcium sulfate ($CaSO_4$). The current

5.1 REGULATORY REQUIREMENTS

Typically, in order for a facility to combust scrap tires on a regular basis, either as a supplemental or primary fuel, an air permit modification is required by the state or local regulatory agency. Modifications usually include additional emission testing or continuous emission monitoring (CEM) requirements. Changes in air emission limits are usually not required by the state agency. Most state agencies require that the air emissions from facilities combusting scrap tires comply with the existing air emission limits presently allowed by the applicable air permit. Emissions testing by an approved testing contractor are often required to determine the impact of combusting scrap tires on air emissions.

5.2 TYPES OF AIR EMISSIONS

Ambient Air Quality Standards have been established by the U.S. Environmental Protection Agency. The standards establish maximum ground level concentrations of criteria pollutants in the ambient air which the agency determines to be adequate to protect the health and welfare of the public. There are both primary and secondary standards. Primary standards are those required to protect the public health; secondary standards, which are more restrictive, establish levels to protect the public welfare from any known or anticipated adverse effects. Presently air quality standards have been adopted by the EPA for six pollutants, otherwise known as criteria pollutants: particulate matter, sulfur dioxide, ozone, oxides of nitrogen, carbon monoxide and lead.

In addition to these criteria pollutants, the air emissions associated with the combustion of scrap tires may contain non-criteria pollutants. The non-criteria pollutants tend to be the pollutants of greater concern to the public and regulatory agencies when combusting non-traditional fuels. Based upon the reviewed data, the non-criteria pollutant emissions data base is limited to the following pollutants: polynuclear aromatic hydrocarbons, volatile organic compounds (VOCs), dioxins, furans, total hydrocarbons, arsenic, cadmium, nickel, zinc, mercury, chromium, vanadium, hydrogen chloride, benzene, and PCBs. While this listing is lengthy, only two facilities have been tested for the majority of these pollutants.

5.3 AIR POLLUTION CONTROL EQUIPMENT

Air pollution control equipment typically utilized by facilities combusting tires include: cyclones, baghouses, electrostatic precipitators, fabric filter collectors, and scrubbers. All are primarily used to remove particulate matter. However, scrubbers will also reduce gaseous emissions. The mechanics and efficiencies of the pollution control equipment vary from facility to facility.

Cyclones are devices that use centrifugal force, generated by a spinning gas stream, to collect the particulate matter (liquid or solid) from the carrier gas. A fabric filter (baghouse) is a porous structure composed of granular or fibrous material, which collects the particulate dust as the carrier gas passes through the voids of the filter. The filter is constructed of material which is compatible with the carrier gas and particulate, and may be arranged in deep beds, mats, or fabric. Electrostatic precipitators (ESP) collect particulates from the mutual attraction between particles of one electrical charge and a collecting electrode of opposite polarity. In a wet scrubber, a liquid, usually water, is used to capture particulate matter. A venturi is a rectangular or circular flow channel, which converges to a narrow throat section and then diverges back to its original cross-sectional area. Venturi scrubbers are primarily used to remove fine particulate matter, but also removes acid gases: SO_2, HCl and HF.

Emissions test results from several combustion sources show an increase in some emissions in the form of fly ash or fine particulate matter when combusting scrap tires, which can only be collected by high efficiency air pollution control equipment. Emission data indicate that electrostatic precipitators have had success in collecting particulate matter or suspended particulates, especially zinc oxide (ZnO) due to the charge on ZnO (Robinson, 1991). A tire burn test conducted at Monsanto Chemical revealed an increase in the performance of the ESP when combusting tires.

The migration velocity is an empirically derived value and is a function of the electrical field characteristics, inlet particle size and resistivity, and ESP design. Migration velocity depends on the voltage strength of both the charging and collection fields. The migration velocity also depends on the particle size; larger particles have higher migration velocities and are collected more easily than smaller ones. Resistivity also affects the migration velocity; the higher the dust resistivity is, the lower will be the migration velocity. Dust resistivity is a term describing the resistance of a collected dust layer to the flow of electric current. Resistivity can generally be reduced by adjusting the temperature and

TABLE 4-1

TYPES OF COMBUSTION SOURCES

	COMBUSTION SOURCES			
	CEMENT KILNS	PULP/PAPER MILLS	ELECTRIC UTILITIES	TIRE-TO-ENERGY FACILITIES
GEOGRAPHIC LOCATION	240 in US Europe Japan	United States	United States	United States– Modesto Energy Co. W. Germany – Gummi–Mayer KG
WASTE TIRE SPECIFICATIONS	Depends on configuration of kiln. Steel in tires supplements iron for cement. Whole or shredded tires.	Must be dewired. Less than 10 % tires of total fuels on Btu Basis	Whole or shredded tires.	Whole tires.
FUEL HANDLING REQUIREMENTS	Separate fuel feed system design.	Install metering system capable of handling high temperatures.	Modification of fuel feed system.	Uses gravity roller conveyor–belt system
WASTE TIRE SUPPLY PROBLEMS	None.	May have problems due to remote locations of many pulp and paper mills.	Concerned with quality of TDF.	None. U.S. facility is located near world's largest known tire dump.

(Modified from Kearney, 1990)

TABLE 4–2

MAJOR CHEMICAL ELEMENTS IN ASH OF COAL AND THREE RUBBER SAMPLES

ASH ANALYSIS (%)	COAL	RUBBER 1/2" "FUZZ"	RUBBER 2" W/O METAL	RUBBER 2" W/METAL
Silicon as SiO_2	47.98	18.21	22.00	5.16
Aluminum as Al_2O_3	20.70	6.99	9.09	1.93
Iron as Fe_2O_3	18.89	30.93	1.45	0.35
Titanium as TiO_2	0.82	6.01	2.57	0.14
Calcium as CaO	3.30	5.99	10.64	0.56
Magnesium as MgO	0.79	0.73	1.35	0.10
Sodium as Na_2O	0.48	1.07	1.10	0.13
Potassium as K_2O	2.06	0.55	0.92	0.14
Sulfur as SO_3	4.33	8.35	15.38	0.99
Phosphorous as P_2O_5	0.62	0.56	1.03	0.10
Zinc as ZnO	0.02	20.60	34.50	5.14
Metal				85.28
Total	100.00	100.00	100.00	100.00
Base/Acid Ratio	0.37	1.26	0.46	*11.98

* Counting metal as Fe_2O_3

All values normalized to 100%

Ash and coal samples laboratory–prepared.

(From Granger and Clark, 1991)

TABLE 4–3

CEMENT FACILITIES WHICH HAVE TEST–BURNED OR ARE BURNING TIRES

COMPANY NAME	PLT/MILL	CITY	STATE	APPX. SIZE TIRE BURNED
Arizona Portland Cement Co.	Rillito	Rillito	Arizona	2" X 2"
Ash Grove Cement West, Inc.	Durkee	Durkee	Oregon	2", wire free
Blue Circle, Inc	Atlanta	Atlanta	Georgia	
Box Crow Cement Co.	Boxcrow	Midlothian	Texas	2" X 6"
California Portland Cement	Mojave	Mojave	California	2.5" X 2.5"
CBR Cement–Calaveras Cement Co.	Redding	Redding	California	shredded
Dundee Cement		Dundee	Michigan	
Essroc Materials, Inc.		Nazareth	Pennsylvania	
Florida Crushed Stone Co.		Leesburg	Florida	
Giant Resource Recovery		Harleyville	South Carolina	
Gifford Hill Cement Co		Harleyville	South Carolina	whole
Gifford Hill Cement Co.		Midlothian	Texas	
HOLNAM, Inc.	Main office	Dundee	Michigan	
HOLNAM, Inc. for Ideal Basic Ind., Inc.		Dundee	Michigan	2" X 2"
Ideal Cement		Seattle	Washington	2", wire free
Illinois Cement Co.		LaSalle	Illinois	
Kosmos Cement Co.		Kosmosdale	Kentucky	shredded
LaFarge Corp.	Main ofc.	Dallas	Texas	
LaFarge Corp.	Balcones	New Braunfels	Texas	2", wire free
LeHigh Portland Cement Co.		Allentown	Pennsylvania	
Medusa Cement		Charlevoix	Michigan	
Medusa Cement Co.		Cleveland	Ohio	
Medusa Concrete		Clinchfield	Georgia	
Monarch Cement Co		Humboldt	Kansas	
St. Marys Peerless Cement		Detroit	Michigan	
River Cement Co.	Selma	Festus	Missouri	
RMC Lone Star		Davenport	California	
Roanoke Cement Co.		Roanoke	Virginia	whole
Southdown, Inc. (Southwestern)	Lyons	Lyons	Colorado	3" x 3"
Southwestern Portland Cement Co.		Fairborn	Ohio	whole–36"
FOREIGN FACILITIES:				
Heidelberger Cement Plant			W. Germany	
Blue Circle Dry Process Cement Works		Hope	England	whole
Sumitomo Cement Co.			Japan	
Onada Cement Co.			Japan	
Chichibu Cement Co.			Japan	
Osaka Cement Co.			Japan	

TABLE 4–4

PULP AND PAPER MILLS WHICH HAVE TEST–BURNED OR ARE BURNING TIRES

COMPANY NAME	PLANT/MILL	CITY	STATE	APPX. SIZE TIRE BURNED
Champion International	Bucksport	Bucksport	Maine	
Champion International		Sartell	Minnesota	TDF
Crown Zellerbach		Port Angeles	Washington	
Fort Howard Corp.	Green Bay	Green Bay	Wisconsin	
Great Southern Paper		Cedar Springs	Georgia	TDF
Inland–Rome Paper		Rome	Georgia	TDF
Port Townsend Paper Company		Port Townsend	Washington	shredded
Rome Kraft Pulp and Paper Mill		Rome	Georgia	
Smurfit Newsprint		Newburg	Oregon	tire chips
Sonoco Products Co.		Hartsville	South Carolina	
Willamette Industries	Albany Paper	Albany	Oregon	

TABLE 4–5

UTILITY FACILITIES WHICH HAVE TEST–BURNED OR ARE BURNING TIRES

COMPANY NAME	PLANT/MILL	CITY	STATE	APPX. SIZE TIRE BURNED
Illinois Power	Baldwin	Baldwin	Illinois	1" X 1"
Manitowoc Public Utilities		Manitowoc	Wisconsin	shredded
Ohio Edison Company	Toronto	Toronto	Ohio	whole
Ottertail Power Co.	Big Stone	Big Stone City	So. Dakota	2" X 2"
Southern Electric International		Niagra Falls	New York	shredded
Traverse City Light & Power		Traverse City	Michigan	
United Power Association, UPA	Elk River	Elk River	Minnesota	shredded
Wisconsin Power & Light	Rock River	Beloit	Wisconsin	1" X 1"

(Source: EPRI)

QUESTIONNAIRE

RECEIVED
MAR 06 1991

March 4, 1991

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6161 Busch Blvd.
Columbus, OH 43229

Dear Steven:

We are presently in the process of seeking a Permit-to-Install (PTI) and a Permit-to-Operate (PTO) a whole waste tire burning system at our Toronto plant. Additional information may be available if you can wait until the EPA completes their review and rules on our application which is expected early-to-mid April, 1991.

QUESTIONNAIRE RESPONSE:

OHIO EDISON CO

PLANT NAME:	TORONTO
ADDRESS:	TORONTO, OHIO
CONTACT:	WILLIAM J. KOLOSI
PHONE NO.:	216-384-5833
# BOILERS:	1
CAPACITY:	418,000 #/HR STEAM
TIRE SPEC:	WHOLE
MAXIMUM SIZE:	PASSENGER/LIGHT COMMERCIAL
% TIRE FUEL:	20% BY BTU INPUT
PC EQUIPMENT:	ESP
CEM:	OPACITY
MODIFICATIONS:	MINIMAL; CONVEYORS & BOILER PENETRATION
SUPPLY PROBLEMS:	NONE
EMISSION DATA:	LEAD DOWN 5%; PARTICULATE DOWN 28%; NITROGEN OXIDES DOWN 36%; SULFUR EMISSION DOWN APPROXIMATELY 13%.
PERMITS:	WAIVER FOR 7 DAY TEST BURN OBTAINED FROM OEPA

Sincerely,

W. J. Kolosi

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QUESTIONNAIRE

SCRAP TIRE USE

COMPANY NAME: KOSMOS CEMENT COMPANY
PLANT NAME:
ADDRESS: 15301 DIXIE HIGHWAY
LOUISVILLE, KY 40272
PHONE NO.: 502-935-7331
ENVIRONMENTAL ENGINEER/CONTACT: JAMES D. PARKER

OF BOILERS: ONE CEMENT KILN
CAPACITY OF EACH: 2160 TONS/DAY
HEAT RATE OF EACH: 302,650,000 BTU/HOUR, 14 TONS OF COAL/HOUR

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

MAXIMUM TIRE PIECE: 28 INCH OUTER DIAMETER
OTHER FUELS: COAL
% TIRE OF TOTAL FUEL: 12%

POLLUTION CONTROL EQUIPMENT:
BAGHOUSE

CONTINUOUS EMISSION MONITORING EQUIPMENT:
OPACITY

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
USING OUR OWN DESIGN FOR TIRES CONVEYING AND FEEDING WITH DOUBLE AIRLOCKS AT ENTRY TO KILN.

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

ANY COMBUSTION/OPERATING PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

AIR EMISSION DATA:
PARTICULATE = 2.32 LB/HR.; SO_2 = 116.6 LB/HR; NOx = 444.7 LB/HR.;
CO = 114.4 LB/HR.; TOTAL HYDROCARBON = 5.6 LB/HR.; HCl = 3.36/LB/H

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION? TEST BURN PERMIT REQUIRED BY THE AIR POLLUTION CONTROL DISTRICT OF JEFFERSON COUNTY, KENTUCKY.

*THE EPA HAS ACKNOWLEDGED THE POSSIBILITY OF ANOMALOUS RESULTS DUE TO CATION INTERFERENCE WHEN EPA METHOD 26 IS USED TO DETERMINE HYDROGEN CHLORIDE EMISSIONS FROM CEMENT KILNS.

QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: HOLNAM INC.
PLANT NAME: SEATTLE PLANT (DEVIL'S SLIDE PLANT)
ADDRESS: 3400 W. MARGINAL WAY SW — 6055 E. CROYDON RD.
SEATTLE, WA 98106 — MORGAN UT 84050
PHONE NO.: 206-937-8025 — 801-829-6821
ENVIRONMENTAL ENGINEER/CONTACT: SCOTT HEARD — LEVIN OVARD

CEMENT KILNS: 1 — 2
CAPACITY OF EACH: 1500 STPD — 600 STPD EACH
HEAT RATE OF EACH: ~5.3 MM Btu/ST — ~6.0 MM Btu/ST

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

MAXIMUM TIRE PIECE: — 2" TOPSIZE BOTH PLANTS
OTHER FUELS: COAL (SEATTLE) — GAS (DEVIL'S SLIDE)
% TIRE OF TOTAL FUEL: 15% PERMITTED — 20% SOUGHT

POLLUTION CONTROL EQUIPMENT:
ESP — ESP'S

CONTINUOUS EMISSION MONITORING EQUIPMENT:
O_2, OPACITY, CO. — O_2, OPACITY PLANNED POSSIBLY CO

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
HOPPER TO SCREW TO PNEUMATIC CONVEYING — PLAN TO USE COAL S

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO ✓
IF YES, PLEASE EXPLAIN:

ANY COMBUSTION/OPERATING PROBLEMS? YES ____ NO ✓
IF YES, PLEASE EXPLAIN: IN FACT, COMBUSTION AT SEATTLE IS IMPROVED

AIR EMISSION DATA:

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES ✓ NO ____
IF YES, WHAT TYPE OF MODIFICATION? AIR PERMIT FOR BOTH PLANTS

QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: GEORGIA PACIFIC
PLANT NAME: CEDAR SPRINGS OPERATIONS
ADDRESS: P.O. BOX 44 HIGHWAY 273 WEST
CEDAR SPRINGS, GA. 31732
PHONE NO.: (912) 372-5104
ENVIRONMENTAL ENGINEER/CONTACT: DONALD J. MILLER

 # OF BOILERS: TWO BFW COMBINATION FUEL BOILERS
CAPACITY OF EACH: DESIGN 690 X 10^6 BTU/HR
HEAT RATE OF EACH: HEAT RELEASE RATE ~ 28,000 BTU/HR/FT^3

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

(SHREDDED) WHOLE SLIT (WITH METAL REMOVED)

MAXIMUM TIRE PIECE: NOMINAL 1 1/2" x 1 1/2"
OTHER FUELS: COAL, WOOD WASTE, PEANUT HULLS, NO. 6 OIL, GAS
% TIRE OF TOTAL FUEL: ~5%

POLLUTION CONTROL EQUIPMENT:
BARON MECHANICAL COLLECTORS (MULTICYCLONES) FOLLOWED BY AERAL VENTURI SCRUBBERS

CONTINUOUS EMISSION MONITORING EQUIPMENT:
NO GAS ANALYZERS, CONTINUOUS MONITORING OF SCRUBBER FLOW AND DIFFERENTIAL PRESSURE

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
INSTALLED SEPARATE FEEDER SYSTEM FOR TIRE FUEL, HAS RECORDING WEIGHTOMETER. TIRE FUEL METERED IN TO WOODWASTE FUEL FEED

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

ANY COMBUSTION/OPERATING PROBLEM: YES X NO ____
IF YES, PLEASE EXPLAIN: HAS TO BE FED WITH WOOD WASTE FUEL BECAUSE HIGH TEMPERATURE OF TIRE FUEL ALONE WILL DAMAGE BOTTOM GRATES. ALSO HIGH METAL CONTENT WILL AFFECT FEED BELTS, GRATES, AND PLUG ASH REMOVAL LINES.

AIR EMISSION DATA:
PARTICULATES 0.10 – 0.14 #/MMBTU
NOX 0.28 #/MMBTU

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES ✓ NO ____
IF YES, WHAT TYPE OF MODIFICATION? MODIFICATION TO ALLOW ALTERNATIVE FUEL, EMISSIONS INCREASE. INSIGNIFICANT

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QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: FORT HOWARD CORPORATION *
PLANT NAME: GREEN BAY MILL
ADDRESS: 1919 S. BROADWAY
P.O. BOX 19130, GREEN BAY, WISCONSIN 54307-9130
PHONE NO.: (414) 435-8821
ENVIRONMENTAL ENGINEER/CONTACT: AL TOMA

 # OF BOILERS: 5; 1 IS USED 20 DAYS/YR
CAPACITY OF EACH: 100,000; 250,000; 375,000; 500,000; 189,000 LBS STEAM/HR
HEAT RATE OF EACH:

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

(SHREDDED) WHOLE SLIT

MAXIMUM TIRE PIECE: 2" X 2", NORMALLY 1' X 1', BUT COMES LARGER
OTHER FUELS: COAL, PET. COKE, SOME RDF (SMALL AMT)
% TIRE OF TOTAL FUEL: 30 TONS TIRES / 1000 TONS COAL PER DAY; @ 3%

POLLUTION CONTROL EQUIPMENT:
ALL 5 BOILERS TIED INTO 1 BAGHOUSE
BACKUP OF PRECIPITATOR ONLY – NO SULFUR OR NOx CONTROL

CONTINUOUS EMISSION MONITORING EQUIPMENT:
OPACITY – SIEGLER
SO_2 – KVB

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
MIX WITH COAL, INCLINE VALVE TO SILOS AND RUN TO COAL CRUSHER

WASTE TIRE SUPPLY PROBLEMS? YES _____ NO X
IF YES, PLEASE EXPLAIN:
WISCONSIN HAS EXCELLENT PROGRAM FOR CLEANING TIRE DUMPS.

ANY COMBUSTION/OPERATING PROBLEMS? YES _____ NO _____
IF YES, PLEASE EXPLAIN: OPERATIONAL PROBLEMS ONLY
500,000 LB CYCLONE BOILER, NO GOOD WAY TO INPUT TIRES, TRIED W/AIR, BUT HAVEN'T ACCOMPLISHED. CHAIN DRIVE OR STOKER BOILERS ARE JAMMED BY **

AIR EMISSION DATA:
NONE. NO PROBLEMS WITH ASH, EP TOXICIY ON ASH FOR METALS – BELOW LIMITS.

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES _____ NO X
IF YES, WHAT TYPE OF MODIFICATION? TIRES ADDED AS AN ALTERNATE FUEL* IF BOILERS ARE CAPABLE OF BURNING.

* Information obtained by phone
** STEEL (BELTS AND BEADS) IF TIRES ARE NOT SHREDDED WELL. ADDITIONAL REQUIREMENT– INCREASE FREQUENCY OF BLASTING GRATES ON STOKER BOILERS TO 4X/YR DUE TO STEEL MELTING ON GRATES.

QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME CHAMPION INTERNATIONAL *
PLANT NAME: BUCKSPORT MILL
ADDRESS: RIVER ROAD
P.O. BOX 1200, BUCKSPORT, MAINE 04416
PHONE NO.: (207) 469-1700
ENVIRONMENTAL ENGINEER/CONTACT: STEVE JOSE

OF BOILERS: 4; 3 BURNS ONLY OIL, 4th BURNS MULTIFUELS
CAPACITY OF EACH: 500,000 LB/HR STEAM (MULTIFUEL BOILER)
HEAT RATE OF EACH: 814 MBTU

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

(SHREDDED) WHOLE SLIT

MAXIMUM TIRE PIECE: 2" OR LESS, METAL REMOVED
OTHER FUELS: #6 OIL, PULV. COAL, BIOMASS, PAPER SLUDGE
% TIRE OF TOTAL FUEL: PERMITTED UP TO 3.5 TONS/HR, OPERATES AT 2.5 TONS/HR (@ 10%

POLLUTION CONTROL EQUIPMENT:
FIVE-STAGE ELECTROSTATIC PRECIPITATOR

CONTINUOUS EMISSION MONITORING EQUIPMENT:
KIKO MONITORS - OPACITY, ELECTRON 400, CO_2, SO_2, NO_x

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
FEEDER UNIT = CUT HOLE IN CONVEYOR GELDER

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:
USES ONE COMPANY TO SHRED TIRES. TIRES SHIPPED FORM TEXAS AND ATLANTA

ANY COMBUSTION/OPERATING PROBLEM: YES ____ NO X
IF YES, PLEASE EXPLAIN:
TIRES DECREASE AIR; SLOW GRATE SPEED TO ALLOW FOR MORE AIR

AIR EMISSION DATA:
WILL SEND

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION? ASH TESTING REQUIRED
AIR LICENSE -- ADD SOLID WASTE, NO CHANGE IN LIMITS.

* Information obtained by phone.

1737-01-1

REV. 0, MARCH 22, 1991

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QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: CALIF PORTLAND CEMENT CO
PLANT NAME: MOJAVE
ADDRESS: PO BOX 910
MOJAVE, CA 93502
PHONE NO.: (805) 824-2401
ENVIRONMENTAL ENGINEER/CONTACT: Michael L Dwyer

CEMENT KILNS: 1 Precalciner
CAPACITY OF EACH: 3250 TON/DAY
HEAT RATE OF EACH: 3.3 MMBtu/TON

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

MAXIMUM TIRE PIECE: 2½" x 2½"
OTHER FUELS: COAL
% TIRE OF TOTAL FUEL: 30%

POLLUTION CONTROL EQUIPMENT:
FILTER BAGHOUSES

CONTINUOUS EMISSION MONITORING EQUIPMENT:
TWO OPACITY MONITORS ONE EACH ON KILN STACK & COOLER STACK

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

ANY COMBUSTION/OPERATING PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

AIR EMISSION DATA:
NONE

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE ~~STATE~~ County Air District REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION? SIMPLY TO USE SHREDDED TIRES AS A FUEL SOURCE.

We operated on tires twice. Once for 5 days and the other 3 days

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QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: Bridgestone / Firestone, Inc. *
PLANT NAME:
ADDRESS: 2500 N. 22nd Street
Decatur, IL 62526
PHONE NO.: (217) 428-2141
ENVIRONMENTAL ENGINEER/CONTACT: Pete Brinkoetter, Mech. Engineer

 # OF BOILERS: 1
CAPACITY OF EACH: 22,000 lb/hr steam
HEAT RATE OF EACH 29 MBtu/hr

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED (WHOLE) SLIT

MAXIMUM TIRE PIECE:
OTHER FUELS: wood, cardboard, paper, some plastics, nat. gas as fuel supplement
% TIRE OF TOTAL FUEL: 15 % to 16 %

POLLUTION CONTROL EQUIPMENT:
none, has secondary combustion chamber

CONTINUOUS EMISSION MONITORING EQUIPMENT:
opacity

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
modifications to secondary combustion chamber.

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:
manufactures tires on-site.

ANY COMBUSTION/OPERATING PROBLEM: YES X NO ____
IF YES, PLEASE EXPLAIN: Proprietary

AIR EMISSION DATA:
measures particulate matter, CO, and CO_2 only

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES ____ NO ____
IF YES, WHAT TYPE OF MODIFICATION? Permit limits number of operating hours. Can burn 100% tires.

* Information obtained by phone.

1737-01-1

REV. 0, MARCH 22, 1991

QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: CALAVERAS CEMENT CO.
PLANT NAME: REDDING PLANT
ADDRESS: 8750 WONDERLAND BLVD.
REDDING, CA 96003
PHONE NO.: 916 225 1581 EXT 141
ENVIRONMENTAL ENGINEER/CONTACT: GREGORY JUELL (PROCESS SUPERINTENDENT)

CEMENT KILNS: ONE
CAPACITY OF EACH: 650,000 TONS / YR
HEAT RATE OF EACH: PROPRIETARY

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

(SHREDDED) WHOLE SLIT

MAXIMUM TIRE PIECE: PROPRIETARY
OTHER FUELS: COAL 80%
% TIRE OF TOTAL FUEL: 20%

POLLUTION CONTROL EQUIPMENT:
FABRIC FILTER BAG HOUSE

CONTINUOUS EMISSION MONITORING EQUIPMENT:
NO_x, CO, O_2 (TOTAL HC SPRING 1991)

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

ANY COMBUSTION/OPERATING PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

AIR EMISSION DATA:
EMISSIONS NOT SIGNIFICANTLY DIFFERENT THAN BURNING COAL

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION? USE PERMIT MODIFICATION FROM THE COUNTY ~~OF~~ AGENCIES - NOT FROM STATE

QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME BOXCROW CEMENT COMPANY *
PLANT NAME: BOXCROW PLANT
ADDRESS: 700 DOVE LANE P.O. DRAWER 1170
MIDLOTHIAN, TEXAS 76065
PHONE NO.: (214) 299 – 6350
ENVIRONMENTAL ENGINEER/CONTACT: ROY CLICK, ENV. ENGINEER

OF KILNS: 1
CAPACITY OF EACH: 3100 TONS CLINKER PER DAY
HEAT RATE OF EACH: 3 1/2 MBTU PER TON OF CLINKER

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

MAXIMUM TIRE PIECE: 2" X 6"
OTHER FUELS: COAL
% TIRE OF TOTAL FUEL: 10 % – 12 %

POLLUTION CONTROL EQUIPMENT:
BAGHOUSE

CONTINUOUS EMISSION MONITORING EQUIPMENT:
SO_2, NOx, OPACITY

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
NONE

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO x
IF YES, PLEASE EXPLAIN: PRESHREDDED WHEN DELIVERED

ANY COMBUSTION/OPERATING PROBLEM: YES ____ NO x
IF YES, PLEASE EXPLAIN:

AIR EMISSION DATA:
ONLY CONTINUOUS MONITORING DATA.
PLAN TO COLLECT DURING NEXT TEST–BURN.

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES x NO ____
IF YES, WHAT TYPE OF MODIFICATION?
NOT SURE YET.

* Information obtained by phone.

1737–01–1

REV, 0, MARCH 22, 1991

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QUESTIONNAIRE
SCRAP TIRE USE

FEB 04 1991

COMPANY NAME: Ash Grove Cement west, Inc.
PLANT NAME: Durkee Cement Plant
ADDRESS: P.O. Box 5
Durkee, Oregon 97905
PHONE NO.: 503-877-2411
ENVIRONMENTAL ENGINEER/CONTACT: Douglas Y. Hale

CEMENT KILNS: One Four Stage Preheater Type
CAPACITY OF EACH: 500,000 ton/year
HEAT RATE OF EACH:

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

MAXIMUM TIRE PIECE:
OTHER FUELS:
% TIRE OF TOTAL FUEL: 10%

POLLUTION CONTROL EQUIPMENT:
Electrostatic Precipitator

CONTINUOUS EMISSION MONITORING EQUIPMENT:
Opacity, CO, O_2, NOx

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

ANY COMBUSTION/OPERATING PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

AIR EMISSION DATA:
Extensive testing for particulates, SOx, metals, total hydrocarbons showed no significant increase.

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION?
Minor air quality

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Arizona Portland Cement
a division of California Portland Cement
P.O. Box 338
Rillito, Arizona, 85654
(602)622-3503

January 29, 1991

Mr. Michael V. O'Brien
Project Environmental Scientist
Malcom Pirnie, Inc.
5001 W.80th Street, Suite 770
Minneapolis, MN 55437

FEB 04 1991

Dear Mr. O'Brien

Arizona Portland Cement has successfully used tire-derived fuel (TDF) in our production process. The following comments are provided in response to your letter of January 18, 1991.

1. TDF has been used only in our #4 Kiln, a suspension pre-heater with pre-calciner.

2. Our main solid fuel, coal, averages 12,500 BTU/lb. Our TDF has a value of about 14,300 BTU/lb. We use 2"x2" shredded tires. TDF use, on a BTU basis, runs from 5 to 20 percent of the total fuel.

3. Fabric collectors are used to remove particulate emissions from the process. The stack opacity is continuously monitored.

4. A front-end loader dumps the TDF into a hopper which has a twin screw feeder discharging onto a conveyor belt. The belt dumps into a bucket elevator that carries the tire chips to a duct through which they enter the calciner. This equipment was all expressly installed for the TDF.

5. The availability of shredded tires is a concern to management. The TDF does not burn as efficiently as pulverized coal, so its use is limited in order to optimize the process. TDF also presents some handling, storage and housekeeping problems that make it less desirable as a fuel source. Its chief benefit is a low cost. Emission rates do not seem to be significantly altered by the use of TDF.

If you have any further questions please contact me at the Rillito plant.

Sincerely,

Steven A. Regis

Steven A. Regis
Process Engineer

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APPENDIX A

QUESTIONNAIRE

SCRAP TIRE USE

COMPANY NAME: _____
PLANT NAME: _____
ADDRESS: _____
_____

PHONE NO.: _____
ENVIRONMENTAL ENGINEER/CONTACT: _____

OF BOILERS: _____
CAPACITY OF EACH: _____
HEAT RATE OF EACH: _____

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

MAXIMUM TIRE PIECE: _____
OTHER FUELS: _____
% TIRE OF TOTAL FUEL: _____

POLLUTION CONTROL EQUIPMENT:

_____
_____

CONTINUOUS EMISSION MONITORING EQUIPMENT:

_____
_____

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:

_____
_____

WASTE TIRE SUPPLY PROBLEMS? YES _____ NO _____
IF YES, PLEASE EXPLAIN: _____
_____

ANY COMBUSTION/OPERATING PROBLEMS? YES _____ NO _____
IF YES, PLEASE EXPLAIN: _____
_____

AIR EMISSION DATA:

_____
_____

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES _____ NO _____
IF YES, WHAT TYPE OF MODIFICATION? _____
_____

APPENDIX B

REQUEST FOR INFORMATION

APPENDIX B

REQUEST FOR INFORMATION

Mr. Ladd Parsons
Vice President-Operations
Medusa Cement Company
P.O. Box 5668
Cleveland, OH 44101

Mr. Greg Juell, Process Superintendent
CBR Cement - Calaveras Cement Company
Redding Plant
8750 Wonderland Boulevard
Redding, CA 96003

Mr. Mike Dwyer, Process Engineer
Mojave Plant
CALMAT Company
P.O. Box 910
Mojave, CA 93501

Mr. John Frye, Plant Manager
Arizona Portland Cement Company
Rillito Plant
P.O. Box 338
Rillito, AZ 85654

Mr. Mike Cawthray
Essroc Materials, Inc.
P.O. Box 32
Nazareth, PA 10864

Mr. Al Asaro
Giant Resource Recovery
P.O. Box 352
Harleyville, SC 29448

Mr. Hank Gross, Vice President-Production
Illinois Cement Company
P.O. Box 442
LaSalle, IL 61310

Mr. Roy Harris, Plant Chemist
Monarch Cement Company
Humboldt, KS 66748

Mr. Greg Carrigan, Production Manager
LaFarge Corporation
Balcones Plant
P.O. Box 311507
New Braunfels, TX 78131

Mr. Tom Donaldson
Lab Production Superintendent
River Cement Company
Selma Plant
Festus, MO 63028

Mr. Doug Hale, Corporate Environmental Manager
Ash Grove Cement West, Inc.
Durkee Plant
P.O. Box 5
Durkee, OR 97905

Mr. Harold Bordon
Environmental Affairs
HOLNAM, Inc.
P.O. Box 122
Dundee, MI 48131

Dr. Greg Miller
HOLNAM, Inc. for Ideal Basic Industries, Inc.
P.O. Box 122
Dundee, MI 48131

Ms. Elizabeth Mikols
Lehigh Portland Cement Company
718 Hamilton Mall
Allentown, PA 18105

Mr. John Whitmore
Lafarge Corporation
P.O. Box 324
Dallas, TS 75221

Mr. Randy Rakes, Environmental Engineer
Roanoke Cement Company
P.O. Box 27
Cloverdale, VA 24077

Eric Hansen, V.P.
Ash Grove Cement Co.
Tel No: (913) 451-8900
Fax No: (913) 451-8324

Mr. Don Miller, Process Engineer
Georgia Pacific Company
Cedar Springs, GA
FAX No: (912) 372-5163

Mr. Randy Thompson
Florida Crushed Stone Company
P.O. Box 490300
Leesburg, FL 34749-0300

Ms. Diedra Vance, Process Engineer
Blue Circle, Inc.
Atlanta Plant
2520 Paul Avenue, N.W.
Atlanta, GA 30318

Mr. Daniel A. Willis
Division Process/Environmental Engineer
Southdown, Inc.
Eastern Division
P.O. Box 191
Fairborn, Ohio 45324

Mr. Jim Parker
Special Projects Manager
Kosmos Cement Company
Kosmosdale Plant
15301 Dixie Highway
Kosmosdale, KY 40272

Mr. Randy Wiley, Plant Engineer
Southdown, Inc.
Lyons Plant
P.O. Box 529
Lyons, CO 80540

Ms. Annette White
Inland-Rome Paper
P.O. Box 1551
Rome, GA 30161

Mr. Charles Wright, Process Engineer
RMC Lone Star
Highway 1
Davenport, CA 95017

Mr. Pete Gruene
Sonoco Products Company
P.O. Box 160
Hartsville, South Carolina 29550

Mr. Chris Nigren
Willamette Industries
P.O. Box 339
Albany, OR 97321

REGULATORY AGENCY REQUESTS

Department of Air Pollution Control
P.O. Box 10089
Richmond, VA 23240

Mr. Gene Drew
Georgia Department of Natural Resources
205 Butler Street SE
Floyd Tower - 1162 East
Atlanta, GA 30334

Mr. Gary Reed, Inspector
Stanislaus County
Air Pollution Control District
1716 Morgan Road
Modesto, CA 95351

Mr. Dave Ferrier
Michigan Department of Natural Resources
Air Quality Division
P.O. Box 30028
Lansing, MI 48909

Ms. Pat Dennis
Permit Section
Illinois EPA
Division of Air Pollution Control
1340 North 9th
Springfield, IL 62702

Paul Castagno
Air Pollution Control District
Jefferson County
850 Barret Avenue
Louisville, KY 40204-1745

OTHER REQUESTS / CONTACTS:

Mr. Lacy Hinther, Permit Engineer
Kansas Department of Air Quality
(913) 296-1576

Su Shant
Arizona Department of Environmental Quality
(602) 257-6956

Mr. Bill Robinson
Virginia Department of Solid Waste Management
Roanoke, Virginia
(804) 371-8714

Ms. Natalie Farber
Ohio Environmental Protection Agency
Office of Solid Waste
Columbus, Ohio
(614) 466-7220 #3135

Mr. Ray Potts
Oregon Department of Environmental Quality
(503) 229-5630

Mr. Mike Stansfield
Missouri Department of Natural Resources
Division of Environmental Quality
Jefferson City, Missouri
(314) 751-4817

Mr. Bob Hudson
South Carolina Department of Air Quality Analysis, State Park
(803) 935-7015

Mr. Stan Miller
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Mr. Ben Ziesmen (via McGowin)
Northern Indiana Public Service Company (NIPSCO)
Hammond, Indiana

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1990 Clean Air Act Amendments need to be analyzed as to how scrap tire combustion may affect permitting and compliance demonstrations.

- Facilities interested in combusting scrap tires may need to add air pollution control equipment due, in part, to the 1990 Clean Air Act Amendments. Since a national solid waste problem is addressed in an environmentally sound manner, the possibility of a tax incentive for the installation of pollution control equipment should be evaluated.

- Further evaluation of tire processing technologies and ash characteristics should be conducted. The ability of chipping and shredding equipment to consistently meet fuel specifications appears to be uncertain. Ash characterization needs to be evaluated in order to facilitate storage at permitted landfills.

9.0 CONCLUSIONS AND RECOMMENDATIONS

As a result of reviewing the literature associated with testing of scrap tires as either a supplemental fuel or at a dedicated waste tire combustion facility, several recommendations are provided regarding the combustion of scrap tires for energy recovery:

- Scrap tires should be considered a resource rather than a waste material. State regulatory agencies should begin an education program which presents waste tires as a resource. This should be a cooperative effort, with local and state health departments and public service agencies involved.

- Tires in either a shredded, chipped, or whole condition can be combusted in an environmentally sound manner. State waste management programs should modify their rules pertaining to unacceptable waste definitions.

- Scrap tires have a significant heat content, and under controlled conditions this heat can be extracted for a beneficial use. State and federal energy agencies should evaluate the effect of combusting scrap tires as part of an overall energy policy.

- Specific controlled test burns should be conducted at each of the combustion facility types to determine optimum feed rates, fuel specifications, operational conditions, air pollution control equipment collection efficiencies, and resultant air emissions. These test burns are necessary for public acceptance of the combustion of scrap tires. The availability of grant programs for off-setting some of the costs of these test burns should be evaluated.

- A standard list of pollutants, both criteria and non-criteria, for air emissions testing needs to be established on a national level. This development would reduce the amount of time and expense to the next potential user. A national data base could possibly preclude each proposer from developing a separate data base.

- Standardized air emission test methods need to be established for the non-criteria pollutants. These methods should include both inlet and outlet testing such that air pollution control system efficiencies may be determined.

- The federal EPA should provide some uniform guidance to state agencies for permitting existing industrial and electric utility facilities to combust scrap tires. Consideration to combust scrap tires is an economic decision, and efforts to establish uniform guidance would enhance the economic decision making process.

- Efforts to allow fuel switching and fuel cleaning, by combusting a fuel mix of scrap tires, should be considered for existing industrial and electric utility facilities for complying with federal and state regulatory requirements. The

8.0 SUMMARY

Significant numbers of scrap tires are presently stored in numerous locations around the United States, and each year more tires are added to the storage piles. These scrap tires are a solid waste management concern, and are contributing to both public health and safety problems.

Scrap tires, however, have an attractive heat content and, as a result, are a potential energy resource. Under the appropriate operating conditions, feed rates and pollution control equipment configurations, these scrap tires have a significant potential as a supplemental or dedicated fuel. A number of industries use the combustion of scrap tires for energy recovery, for varied economic reasons.

The feasibility of combusting scrap tires has been demonstrated to be both environmentally and technically sound. However, the feasibility typically is state- and site-specific in nature. State regulatory requirements range from silence to imposition of extensive emissions testing and air pollution control equipment. The air emissions testing specifications also vary from state to state. For example, some regulatory agencies require that the Method 5 testing include both front and back-half catch for particulate matter compliance demonstrations. The back-half catch requirement results in a more restrictive particulate matter permit emission limit. These types of differences cause a difficulty in interpreting data results and developing any technical comparisons of test results at different facilities.

Regardless of these data limitations, the combustion of scrap tires, either whole or chips, is occurring and is a permitted option available to mitigate a solid waste problem that is also a public health and safety concern.

QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: Southwestern Portland Cement Co.
PLANT NAME: Quarry Plant
ADDRESS: 506 E. Xenia Drive, P. O. Box 191
Fairborn, OH 45324
PHONE NO.: (513) 878-8651
ENVIRONMENTAL ENGINEER/CONTACT: Daniel A. Willis

OF BOILERS: N/A
CAPACITY OF EACH:
HEAT RATE OF EACH:

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

MAXIMUM TIRE PIECE: 36 inches diameter
OTHER FUELS: Fossil fuels, hazardous waste fuel
% TIRE OF TOTAL FUEL: 10 - 15%

POLLUTION CONTROL EQUIPMENT:

~~Fabric filter dust collectors~~

CONTINUOUS EMISSION MONITORING EQUIPMENT:
Altech system for NO, SO_2, CO_2, CO O_2, HC

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
Added conveyors, elevator, scale, double tipping valve air lock, electric eyes, misc. hardware and software

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

ANY COMBUSTION/OPERATING PROBLEMS? YES X NO ____
IF YES, PLEASE EXPLAIN: Limited to 18% of total heat input

AIR EMISSION DATA:
Bypass Stack: PM = .03 gr/dscf @ 7% O_2
Main Stack: PM = .02 gr/dscf @ 7% O_2

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION? RAPCA and OEPA require operating permit for each type of fuel burned.

MALCOLM PIRNIE	Completed Questionnaire Southwestern Portland Cement Company 1737-01-1 REV. 2, May 3, 1991	FIGURE 7-1

TABLE 7–6

TIRE BURN BOTTOM ASH TRANSPORT WATER
TOTAL METALS ANALYSIS *
OHIO EDISON TORONTO PLANT

PARAMETERS	DRINKING WATER LIMITS	DAY 1 0% TIRES AS FUEL	DAY 2 5% TIRES AS FUEL	DAY 3 10% TIRES AS FUEL	DAY 4 15% TIRES AS FUEL	DAY 5 20% TIRES AS FUEL
ARSENIC	0.05	**ND	ND	ND	ND	ND
BARIUM	1	0.05	0.04	0.05	0.04	0.04
CADMIUM	0.01	ND	ND	ND	ND	ND
CHROMIUM	0.05	0.04	ND	0.05	ND	ND
LEAD	0.05	ND	ND	ND	ND	ND
MERCURY	0.002	ND	ND	ND	ND	ND
SELENIUM	0.01	ND	ND	ND	ND	ND
SILVER	0.05	ND	ND	ND	ND	ND

* In mg/l
** ND – None Detected

(From Horvath, 1991)

TABLE 7–5

TIRE BURN BOTTOM ASH TRANSPORT WATER
DISSOLVED METALS ANALYSIS *
OHIO EDISON TORONTO PLANT

PARAMETERS	DRINKING WATER LIMITS	DAY 1 0% TIRES AS FUEL	DAY 2 5% TIRES AS FUEL	DAY 3 10% TIRES AS FUEL	DAY 4 15% TIRES AS FUEL	DAY 5 20% TIRES AS FUEL
ARSENIC	0.05	**ND	ND	ND	ND	ND
BARIUM	1	0.04	0.04	0.04	0.04	0.04
CADMIUM	0.01	ND	ND	ND	ND	ND
CHROMIUM	0.05	ND	ND	ND	ND	ND
LEAD	0.05	ND	ND	ND	ND	ND
MERCURY	0.002	ND	ND	ND	ND	ND
SELENIUM	0.01	ND	ND	ND	ND	ND
SILVER	0.05	ND	ND	ND	ND	ND

* In mg/l
** ND – None Detected

(From Horvath, 1991)

TABLE 7–3

TIRE FEED RATES FOR TEST BURNS AT THE OHIO EDISON TORONTO PLANT

DAY	TIRE FEED RATE	FUEL COMPOSITION	
		COAL	TIRES
1	NONE (BASELINE)	100	0
2	1 PER 34 SECONDS	95	5
3	1 PER 17 SECONDS	90	10
4	1 PER 11.3 SECONDS	85	15
5	1 PER 8.5 SECONDS	80	20

(From Horvath, 1991)

TABLE 7–4

EMISSION RATES DURING THE OHIO EDISON TIRE BURN TEST

POLLUTANT	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	PERMIT LIMIT (lb/MBtu)
SO_2	5.30	5.73	5.71	5.47	5.34	8.10
NOx	0.601	0.57	0.436	0.443	0.387	NONE
PARTICULATE MATTER	0.0631	0.0717	0.0564	0.0815	0.0453	0.10
LEAD	0.0000963	0.0000993	0.0000963	0.0000966	0.0000912	NONE

All emission rates measured in lbs/MBtu

(From Horvath, 1991)

TABLE 7-2

PULP AND PAPER MILLS IN OHIO

CITY	COMPANY NAME	ADDRESS	BURN TIRES?	REMARKS
Avery	CertainTeed Corp	POBox 600	NO	Cannot burn solid fuels
Baltimore	Fairfield Paper Co, L.P.	310 Water St.	NO	Has not considered.
Chagrin Falls	IVEX Corp	218 Cleveland St.	NO	Cannot burn solid fuels
Chillicothe	Mead Corp	401 S. Paint St.		Unable to contact.
Cincinnati	Cincinnati Paperboard Corp.	5500 Wooster Rd.	NO	Cannot burn solid fuels
Cincinnati	Ohio Pulp Mills Inx.	2100 Losantiville Rd.	NO	Does not have boilers
Cincinnati	Rock-Tenn Co.	3347 Madison Rd.	NO	Never heard of burning tires.
Circleville	Container Corp. of America	401 W. Mill St.	NO	Worried about quality control.
Columbus	DuPont Specialty Imaging Media Inc.	785 Frebis Av.	NO	Cannot burn solid fuels
Coshocton	Stone Container Corp.	500 N. 4th St.	NO	Worried about env. issues.
Dayton	Howard Paper Mills, Inc.	115 Columbia St.	NO	Never considered burning tires
Franklin	Cheney Pulp & Paper Co.	P.O. Box 215	NO	Cannot burn solid fuels
Franklin	Franklin Boxboard Corp.	50 E. 6th St.	NO	Cannot burn solid fuels
Franklin	Georgia-Pacific Corp.	125 No. River St.	NO	Cannot burn solid fuels
Franklin	IKO Industries	1200 S. Main ST.	NO	Cannot burn solid fuels
Gypsum	USG Industries, Inc.	NL	NO	Too much modif. in fuel feed syst. req
Hamilton	The Beckett Paper Co.	400 Dayton St.	NO	Cannot burn solid fuels
Hamilton	Champion International	601 North B St.	NO	Permitting is concern.
Lancaster	Sonoco Products Co.	831 S. Columbus St.	NO	Have not considered burning tires at this time
Lockland	Erving Paper Mills	NL	-	Paper Mill is idle
Lockland	Jefferson Smurfit Corp./Container Corp. of America	S. Cooper Av.	NO	Fuel feed system is not right. Have pulverized boiler.
Massillon	Cleaners Hanger Co.	670 17th ST. NW	NO	Cannot burn solid fuels
Massillon	Greif Board Corp	9420 Warmington St.		Unable to contact.
Middletown	Crystal Tissue Co.	3120 S. Verity Pkwy.	NO	Fuel feed system is not right.
Middletown	Middletown Paperboard Co.	427 Vandervoer St.	NO	Cannot burn solid fuels
Middletown	Packaging Corp. of America	806 Centeral Av.	-	Paper Mill is idle
Middletown	Simpson Paper Co.	S. Main St.	NO	Closed down.
Middletown	Jefferson Smurfit Corp./Container Corp. of America	407 Charles St.	NO	Has not considered. Set up to burn coal only.
Middletown	Sorg Paper Co.	901 Manchester Av.	NO	Needs pulverized coal.
Munroe Falls	Sonoco Products Co.	59 N. Main St.	NO	Cannot burn solid fuels
Rittman	Packaging Corp. of America	100 Industrial Av.	NO	Has contemplated only.
Toronto	Valley Converting Co.	405 Daniels St.	NO	Cannot burn solid fuels
Urbana	Howard Paper Mills, Inc.	W. Church St.	NO	Never considered.
West Carrollton	Appleton Papers, Inc.	P.O. Box 68		Unable to contact.
West Carrollton	Miami Paper Corp.	P.O. Box 66	NO	Too much modif. and permitting req.

NL - NOT LISTED

(From Lockwood-Post's Directory, 1991)

TABLE 7-1

SULFUR AND ASH DATA FOR THE MOST PRODUCTIVE COAL BEDS IN OHIO

COAL SEAMS	NO. OF ANALYSES	AVERAGE PERCENT					AVERAGE HEAT RATE (BTU/LB)	ESTIMAT RECOVERA RESERVI (BILLION T
		ASH	TOTAL SULFUR	SULFATE SULFUR	PYRITIC SULFUR	ORGANIC SULFUR		
WASHINGTON (NO. 12)	6	28.30	2.41	0.08	1.42	0.82	10,427	
WAYNESBURG (NO. 11)	34	17.31	2.93	0.12	1.64	1.12	11,825	
MEIGS CREEK (NO. 9)	100	13.04	4.00	0.07	1.69	1.85	12,425	
REDSTONE (NO. 8A)	27	12.34	3.52	0.10	2.44	1.15	12,451	
PITTSBURGH (NO. 8)	188	10.58	4.24	0.15	2.56	1.67	12,948	
HARLEM	5	8.72	0.97	0.01	0.50	0.49	13,369	
ANDERSON	9	12.94	3.73	0.01	2.56	1.03	12,504	
MAHCNING (NO. 7A)	5	8.73	2.65	NL	NL	NL	13,796	
UPPER FREEPORT (NO. 7)	110	11.01	3.11	0.05	2.21	0.91	12,952	
LOWER FREEPORT (NO. 6A)	51	11.82	3.72	0.15	2.51	1.19	13,155	
MIDDLE KITTANNING (NO. 6)	272	9.12	3.48	0.10	2.07	1.47	[illegible]	
LOWER KITTANNING (NO. 5)	162	11.19	4.50	0.11	3.16	1.44	12,772	
CLARION (NO. 4A)	73	12.89	4.19	0.24	2.41	1.59	12,367	
BROOKVILLE (NO 4)	36	12.60	3.15	0.08	1.87	1.35	12,634	
TIONESTA (NO. 3B)	6	14.64	4.45	0.02	3.87	1.17	12,176	
QUAKERTOWN (NO. 2)	11	6.43	1.28	0.05	0.59	0.47	13,364	
SHARON (NO. 1)	14	10.01	0.84	0.30	0.50	0.38	12,884	

COAL SEAMS LISTED STRATIGRAPHICALLY

(From Ohio Geology, 1989; and Ohio Geological Survey)

were below drinking water standards. Tables 7-5 and 7-6 list the dissolved and total metal analyses, respectively, for the tire burn bottom ash transport water.

Fly ash and bottom ash samples were also collected and analyzed for RCRA heavy metals using the USEPA toxic characteristic leachate procedure. All TCLP leachate results for fly ash and bottom ash from the tire combustion test were below drinking water standards.

Ohio Edison plans to conduct a second test burn while cofiring coal and up to 40 % whole tires (Gillen, personal communication). At this rate, the Toronto Plant has the potential to combust approximately 6 million tires per year in its boilers.

7.6 SOUTHWESTERN PORTLAND CEMENT COMPANY

According to a completed questionnaire received by Southwestern Portland Cement Company's Quarry Plant (Southwestern) in Fairborn, Ohio, Southwestern combusts whole tires in their cement kilns. Pollution control equipment includes fabric filter dust collectors and the facility is continuously monitored for NO, SO_2, CO_2, CO, O_2, and HCL. Figure 7-1 provides a copy of the completed questionnaire by Southwestern. In order to combust whole tires in its kilns, Southwestern added conveyors, an elevator, scale, double tipping valve air lock, electric eyes, and miscellaneous hardware and software. Southwestern produces 10 to 15 percent of its total heat using tires as fuel with an upper limit of 18 percent. Particulate emissions in the bypass and main stacks are 0.03 gr/dscf corrected to 7% O_2 and 0.02 gr/dscf corrected to 7% O_2, respectively. As mentioned previously, Southwestern plans to conduct extensive air emissions testing in March, 1991.

that, although they were very interested in combusting tires, they were anticipating some technical and regulatory problems that would have to be confronted by the pioneering facilities such as Ohio Edison.

7.5 SUMMARY OF AIR EMISSIONS TESTS AT OHIO EDISON COMPANY

On May 21 through 25, 1990, test burns of a mixture of coal and whole tires were conducted at the Ohio Edison Toronto Plant. Their #9 pulverized coal-fired boiler was modified so that whole tires could be added to the boiler at varying feed rates. Specifically, an additional opening was created in the boiler wall to feed whole tires into the boiler. Pollution control equipment for this facility is an electrostatic precipitator, and the stack is continuously monitored for opacity.

Table 7-3 lists the feed rates of coal and tires selected for the five test days. Stack gas samples were collected and analyzed to quantify SO_2, NO_x, particulates, and lead emissions. Both the fly ash and bottom ash were analyzed for heavy metals. Three test runs were conducted daily and averaged for each day. Average emission rates for all variables are provided in Table 7-4.

Results of the stack tests are as follows:

1. Particulate and SO_2 emission rates were less than the compliance limits (Table 7-4). There are no emission limits for NO_x and lead for Ohio Edison Toronto Plant.

2. Emission rates for SO_2, NO_x, particulates, and lead decreased as the percent of tires as fuel increased.

3. While the maximum percent of tires as fuel were combusted (20 % of total Btu input),

   a) SO_2 emission rates were equivalent to non-tire emission rates;
   b) lead emission rates were 5% lower;
   c) particulate emission rates were 28% lower; and
   d) NO_x emission rates were 36% lower.

4. The higher emission rates at lower tire feed rates are assumed to be related to the non-uniform Btu supply associated with slower whole tire feed rates.

One bottom ash transport water grab sample was collected each day and analyzed for total and dissolved RCRA heavy metals. Results of the analyses indicate that all dissolved metals and total metals from the bottom ash transport water during the tire combustion test

manufacturer that has combusted scrap tires in the past and is planning to conduct extensive compliance testing in March, 1991 as part of the application for a Permit-to-Operate. Ohio Edison successfully completed compliance testing in May, 1990 and anticipates receiving their Permit-to-Install and Permit-to-Operate from the Ohio EPA in the near future. Other cement kiln facilities located in Ohio, such as LaFarge Corporation and Medusa, have conducted scrap tire test burns at facilities located outside of Ohio but have not yet begun using scrap tires at their facilities in Ohio. Although preliminary reports from test burns at Ohio Edison indicate overall positive results when using scrap tires as 5 to 20 percent of the total fuel (including higher Btu and lower emissions of particulates, lead, SO_2, and NO_x), scrap tire usage is not being fully utilized as a viable supplemental fuel source in private industry. The environmental issues to be addressed by industrial facilities when considering scrap tire combustion include the laws regulating waste tire collection, public perception, storage, and recovery facilities and the transportation of scrap tires.

According to the Lockwood-Post's Directory (1991), 35 pulp and paper mills are located in Ohio. Table 7-2 lists these pulp and paper mills and their locations. All but three of these mills were contacted to determine if they had experience in combusting scrap tires in their boilers. None had such experience. Champion International, however, had experience in combusting tires at several plants outside of Ohio, but has decided not to pursue combusting tires at their Ohio facility. Of the mills contacted, thirteen are not equipped to combust solid fuels, two are currently idle, one has closed down, and one does not have boilers. Only nine mills have considered combusting tires, but due to modification requirements, and economic, fuel quality, and permitting problems, these mills have decided not to combust tires in their boilers (Table 7-2). The remaining six mills have never considered or never heard of combusting tires as a primary or supplementary fuel source.

Proposed Ohio regulations concerning the storage of waste tires may generate questions regarding the pricing of waste tires. For example, this position was stated by the owner of a nursery and greenhouse complex who considered combusting waste tires in his boilers but feared that such regulations may make high-sulfur Ohio coal more attractively priced. Proposed state regulations define a "waste tire storage facility" as a site or facility for the storage of whole waste tires having at least 1,000 tires on-site on any day. These regulations would require that such facilities, in order to be permitted, must submit engineering and contingency plans to be approved by the OEPA. It is feared by some that very stringent permitting governing the storage and handling of waste tires may reduce the quantity of facilities interested in combusting tires. Some of the facilities interviewed stated

with liquids of varying densities. During this process, most of the pyritic sulfur and some of the sulfate sulfur is removed. The organic sulfur, or the sulfur which was in the plant when it died, cannot be extracted from the coal.

Of the coal seams mined in Ohio, three are relatively low in sulfur content. Two of these seams, the Sharon and Quakertown, were heavily mined in the 1950's and 1960's, and have essentially been "mined out". Approximately 30 million tons of the Sharon seam are estimated to remain in the mines. The Harlem seam is also a very low-sulfur coal, with approximately 0.46 percent organic sulfur. The Harlem seam is currently being mined, but its reserves are minimal. Thus, the majority of Ohio's minable coal reserves are made up of high-sulfur coals, and a large variability in the grade of coal can exist within the same seam and over a given area.

Approximately 30 million tons of coal are mined in Ohio every year. Prior to the Clean Air Act Amendments of 1970, Ohio was mining approximately 55 million tons per year. Because the majority of Ohio coals have a high sulfur content, several mines in Ohio have closed, or are in the process of closing down operations. Peabody owns two mines in Ohio, both of which will be shut down. American Electric Power (AEP), which is the largest utility company in Ohio, owns Southern Ohio Coal. This coal company mines 5 million tons of coal per year, or one-sixth of the total tonnage of coal mined in Ohio. Southern Ohio Coal mines primarily the Clarion (No. 4A) (Line 13 in Table 7-1) for American Electric Power to combust in their utility boilers. However, because AEP does not have scrubbers and the boilers are old, combusting the Clarion coals exceeds the regulatory emission standard for SO_2, which is 1.2 lb/MBtu of coal. The alternatives for AEP are to install modern pollution control equipment (scrubbers) or switch to a low-sulfur coal. According to initial AEP estimates, the pollution control equipment will cost approximately $800 million, whereas a fuel switch will cost $200 million. Unless other alternatives are discovered, a fuel switch would significantly decrease Ohio's coal production.

7.4 INDUSTRIES CURRENTLY COMBUSTING SCRAP TIRES FOR ENERGY RECOVERY

Two facilities in Ohio have some experience with combusting scrap tires as a supplemental fuel in their process furnaces: the Southwestern Portland Cement Company Quarry Plant facility at Fairborn, Ohio (Southwestern), and the Ohio Edison Company Toronto Plant facility at Toronto, Ohio (Ohio Edison). Southwestern is a cement

One of the strategies recommended in the State SWMP is energy recovery from waste tires. This can occur in one of two ways: shredding scrap tires and using them as a supplemental fuel, or constructing a dedicated waste tire-to-energy facility. According to Natalie Farber (personal communication) of the OEPA, there has been very little development of scrap tire combustion within Ohio's industrial sector. Although there was considerable interest in combusting scrap tires as a supplemental fuel in the past, most industries concluded that it was not cost effective. As industries studied the process involved in combusting tires as a supplemental fuel for their boilers, most companies found that significant modifications to their existing fuel feed system would be necessary. In addition, these facilities would require either a shredder or shredded tires, as well as specifications as to the size and quality of TDF. As the industries added the costs required for tire specifications, the modifications necessary for their pollution control equipment to comply with allowable air emissions, and testing of air emissions, they determined that combusting scrap tires would not be as cost effective as originally anticipated. Some type of financial incentive could increase the usage of scrap tires as a supplemental fuel by these industries. However, the state of Ohio has not initiated any such incentives. As noted in Section 7.4, Minnesota, Wisconsin, and Illinois have established grant/loan programs for companies recycling, reusing, or processing scrap tires. Therefore, unless disposal costs increase significantly or electrical costs become high enough to warrant some type of change in fuel, most facilities capable of combusting scrap tires will remain with their primary fuel source, usually coal (Farber, 1991).

7.3 COAL RESERVES

Approximately 17 coal seams are currently mined in Ohio. Table 7-1 lists the heat content, ash and sulfur percent of these 17 coal seams. The average heat content ranges from 10,472 to 13,796 Btu/lb. The average percent ash in moisture-free Ohio coals ranges from 6.43% to 28.3%. Many more coal seams are present in Ohio. However, some are not persistent and others, such as the Dunkard Group, have high ash and sulfur contents and correspondingly low Btu content, and are mined only on a small scale for local use.

Sulfate sulfur, pyritic sulfur, and organic sulfur comprise the total sulfur content in the coal. There is less sulfate sulfur in the coal than the other two types of sulfur. The pyritic sulfur makes up the largest portion of the total sulfur. Coal is "washed" after it is recovered and then ground down to a particular size. The coal is then subjected to a float/sink wash

wastes inside its boundaries. Thus, provisions must be included in each SWMP to allow for the county to assess a levy for wastes disposed at its disposal facility. For scrap tires, a tip fee could be instituted, if not already in place.

The Ohio Solid Waste Management Plan (SWMP), which was approved through H.B. 592 in June, 1989, requires:

- Effective January 1, 1993, waste tires must be shredded or processed (cut, sliced, etc.) prior to disposal. Disposal of whole scrap tires at landfills will no longer be allowed.
- Effective January 1, 1995, neither whole nor shredded tires will be accepted for disposal at sanitary landfills. Tires will only be accepted at tire monofills or monocells (shredded) or at legitimate recycling facilities.

Anyone planning to construct a shredded tire monofill, or purchasing an abandoned strip mine to be used as a monofill, must first submit an application to the State EPA for a permit-to-install. Although regulations for the monofilling of waste tires were not completed in 1990, the agencies expect to redraft monofill regulations in 1991 (Scrap Tire News, 1991). The primary objective regarding scrap tire management by the Ohio EPA is to remove existing tires stockpiled at landfills and prevent further tires from entering into landfills. The current emphasis for disposal methods of existing scrap tires is to place them into tire monofills where they can be readily mined when technologies for utilizing scrap tires is more advanced and economical.

In order to reduce and minimize the threats posed by outdoor storage of scrap tires, the OEPA and Department of Natural Resources (DNR) have completed draft rules regarding the storage of waste tires. According to these draft rules, the storage of tire piles is limited to 2500 sq. ft., with minimum of 50 ft. fire lanes between tire piles.

The Ohio Tire Recycling and Recovery Act was originally proposed in House Bill 847 (H.B. 847) in 1990, but was not enacted. This Act was re-introduced in the 1991 legislature. The bill was assigned a house and senate number of H.B. 293 and S.B. 115, respectively. In addition to tire recycling and recovery, this proposed bill would also require licensing of scrap tire transporters, collectors, and processors, and set up a system to track waste tires from collection through disposal. The following statement is taken from the pending legislation:

> The director may use moneys credited to the fund in excess of those needed to implement, administer, and enforce this chapter for research and development regarding waste tire management and for promoting or assisting in the development of markets for materials or energy recovered form waste tires.

Although only a few species interfere with human activities, mosquitoes are ubiquitous. Mosquitoes which attack house pets and farm animals can cause weight loss and decreased milk production, and can transmit diseases. Malaria to humans, encephalitis to humans and horses, and heartworm to dogs are all transmitted through mosquitoes.

Birds are the normal hosts of St. Louis encephalitis which is transmitted by the Northern House Mosquito (Culex pipiens). In 1975, 416 cases of St. Louis encephalitis were diagnosed in Ohio resulting in 29 deaths. This was the worst epidedemic of St. Louis incephalitis in Ohio history. Between 1964 and 1985, 439 cases of St. Louis encephalitis were diagnosed in Ohio with 32 associated deaths.

Animals of the squirrel family are the normal hosts of LaCrosse (formerly California) encephalitis which is transmitted by the Tree Hole Mosquito (Aedes triseriatus) and the Asian Tiger Mosquito (Aedes albopictus). Between 1963 and 1985, 617 cases of LaCrosse encephalitis with five deaths were reported in Ohio.

Dengue and yellow fever are transmitted by the Yellow Fever Mosquito (Aedes aegypti) and the Asian Tiger Mosquito. Between 1976 and 1980, 83 cases of imported malaria were reported in Ohio.

Other species of mosquitoes which have been found breeding in tires in Ohio include: Culex restuans, salinarius, and territans; Anopheles barberi and punctipennis; Orthopodomyia alba and signifera; and Toxorhynchites rutilis septentrionalis.

7.2 SCRAP TIRE LEGISLATION

In order to address the solid waste generated within the state of Ohio, including the handling of scrap tires, House Bill 592 (H.B. 592) was approved in 1989. The purpose of H.B. 592 is to ensure that all solid waste generated in the state of Ohio is planned, accounted for, and disposed of in an acceptable manner.

H.B. 592 requires each county, or each joint county district, to prepare a Solid Waste Management Plan (SWMP) which includes provisions for compliance with the objectives established in the State SWMP and the rules/guidelines of the Ohio Environmental Protection Agency (OEPA). Ohio has placed the responsibility for solid waste management planning at the county level. As part of their SWMP, each county district, or regional district must first identify all existing tire dumps, then develop a plan that includes strategies for managing waste tires. This plan requires a schedule for implementation and purchase of equipment to manage waste tires. Each county has the ultimate responsibility for all

An estimated 120,000 tons of scrap tires, or 15 million tires, are generated in Ohio annually. Approximately 40 percent or 6 million scrap tires are reused or recycled, which is a higher rate than the national average of 25 to 30 percent. The remaining 60 percent or 9 million or more scrap tires are disposed at landfills, and frequently at illegal dumpsites. An estimated 80 million scrap tires are already stockpiled in Ohio. This estimate appears low, especially when considering that 26 million scrap tires are estimated to be in Wyandot County (midway between Toledo and Columbus) alone (Blumenthal, personal communication).

Although the annual generation of scrap tires represents only about one percent of the Ohio solid waste stream, scrap tires in Ohio cause significant disposal problems as in any other state. Because scrap tires buried in landfills cause structural, health, and environmental problems, many landfill owners are refusing to accept tires. This has caused an increase in the number of tires disposed in tire stockpiles and illegal dumpsites.

7.1 MOSQUITOES

Lyons, Parsons, and Collart (1986) and Parsons (1987) studied mosquitoes in Ohio, including the effects of mosquitoes on humans and animals. The following is a summary of their studies.

At least 63 different species of mosquitoes have been identified in Ohio. Six of the 63 mosquito species are considered pathogenic to humans and animals. Four of these six disease vector species are known to breed in tires. In general, data suggest that the geographic spread of vector mosquitoes and thus, the diseases borne by them, are significantly increased by scrap tires (Parsons, 1987). Imported vectors are non-native species which carry these diseases. Indicator species are mosquitoes which are not necessarily vectors, but occur in Ohio only through the interstate transport of tire casings. Studies by the Ohio Department of Health indicate that any humans living, working, visiting, or playing near used tires and tire piles are at a greater risk of exposure to mosquitoes than those who live in or enter areas without tires, even in environments where the vector mosquitoes naturally occur (Parsons, 1987). Mosquito eggs hatch only if they are in water; and removing standing water, if possible, is essential in preventing mosquito breeding. Disposing of old tires is an essential element in effectively controlling mosquito populations.

TABLE 6–18

EMISSIONS DATA FROM TIRE AND REFUSE DERIVED FUEL (RDF) COMBUSTION TESTING

PARAMETER	TIRES (PPM)	RDF (PPM)
CO	30	20
NOx	222	412
NOx w/DeNOx	46	47
SO_2	630	–
SO_2 w/lime	60	0
VOC	ND*	ND*
HCl	0	250
HCl w/lime	0	25

* ND = NONE DETECTED

(From Pope, 1991)

TABLE 6–17

SUMMARY OF PRELIMINARY AVERAGE EMISSION RATES
MONSANTO COMPANY

POLLUTANT	FUEL TYPE		% DIFFERENCE 90% COAL/10% TDF AS COMPARED TO 100% COAL
	100% COAL	90% COAL/ 10% TDF	
VOLUME FLOW (scfm)	41000	37000	−11
PARTICULATE MATTER–OUTLET (lb/hr)	3.6	1.79	−50
ESP CONTROL EFFICIENCY (%)	92.8	96.1	4
O_2 (%)	10.1	9.6	−5
CO (lb/hr)	0.38	0.53	40
VOC (as CH_4) (lb/hr)	1.04	0.73	−30
SO_2 (lb/hr)	83	109	31
NOx (lb/hr)	34.7	24.3	−30
HCl (lb/hr)	13.5	9.59	−29
HF (lb/hr)	0.93	0.84	−10

(From The Almega Corporation, 1991)

TABLE 6–16

SUMMARY OF AVERAGE EMISSION RESULTS
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

POLLUTANT		COAL ONLY	10% TIRES	20% TIRES	BLANKS
PARTICULATE MATTER	(lb/MBtu)	0.88	2.29	2.08	
CO	(lb/MBtu)	0.17	0.21	0.32	
PAH**	(mg/MBtu)				
	Phenol	*	14.00	11.00	13.00
	Benzene	47.00	25.00	37.00	25.00
	Chrysene	*	*	0.41	0.00
	Benzo(a)pyrene	3.68	3.87	2.10	0.00

* Below detection limits
** Average calculations included * and negative (after blank corrections) values as 0.

(From Virginia Polytechnic Institute and State University,
Departments of Civil Engineering and Mechanical Engineering, 1990)

TABLE 6–15

SUMMARY OF EMISSION COMPLIANCE TEST RESULTS
UNIROYAL GOODRICH TIRE COMPANY, EAU CLAIRE, WISCONSIN

PARAMETER	RUN 1 11.5% TDF	RUN 2 (SOOT BLOWN)	RUN 3 COAL ONLY	ALLOWABLE LIMIT
PARTICULATE MATTER (LB/MBTU)	0.417	0.938	0.35	0.6
CARBON MONOXIDE (LB/HR)	1.1	2.2	3.1	NL
TOTAL GASEOUS HYDROCARBONS (LB C/HR*)	0.28	0.24	0.19	NL
BENZENE (10^{-3} LB/HR)	<0.029	<0.029	<0.030	NL
PAH** (10^{-6} g/sec)				
Benzo–a–anthracene	14	12	14	
Benzo–b–fluoranthene	7.7	6.9	7.7	
Benzo–a–pyrene	3	2.7	3	
Dibenzo–a,h–anthracene	6.9	6.1	6.8	
Indeno,1,2,3–pyrene	7	6.2	7	
Dibenzo–a,h–acridine	117	104	116	
Dibenzo–a,j–acridine	117	104	116	
7H–Dibenzo–c,g–carbazole	7.8	6.9	7.7	
Dibenzo–a,h–pyrene	156	139	155	
Dibenzo–a,i–pyrene	156	139	155	
METALS (10^{-3} LB/HR)				
ARSENIC	7.9	21.9	9.6	2.85
BERYLLIUM	0.14	0.44	0.14	2.85
CADMIUM	5	53	9.2	2.85
CHROMIUM	3.3	6.6	2.4	1.7
COPPER	33	61.9	30.2	336
LEAD	15.9	36.6	15.1	R
MERCURY	0.19	0.16	0.12	33.6
NICKEL	4.8	10.4	5	28.5
SELEMIUM	4.8	38	3.7	67.2
ZINC	8630	13000	5800	UR

* LB C/HR = Pounds Carbon per hour
** ALL PAH CONCENTRATIONS WERE BELOW THE DETECTION LIMIT
NL = Not Listed
UR = Unregulated
R = Regulated by DNR on a case by case basis

(From Interpoll Laboratories, Inc., 1990)

TABLE 6–14

METAL EMISSIONS SUMMARY FROM BURNING TDF
DOW CORNING CORPORATION, MIDLAND, MICHIGAN

METAL	UNITS	0% TDF*	15% TDF*	INCREASE/ DECREASE
CADMIUM	LB/HR	0.00049	0.0028	INCREASE
TOTAL CHROMIUM	LB/HR	0.00128	0.0019	INCREASE
ZINC	LB/HR	0.0634	11.32	INCREASE
BERYLLIUM	LB/HR	ND**	ND**	NO CHANGE

* Balance of fuel is wood.

** ND = Not detected at a detection limit of 0.16 ug/m^3 and 7.3 x 10^{-5} lbs/hr.

(From EDI Engineering & Science, 1989)

TABLE 6–13

AIR EMISSIONS SUMMARY FROM BURNING TDF
DOW CORNING CORPORATION, MIDLAND, MICHIGAN

POLLUTANT	UNITS	0% TDF*	5% TDF*	10% TDF*	15% TDF*	EMISSION LIMIT
TOTAL PARTICULATE MATTER @ 12% CO_2	LB/MBTU	0.0117	0.0196	0.0313	0.0114	0.035
PM–10 @ 12% CO_2	LB/MBTU	0.0078	0.0174	0.0244	**	**
OPACITY	%	5.89	6.9	7.46	15.8	**
SOx	LB/MBTU	0.026	0.028	0.037	0.059	0.8
NOx	LB/MBTU	0.153	0.162	0.133	0.081	0.7

* Balance of fuel is wood
** – Not Listed

(From EDI Engineering & Science, 1989)

TABLE 6–12B (Page 2 of 2)

MODESTO ENERGY COMPANY
SUMMARY OF MEASURED EMISSIONS, 1990

PARAMETER	ACTUAL EMISSIONS (lb/hr)	PERMIT LIMIT
Phenol	0.000	–
Formaldehyde	30.61×10^{-3}	–
PCDD	NR	•• TCDD = 2.60×10^{-7} g/sec
PCDF	NR	–
PAHs		•• 9.42×10^{-5} g/sec
Naphthalene	0.207×10^{-3}	
Acenaphthylene	0.000	
Acenaphthene	0.001×10^{-3}	
Fluorene	0.003×10^{-3}	
Phenanthrene	0.010×10^{-3}	
Anthracene	0.002×10^{-3}	
Fluoranthene	0.003×10^{-3}	
Pyrene	0.004×10^{-3}	
Benz(a)anthracene	0.000	
Chrysene	0.000	
Benzo(b)fluoranthene	0.001×10^{-3}	
Benzo(k)fluoranthene	0.000	
Benzo(a)pyrene	0.000	
Indeno(1,2,3–cd)pyrene	0.000	
Dibenzo(ah)anthracene	0.000	
Benzo(ghi)perylene	0.000	
Monochlorobiphenyl	0.000	–
PCBs		•• 1.93×10^{-5} g/sec
Dichlorobiphenyl	0.000	
Trichlorobiphenyl	0.000	
Tetrachlorobiphenyl	0.000	
Pentachlorobiphenyl	0.000	
Hexachlorobiphenyl	0.000	
Heptachlorobiphenyl	0.000	
Octochlorobiphenyl	0.000	
Nonachlorobiphenyl	0.000	
Decachlorobiphenyl	0.000	

NOTE: 1 lb/hr = 24 lb/day; 1 lb/hr = 0.126 g/sec
NR – Not Reported
• Expressed as parts per million methane.
•• Permit Limit obtained from Modesto Tire Incinerator Health Risk Assessment.
(Data from The Almega Corporation, 1990)

TABLE 6–12B (Page 1 of 2)

MODESTO ENERGY COMPANY
SUMMARY OF MEASURED EMISSIONS, 1990

PARAMETER	ACTUAL EMISSIONS (lb/hr)	PERMIT LIMIT
TOTAL NON–METHANE ORGANICS	0.0	–
THC*	NR	148.4 lb/day
Benzene	0.0	–
NOx	17.69	500 lb/day
SOx –		250 lb/day
– SO_3	2.58	
– SO_2	NR	
– H_2SO_4	0.0	
VINYL CHLORIDE	0.0	–
CO	12.98	346.4 lb/day
PARTICULATE MATTER	3.88	113 lb/day
METALS:		
Al	4.21×10^{-3}	2.02×10^{-3} g/sec
As	0.00	4.61×10^{-4} g/sec
Be	0.00	–
Cd	0.67×10^{-3}	2.22×10^{-3} g/sec
Cd (Method 429)	0.64×10^{-3}	–
Cr(Total)	0.84×10^{-3}	8364×10^{-5} g/sec
Cr (Hexavalent)	0.0	–
Cu	1.35×10^{-3}	2.30×10^{-3} g/sec
Fe	13.15×10^{-3}	–
Hg	NR	5.76×10^{-4} g/sec
Mg	0.12×10^{-3}	2.30×10^{-3} g/sec
Mn	0.28×10^{-3}	–
Na	NR	$<2.88 \times 10^{-4}$ g/sec
Ni	1.14×10^{-3}	–
Pb	0.23×10^{-3}	1.15×10^{-3} g/sec
Fe	NR	2.24×10^{-2} g/sec
K	NR	$<2.88 \times 10^{-4}$ g/sec
Sn	0.76×10^{-3}	–
Zn	25.96×10^{-3}	2.10×10^{-1} g/sec

NOTE: 1 lb/hr = 24 lb/day; 1 lb/hr = 0.126 g/sec

NR – Not Reported

* Expressed as parts per million methane.

** Permit Limit obtained from Modesto Tire Incinerator Health Risk Assessment.

(Data from The Almega Corporation, 1990)

SCRAP TIRE USE

MPANY NAME: Willamette Industries
NT NAME: Albany Paper Mill
RESS: P.O. Box 335
Albany OR 97321
NE NO.: (503) 926-2281
IRONMENTAL ENGINEER/CONTACT: Chris Nygren

EMENT KILNS: None (1) Hog Fuel Boiler
ACITY OF EACH: 180,000 lb steam/hr
T RATE OF EACH: 3,400 mBTU/day

STE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

IMUM TIRE PIECE: 2" x 4"
IER FUELS: Hog Fuel (Wood Bark and Sawdust)
TIRE OF TOTAL FUEL: 2% by weight

LLUTION CONTROL EQUIPMENT:
Wet scrubber only

NTINUOUS EMISSION MONITORING EQUIPMENT:
Opacity only now although

EL HANDLING REQUIREMENTS/MODIFICATIONS:
None, fed directly into the boiler with the fuel

ASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

IY COMBUSTION/OPERATING PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

R EMISSION DATA:

Zinc levels in our primary sludge treatment is a concern ~~here~~. No other problems ~~were noted~~ have been noticed.

AS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION?
No limits were changed but now the amount of tires burned must be reported

QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: UNIROYAL GOODRICH *
PLANT NAME: EAU CLAIRE
ADDRESS: 799 WISCONSIN ST.
EAU CLAIRE, WI 54703
PHONE NO.: (715) 836-6200
ENVIRONMENTAL ENGINEER/CONTACT: BILL HABLE -PROCESSING
JOHN GLENZ - ENG. MGR. OF PLANT
OF BOILERS: 1 BURNING TIRES - STOKER TYPE
CAPACITY OF EACH:
HEAT RATE OF EACH 100,000 LB/HR - MAX

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

(SHREDDED) WHOLE SLIT

MAXIMUM TIRE PIECE: 3 SQ. INCH
OTHER FUELS: COAL - LOW S, HIGH BTU EASTERN COAL
% TIRE OF TOTAL FUEL: 5%

POLLUTION CONTROL EQUIPMENT:
PARTICLE COLLECTORS ON STACK (NO ESPs)

CONTINUOUS EMISSION MONITORING EQUIPMENT:
O_2

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
NEED EVEN DISTRIBUTION OF TIRE AND COAL
UNDERFED STOKERS

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:
INTERNAL SUPPLY - MAKES TIRES AT SITE, SCRAP BAD TIRES

ANY COMBUSTION/OPERATING PROBLEM: YES ____ NO X
IF YES, PLEASE EXPLAIN: WIRES STICKING OUT OF TIRES CAN PLUG STOKERS WITH BASD SHREDS, NO PROBLEMS WITH GOOD SHREDS

AIR EMISSION DATA:
NO PREVIOUS TESTING ON COAL - HIGH EMISSION RATES MAY BE DUE TO COAL, NOT RUBBER. ARSENIC IS PROBLEM (Limit-25 lb/hr, Test-70lb/hr) - NOT SURE IF DUE TO COAL OR RUBBER.

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION?

* Information obtained by phone.
1737-01-1

REV. 0, MARCH 22, 1991

SCRAP TIRE USE

ANY NAME: Willamette Industries
T NAME: Albany Paper Mill
ESS: P.O. Box 339
Albany OR 97321
E NO.: (503) 926-2281
RONMENTAL ENGINEER/CONTACT: Chris Nygren

MENT KILNS: None (1) Hog Fuel Boiler
CITY OF EACH: 180,000 lb steam/hr
RATE OF EACH: 3,400 mBTU/day

TE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

MUM TIRE PIECE: 2" x 4"
ER FUELS: Hog Fuel (Wood Bark and Sawdust)
RE OF TOTAL FUEL: 2% by weight

UTION CONTROL EQUIPMENT:
Wet scrubber only

TINUOUS EMISSION MONITORING EQUIPMENT:
Opacity meter only now although

L HANDLING REQUIREMENTS/MODIFICATIONS:
None, fed directly into the boiler with the fuel

STE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

Y COMBUSTION/OPERATING PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

R EMISSION DATA:

Zinc levels in our primary sludge treatment is a concern. No other pollutants have been noticed.

AS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION?
No limits were changed but now the amount of tires burned must be reported

QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: UNIROYAL GOODRICH *
PLANT NAME: EAU CLAIRE
ADDRESS: 799 WISCONSIN ST.
EAU CLAIRE, WI 54703
PHONE NO.: (715) 836-6200
ENVIRONMENTAL ENGINEER/CONTACT: BILL HABLE -PROCESSING
JOHN GLENZ - ENG. MGR. OF PLANT
OF BOILERS: 1 BURNING TIRES - STOKER TYPE
CAPACITY OF EACH:
HEAT RATE OF EACH 100,000 LB/HR - MAX

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

(SHREDDED) WHOLE SLIT

MAXIMUM TIRE PIECE: 3 SQ. INCH
OTHER FUELS: COAL - LOW S, HIGH BTU EASTERN COAL
% TIRE OF TOTAL FUEL: 5%

POLLUTION CONTROL EQUIPMENT:
PARTICLE COLLECTORS ON STACK (NO ESPs)

CONTINUOUS EMISSION MONITORING EQUIPMENT:
O_2

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
NEED EVEN DISTRIBUTION OF TIRE AND COAL
UNDERFED STOKERS

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:
INTERNAL SUPPLY - MAKES TIRES AT SITE, SCRAP BAD TIRES

ANY COMBUSTION/OPERATING PROBLEM: YES ____ NO X
IF YES, PLEASE EXPLAIN: WIRES STICKING OUT OF TIRES CAN PLUG STOKERS WITH BASD SHREDS, NO PROBLEMS WITH GOOD SHREDS

AIR EMISSION DATA:
NO PREVIOUS TESTING ON COAL - HIGH EMISSION RATES MAY BE DUE TO COAL, NOT RUBBER. ARSENIC IS PROBLEM (Limit-25 lb/hr, Test-70lb/hr) - NOT SURE IF DUE TO COAL OR RUBBER.

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION?

* Information obtained by phone.

1737-01-1

REV. 0, MARCH 22, 1991

SCRAP TIRE USE

PANY NAME: Willamette Industries
NT NAME: Albany Paper Mill
RESS: P.O. Box 335
Albany, OR 97321
NE NO.: (503) 926-2281
RONMENTAL ENGINEER/CONTACT: Chris Nyman

MENT KILNS: None (1) Hog Fuel Boiler
ACITY OF EACH: 180,000 lb steam/hr
T RATE OF EACH: 3,400 mBTU/day

STE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

SHREDDED WHOLE SLIT

IMUM TIRE PIECE: 2" x 4"
ER FUELS: Hog Fuel (Wood Bark and Sawdust)
IRE OF TOTAL FUEL: 25% by weight

LLUTION CONTROL EQUIPMENT:
Wet scrubber only

NTINUOUS EMISSION MONITORING EQUIPMENT:
Opacity meter only now although

EL HANDLING REQUIREMENTS/MODIFICATIONS:
None, fed directly into the boiler with the fuel

ASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

IY COMBUSTION/OPERATING PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:

R EMISSION DATA:

Zinc levels in our primary sludge treatment is a concern. No other problems have been noticed.

AS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION?
No limits were changed but now the amount of tires burned must be reported

QUESTIONNAIRE
SCRAP TIRE USE

COMPANY NAME: UNIROYAL GOODRICH *
PLANT NAME: EAU CLAIRE
ADDRESS: 799 WISCONSIN ST.
EAU CLAIRE, WI 54703
PHONE NO.: (715) 836-6200
ENVIRONMENTAL ENGINEER/CONTACT: BILL HABLE -PROCESSING
JOHN GLENZ - ENG. MGR. OF PLANT
OF BOILERS: 1 BURNING TIRES - STOKER TYPE
CAPACITY OF EACH:
HEAT RATE OF EACH 100,000 LB/HR - MAX

WASTE TIRE SPECIFICATIONS: (CIRCLE THOSE WHICH APPLY)

(SHREDDED) WHOLE SLIT

MAXIMUM TIRE PIECE: 3 SQ. INCH
OTHER FUELS: COAL - LOW S, HIGH BTU EASTERN COAL
% TIRE OF TOTAL FUEL: 5%

POLLUTION CONTROL EQUIPMENT:
PARTICLE COLLECTORS ON STACK (NO ESPs)

CONTINUOUS EMISSION MONITORING EQUIPMENT:
O_2

FUEL HANDLING REQUIREMENTS/MODIFICATIONS:
NEED EVEN DISTRIBUTION OF TIRE AND COAL
UNDERFED STOKERS

WASTE TIRE SUPPLY PROBLEMS? YES ____ NO X
IF YES, PLEASE EXPLAIN:
INTERNAL SUPPLY - MAKES TIRES AT SITE, SCRAP BAD TIRES

ANY COMBUSTION/OPERATING PROBLEM: YES ____ NO X
IF YES, PLEASE EXPLAIN: WIRES STICKING OUT OF TIRES CAN PLUG STOKERS WITH BASD SHREDS, NO PROBLEMS WITH GOOD SHREDS

AIR EMISSION DATA:
NO PREVIOUS TESTING ON COAL - HIGH EMISSION RATES MAY BE DUE TO COAL, NOT RUBBER. ARSENIC IS PROBLEM (Limit-25 lb/hr, Test-70lb/hr) - NOT SURE IF DUE TO COAL OR RUBBER.

WAS AN OPERATING PERMIT MODIFICATION REQUIRED FROM THE STATE REGULATORY AGENCY? YES X NO ____
IF YES, WHAT TYPE OF MODIFICATION?

* Information obtained by phone.

Appendix D-13

Business Cards of Contacts

Brocēni Cement
January 16, 17, & 18, 1995

BROCĒNI
JOINT STOCK COMPANY
16-17-18 Jan. 1995
J Reisons President in Riga
dr. sc. ing. JĀNIS KĻAVIŅŠ,
Tehnical vicepresident

4 Tirgonu street, 3rd floor
LV 1050 Riga
Latvian Republic
BEST
Phone: (371) 2 212587
Phone/ Fax: (371) 9 348058 RIGA
Tlx: 161156 INTA SU

LV 3851 Brocēni
Saldus district
Latvian Republic
Phone: (371) 38 65208
(371) 38 65212
Fax: (371) 38 65067
Brocēni

BROCĒNI
JOINT STOCK COMPANY
17-18 Jan 1995
AUSEKLIS GALINDOMS
Laboratory manager

Brocēni LV 3851
Saldus rajons
Latvija
Phone (371) 38 65149
(371) 38 65541
Fax (371) 38 65067

4 Tirgoņu iela, 3rd floor
Riga LV 1050
Latvija
Phone (371) 2 212587
Tel/Fax (371) 9 348058
Tlx 161156 INTA SU

Termolat SIA
Refractories
17 Jan 1995
4 Oct 1994
Dr. eng. Karlis Roze
Technical director
Consultant to Brocēni

88 Kr. Barona str.
226450, PDP, Riga
Latvia
ph. office 273324
lab. 392654
pr. 270861

Consultant from St Petersburg Russia
Nicolaj Garmonov
Oct. 1994 and Jan 1995

In talks with Mr F. Stevens from Brocēni
took part following persons :

Jānis Kļaviņš, technical manager ;
Guna Zauerhāgena, chief technologist ;
Edgars Vārna, manager resources department ;
Artūrs Andersons, production manager of Brocēni ;
Romualda Laurinoviča, assistant of technical manager on enviromental questions ;
Auseklis Galindoms laboratory manager

Brocēni 17.01.95

STEVENS CONSULTING CO.
13888 OAK MOUNTAIN DR. SUITE II
YUCAIPA, CA 92399
PHONE (909) 790-4031
FAX (909) 790-4031
FRANK C. STEVENS
PRESIDENT

CEMEX
FRANK C. STEVENS
TECHNICAL ADVISOR
AVE. CONSTITUCION 444 PTE. PH. 52(83) 28-30-00 EXT. 3602 DIR. 28-36-07
P.O. BOX 392, 64000 MONTERREY, N. L., MEXICO
FAX 52(83) 28-30-35

Appendix D-14

Curriculum Vitae of Frank C. Stevens and Franklin A. Phillips

Frank C. Stevens
President
Stevens Consulting Company
13688 Oak Mountain Drive
Yucaipa, California, 92399
Tel: 909-790-4033 Fax: 909-790-4031

SUMMARY

Qualified and experienced for consulting world wide on all phases of businesses connected with cement, concrete, construction, industrial minerals, alternative fuels, enviromental and energy. Handled mergers and acquisitions. Managed as President and CEO, companies connected with aggregates,cement concrete, oil and gas exploration, coal mining, transportation, and waste fuels.

RESUME

January 1991
To Present — CEMEX, Monterrey México

Consultant and technical adviser to CEMEX, fourth largest cement company in the world with 19 plants in Mexico, 12 plants in Spain, and large cement and concrete activities in the United States. Performed many assignments in transfer and use of cement manufacturing technology, and enviromental improvements. First in Mexico to use alternatives and waste fuels in cement kilns. Developed the Department of Energy covering fuels, electricity and enviromental, Trained personnel, in all phases including engineering, construction, procurement, and studies. Worked with other divisions for activities in Mexico, Spain and United States.

January 1985
to December 1990 — **Continental Cement Company, Hannibal Missouri**

President and CEO of 650,000 tons per year cement plant with four distribution terminal on inland water ways. Turned company around, reduced costs, and increased sales. Started the first waste fuel facility in Missouri in 1986, utilizing latest and new technology for using liquids, sludges and solids fuels in wet process kiln. In 1990 as a consultant, started a waste fuel facility in Australia.

September 1980
to December 1984

Stanford Research Institute (SRI)
Menlo Park California

Senior Management Consultant and Senior Industrial Economist for one of the best consulting organizations in the world. Performed many studies and assisted clients around the world including United States, Europe and Asia. Scope of reports and assignments covered manufacturing plants, energy projects (fuel and electricity), industrial minerals, enviromental projects, cement, concrete, construction, mergers, and acquisitions. Performed in-house management and improvement studies that resulted in increased profits for clients.

January 1980 to
August 1980

Special Assigment Activities for Unicem, Turin Italy

July 1970 to
December 1980

River Cement Company, St. Louis, Missouri

President, CEO, and Director of River Cement Company, Vice president of Missouri Pacific Corporation (Parent Company), Chariman and CEO of four ready-mix concrete companies and Chairman of River Corporation (gas and oil exploration and development). River Cement had annual production of 1.2 million tons per year using 2 dry process kilns in a highly automated, low cost, and profitable company with five distribution terminals on inland water system. Parent company owned the Misssouri Pacific Railroad, and Mississippi River Gas Transmission Company. Built the cement plant and terminals when Vice President Operations of River Cement in1963 to 1968.

September 1968 to
July 1970

Medusa Corporation, Cleveland Ohio

Vice President Operations and Engineering in charge of 6 cement plants producing grey cement, white cement, expansive cement and special products, and limestone aggregates. Expanded the facilities, reduced costs and increased production.

Other major Activities
1945 to 1968

- Build River Cement Company in Missouri
- Vice President Operations Lake Ontario Cement Company, Toronto Canada. Rebuilt and expanded cement plant and aggregate plant.
- Started career at Riverside Cement Company in research and quality control. Production manager. Built waste heat power plant (15 megawatts).Added kilns and mills to plants. Conducted other special assignments resulting in cost reduction and production increases.

Personal and other Information

- Married to Elisabeth with three grown children.
- Graduate Harvard Business Schools, Advanced Management Program in 1975.
- Graduate Texas A & M Electrical Engineering and U.S. Navy Electronics Program in 1943 and 1944.
- Graduate Riverside City College in Chemical Engineering in 1942.
- Aviation Electronics Officer in U.S. Navy (active duty and organized reserve) 1942 to 1947.
- Active in community affairs including President of Rotary Clubs in California and Canada.
- Participated in Portland Cement Association as Chairman of Research and Development Committee1976 through 1978, Chairman General Technical Committee 1974 through 1976. Member of Waste Management Task Force, Washington Affairs, Energy Task Force and on the Board of Directors 1970 through 1978.

FCS.
Nov.1994

APPENDIX D

Franklin A. Phillips

Education

B.S. Physiology (Pre-Medical) from Southern Illinois University at Carbondale.

Graduate studies in Chemistry at the University of Houston, Texas.

Masters in Business Administration from Lindenwood College in St. Charles, Missouri,

Current Position

President of Phillips Environmental Training and Resource Associates Inc., a firm specializing in hazardous waste, emergency response, safety, and transportation programs and training for industry compliance with regulations

Mr. Phillips is certified as an Environmental Trainer, and as a Hazardous Materials Manager.

Experience

Background of hazardous waste treatment, storage, and disposal facility services including permitting, waste analysis plans, trial burns, emergency response training, air quality, stormwater best management practices plans , corrective action cleanups, and risk assessments. Positions included Environmental Manager, Safety Director , and Chemist.

Technical liaison with EPA Region & for RCRA hazardous waste industrial incineration trial burn and Part B Permit at McDonnell Douglas Corporation.