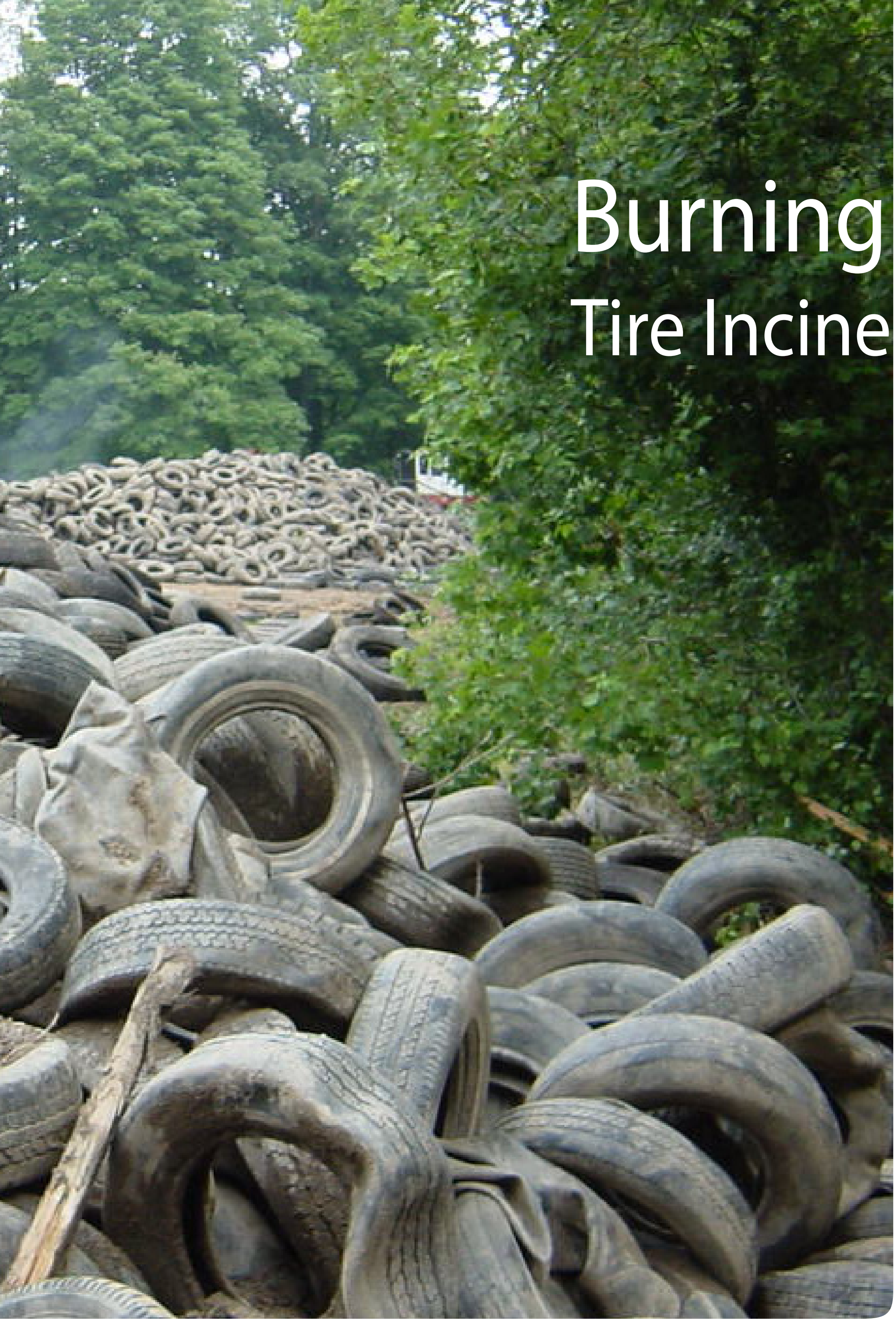

Burning Rubber

Tire Incineration

Center for Health, Environment & Justice
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Burning Rubber

Tire Incineration

Center for Health, Environment, and Justice

FactPack- PUB101

November 2011

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Mentoring a Movement

Empowering People

Preventing Harm

About the Center for Health, Environment & Justice

CHEJ mentors the movement to build healthier communities by empowering people to prevent the harm caused by chemical and toxic threats. We accomplish our work by connecting local community groups to national initiatives and corporate campaigns. CHEJ works with communities to empower groups by providing the tools, strategic vision, and encouragement they need to advocate for human health and the prevention of harm.

Following her successful effort to prevent further harm for families living in contaminated Love Canal, Lois Gibbs founded CHEJ in 1981 to continue the journey. To date, CHEJ has assisted over 10,000 groups nationwide. Details on CHEJ's efforts to help families and communities prevent harm can be found on www.chej.org.

Introduction

The Center for Health, Environment, and Justice has developed this fact pack "Burning Rubber" on tire incineration in response to numerous requests for information that we have had on this topic. This fact pack includes three types of information:

- Selections from technical papers and statistics describing of tire-derived fuel (TDF)
- Reports and articles from community organizations that express their concerns and actions they have taken to stop tire incineration
- News clips describing community struggles to address problems posed by tire incineration

We have included materials from nonprofit organizations, government agencies, consulting companies, newspapers, and journals in an effort to provide a thorough introduction to the issues. We have included the executive summary of technical reports that highlight what we believe is important information.

We intend this fact pack to be a tool to assist you in educating yourself and others. We do not endorse the conclusions of the government and consulting reports in this fact-pack. We've included them because they provide valuable information describing the kinds of chemicals typically found when incinerating tires and how the process impacts the surrounding community.

Our hope is that reading this fact pack will be the first step in the process of empowering your community to protect itself from environmental health threats. CHEJ can help with this process. Through experience, we've learned that there are four basic steps you'll need to take:

1. Form a democratic organization that is open to everyone in the community facing the problem.
2. Define your organizational goals and objectives.
3. Identify who can give you what you need to achieve your goals and objectives. Who has the power to shut down the landfill? Do a health study? Get more testing done? It might be the head of the state regulating agency, city council members, or other elected officials.
4. Develop strategies that focus your activities on the decision makers, the people, or person who has the power to give you what you are asking for.

CHEJ can help with each of these steps. Our mission is to help communities join together to achieve their goals. We can provide guidance on forming a group, mobilizing a community, defining a strategic plan, and making your case through the media. We can refer you to other groups that are fighting the same problems and can provide technical assistance to help you understand scientific and engineering data and show you how you can use this information to help achieve your goals.

If you want to protect yourself, your family, and your community, you need information, but equally important is the need to organize your community efforts.

Thank you for contacting us.

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Burnin' Rubber: The Dangers of Tire Incineration

Recycling efforts are reaching record levels in communities across the country. But, many programs are coming to a dead-end when confronted with what to do with automobile tires. Estimates vary, but there is little doubt that there are **billions** of discarded tires nationwide lying in huge piles with an estimated 200 million more tires being added each year.

Some have suggested that the solution to this problem is to burn the tires. In fact, burn them and generate energy in a "Tire-to-Energy" or "Tire-Derived-Fuel" plant. This idea is fast becoming the latest "magic machine" or quick-fix solution to this waste problem.

The leading proponent of burning tires is Oxford Energy, Inc. of New York City. They market a machine that burns tires using a West German technology brought to this country in the mid-1980's. Since that time, Oxford has only managed to site two plants. Their only operating plant is in Modesta, California. A second plant is being built in Sterling, Connecticut.

Why Not Burn Tires?

The main problem with burning tires is the toxic emissions they generate. No form of incineration is 100% effective. Whatever chemicals exist in the tires will end up in the emissions. Among the most common emissions are volatile organic chemicals (VOCs) such as benzene, chloroform, 1,2-dichloroethane (DCE), methylene chloride (MC), toluene, trichloroethylene (TCE) and xylene, metals such as lead, chromium and zinc and polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene, benzo(g,h,i)perylene and phenanthrene. In addition, specific rubber components such as butadiene and styrene are also found in emission gases. Because many of the chemicals contain chlorine, dioxins and furans are also released from tire burning incinerators.

All of these VOCs damage the central nervous system and the liver. Benzene, chloroform, 1,2-DCE, MC and TCE cause cancer as does lead, chromium and many PAHs. Butadiene is considered to be one of the most potent liver carcinogens ever observed. Dioxin is considered one of the most toxic chemicals ever tested.

Not only do air emissions include toxic chemicals present in the original waste, but they also produce new chemicals that were not in the original waste. These are called "Products of Incomplete Combustion" or PICs." Dioxins and furans are the most common PICs.

These chemicals are found not only in emission gases, but also in other pollution sources generated by the plant. These include the oily fluid that remains after the burning is completed (heated tires melt into from 3-10 gallons of contaminated oil depending on the size of the tire), residual ash, particulate ash captured by air pollution control equipment and contaminated waste water also generated by pollution control equipment and as ash quench water.

No Track Record on Emissions

Much of the information described above comes from data collected from uncontrolled burning of huge stacks of tires. There is very little data on emissions from burning tires in "controlled" incinerators. There are very few facilities in this country that burn tires. According to Oxford, air emissions include carbon monoxide, oxides of nitrogen, sulfur dioxide, particulate and hydrocarbons. In addition, Oxford estimates that 1.3 lbs of mercury, 2.9 lbs of lead and 0.00003 lbs of dioxins and furans will be released into the air each day 560 tires are burned.

Incineration is a Poor Disposal Alternative

No matter how new and improved the technology, burning tires is going to generate toxic emissions. Emissions cannot be avoided because 1) 100% destruction cannot be achieved by incineration; 2) combustion efficiency is very hard to maintain because chlorine and metal content can vary widely from tire to tire; 3) untrained and inexperienced operators don't know how to run plants properly; 4) upkeep and maintenance are often not a high priority; 5) pollution control devices are not 100% effective no matter how new and improved.

Like any machine, incinerators wear out and break down with use. A new car doesn't work as well after 15,000 miles as it did brand new. Likewise incinerators don't work as well after burning 500 tires/day for a year as they did brand new.

Upset or failure conditions are another problem. These conditions occur with all incinerators. Failures result from loss of power, poor mixing, equipment failures, burning waste with inconsistent heat value or high moisture content, changes in pressure due to mixing reactive wastes or quenching gases before combustion is complete. Very little is known about these events **except you can expect them to occur regularly and that emissions increase sometimes by as much as 100 fold.** When you also consider the fact that tire burner operators have little experience in operating the complicated equipment used to burn tires, it becomes clear that upset conditions are going to occur.

Tire incinerators pose another problem - where do you store the tires until they are burned? In Modesto, California, tires are burned whole so they have a huge storage area. Tires can catch on fire spontaneously posing severe risks to a surrounding community. Uncontrolled open burning generates the same chemicals already described only in higher quantities. Stored tires are also ideal breeding grounds for mosquitoes. Usually, stored tires are sprayed with pesticides to kill the mosquitoes, adding another ingredient to the tires that will end up in the toxic emissions. If tires are shredded, the storage problem is reduced but not eliminated.

What Are the Alternatives to Burning?

While there is no simple solution to the stockpiles of tires that exist, there are some good alternatives that are not being used enough. Some are better than others. These include shredding and using tires as raw materials for roads beds, combined with asphalt as a new road top material or in cement, remanufacturing into retreaded tires and other rubber products such as floor mats, gaskets, sandals, shoe soles and bumpers.

This article is a reprint, with some modifications, which originally appeared in *Everyone's Backyard*, Vol.9, No. 3- June 1991

ERIE COUNTY
DEPARTMENT OF HEALTH

ERIE COUNTY, PA

Andrew J. Glass, Director of Health

Mark A. DiVecchio, County Executive

FOR IMMEDIATE RELEASE

July 1, 2009

By resolution of Erie City Council dated April 15, 2009, the attached statement was made today to council by Paul Burroughs, Esq., chair of the Erie County Board of Health.

I am Attorney Paul Burroughs, chair of the Erie County Board of Health. I am here today to respond to your request that the board of health review the Inhalation Risk Assessment report of ERE and make our findings know to the Erie City Council.

The Erie County Board of Health continues to have significant concerns regarding the development and operation of a tires derived fuel plant in the county and specifically within the city.

In October 2008, we formulated a resolution which was unanimously approved by all members of the board. The resolution was based upon study and review of ERE application documents and upon interviews with numerous scientists and practitioners representing the fields of climatology, chemistry, wildlife biology, as well as several physician specialists. Additionally, we reviewed a significant number of scientific articles and research papers all dealing with the pollutants identified by Erie Renewable Energy and the PA Department of Environmental Protection as criteria pollutants. We also reviewed numerous other albeit non-regulated pollutants which will be pumped into the environments in which we live.

Our research has shown:

- ERE has estimated that, on average, 900 tons per day of tire derived fuel (TDF) would be combusted at the facility.
- The combustion of the TDF will generate approximately 155 tons per day of ash.
- There is no estimate of the emission of carbon dioxide. (Because CO^2 is one of those non-regulated emission, yet, as we know, CO^2 is a primary cause of global warming.)
- There is no emission estimate given in the plan approved application for polyaromatic hydrocarbons (PAHs). PAHs are a subset of volatile organic compounds (VOCs). ERE has estimated that 27.5 tons per year of VOCs will be emitted per year.

606 W.Second St. Erie, PA 16507 . Tel. 814 / 451-6700 . Fax: 814 / 451-6767 . Website: http://www.ecdh.org

- Page 2 July 1, 2009
  - There is no direct estimate of the amount of PM-2.5 emitted from the facility. ERE will most likely be required to conduct a stack test for filterable PM-2.5 as part of the plan approval.
  - Nitrous and sulfur oxides produced contribute to acid rain.
  - Mercury compounds concentrates in the lake/water and benthos, bioaccumulates and biomagnifies through the food chain. Even the smallest amount of Mercury is harmful to humans, fish and animals.

(January 2009 New England Journal of Medicine) scientific study has proven:

- There is direct relationship between the level of fine-particle pollutants in the air people breathe and life expectancy in cities across the United States.
- Reducing the average level of fine-particle pollutants – the most damaging kind – by 10 micrograms per cubic meter of air adds about seven months of life expectancy, according to the study of 51 metropolitan areas from Portland, Wash., to Tampa Bay, Fla.
-

(2006 Air and Waste Management Association)

- Despite important gaps in scientific knowledge and continued reasons for some skepticism, a comprehensive evaluation of the research findings provides persuasive evidence that exposure to fine particulate air pollution has adverse effects on cardiopulmonary health.

- Since 1997, there has been a substantial amount of research that added to the evidence that breathing combustion-related fine particulate air pollution is harmful to human health.
- Tires contain around 20 different metals most of which have effects on humans, aquatic life and animals.

(2002 Environmental Health Perspectives)

- The magnitude of the association between particulate pollution and daily deaths suggests that controlling fine particle pollution would result in thousands fewer early deaths per year.

(Circulation 2008)

- Studies show an association between long-term air pollution and well-established quantitative measures of atherosclerosis. Biological plausibility for a causal relationship between air pollution and atherosclerosis is supplied by animal studies.

(Environmental Science Technology 2006)

- Ultrafine particles are emitted preferentially and exhibit the longest atmospheric residence time.
- “Atmospheric PM has been liked with adverse effects on human health.”

(Environmental Science and Technology 2001)

- During their migration through the air, PAHs can undergo environmental factors which transform them into products in some cases more dangerous than the originally released. PAHs or their derived compounds can get into water and soil being assimilated by the different organisms (plants, animals, fish, etc.) existing in the corresponding ambient. As result and due to the biological cycle at which living species are submitted, PAHs and derived compounds can get into the human body more or less directly, by ingestion, inhalation, or contact with the skin forming adducts which could alter the regular behavior of cells.

(JAMA 2002)

- Long-term exposure to combustion-related fine particulate air pollution is an important environmental risk factor for cardiopulmonary and lung cancer mortality.

Based upon these and numerous other research findings, our resolution recommended four steps are taken:

1) that an independent risk assessment of the long term operation of this plant on the health, safety and welfare of the people and the environment be required as a part of the review process by the Pennsylvania Department of Environmental Protection;
2) that the developer provide to the Board of Health and the Erie community the design of the risk assessment and the raw data following the assessment as well as the report itself and all supporting data;
3) that specific reference to current research regarding polycyclic aromatic hydrocarbons (PAH's) and the specific emissions of this plant be addressed within the assessment;
4) that specific reference to current research regarding ultrafine particulate matter (less than 2.5 microns in size) and the specific emissions of this plant be addressed within the assessment.

We have subsequently reviewed the ERE submitted assessment and find that the report closely follows the regulated parameters of the DEP and verifies that operations of the plant would be within those guidelines. The report does not offer any interpretive data and corresponding affects on health. The report also does not address our request for raw data and other specific components of our resolutions. There is a noticeable absence in the report of the public health effects of (known) non-criteria pollutants.

The Board of Health shares the opinions and findings of the Erie County Medical Society. We recognize that the operation of this plant will significantly raise the pollutants being emitted into our air, our ground and our water. According to the literature, the pollutants, both criteria and non-criteria, will have a measurable, definite negative impact on the health of the residents of the City of Erie, the County of Erie and surrounding populations.

The Board of Health is even more concerned when we see and are told that the current regulatory process has such a difficult time monitoring and enforcing pollution controls at a neighboring facility which has been operating out of compliance for years, namely Erie Coke. All the while, while we had been being assured by DEP that Erie Coke was operating within regulatory compliance, large amounts of non-compliant discharges are finding their way into our environment.

You should also be aware that the Board of Health requested assistance from the PA Department of Health. As a result, the Bureau of Epidemiology and the Agency for Toxic Substances and Disease Registry is currently reviewing all submitted data and considering the health impacts of the proposed plant. The Department of Heath is in contact with the DEP and has assured us that this review will be complete and submitted to the Erie County Department of Health and the DEP prior to any final decision being made by the DEP. The resultant assessment documents will provide information regarding potential exposures and probable adverse health effects associated with such levels of exposure to various compounds.

At this time, based upon the information which we have been provided, the opinion of the Erie County Board of Health is that the operation of the proposed ERE facility will pose a definite short term as well as long term negative health risks and consequences upon the residents of Erie County. The operation of this plant will also pose a negative risk and consequences to the quality and health of the environment of Erie County.

Letters to the Editor
The Meadville Tribune
947 Federal Court
Meadville, PA 16335
trinune@meadvilletribune.com

July 5, 2010

I am writing in response to an op-ed piece by Gary DeSantis entitled "Tired Of Lame Pollution Predictions."

Opponents of the proposed tire-to-energy plant originally planned for Erie and now planned for Meadville have sound reasons for their concerns. It is not fear-mongering, it is based upon sound scientific evidence.

Tire-derived fuel does NOT burn cleaner than coal. It is really that simple.

Smaller, lower molecular weight, carbonaceous molecules, such as methane (CH_4) with its single carbon atom and four hydrogens, are the cleanest burning fuels. Since there are fewer chemical bonds, there is a greater likelihood that the fuel will completely oxidize, which is the ultimate purpose of the combustion process. As the complexity and the molecular weight of the fuel increases so does the plethora of products from the combustion process, i.e., what we refer to as "pollution." Thus, methane burns cleaner than gasoline (a mixture of hydrocarbons with anywhere from five to twelve carbons), which, in turn, burns cleaner than coal. (Coal is a complex fuel with no specific chemical formula but on average contains about 150 carbon atoms.)

Tires are mainly formed from natural and synthetic rubber, a high molecular weight, polymeric material. Polymers are long chains of repeating units (picture a train formed from hundreds of individual train cars), which can be anywhere from hundreds to thousands to hundreds of thousands of carbons in length, such as is the case of the rubber in tires. Tire-derived fuel will produce more emissions and a greater variety of emitted compounds than does coal because of the increased complexity of the composition, or chemical make-up, of the fuel.

Furthermore, studies conducted by the Mastral research group and published in well-respected, peer-reviewed scientific journals between the years 1999 through 2003 have all concluded that under a wide range of combustion conditions the highest Polycyclic Aromatic Hydrocarbon (PAH) emissions were produced when using tires as a fuel as compared to coal or even coal-tire mixtures. These studies were conducted using the same fluidized bed combustor as that being proposed for the Meadville plant.

PAHs are a group of compounds whose toxicity, owing to their mutagenic and carcinogenic properties, is extremely well-documented. Members of this group, and a related group of compounds the Dioxins/Furans, which will also be released from the proposed facility, can start to have an impact upon ecosystem health at the part per trillion level. Air pollution control devices do not work down to this level.

Having taking the time to seek out and review these studies, I would be happy to supply electronic versions to anyone interested in reading them. I have done so for both the Erie and Buffalo-Niagara sections of the Sierra Club, the Erie County Health Department, and for KEEP, the citizen's action group that formed in order to fight the establishment of this plant in Erie. It is based upon these studies, as well as numerous discussions with respected scientists in various fields of expertise (air quality, human health impacts, environmental scientists, etc.) , that ALL of these groups have issued statements and reports in opposition to this facility. I am certain that electronic versions of these reports, along with their cited sources, are also available to anyone person looking to understand the scientific basis for the concerns surrounding this facility.

History has shown us time and again that corporations only have short-term vision, focused solely upon quarterly profit that neglect the very real, long-term impacts of their processing. Look at what is happening in the Gulf of Mexico right now, not to mention Love Canal, the Berkeley Pit, the recent explosion of a Marcellus Shale rig, the West Valley Nuclear Repository, the legacy of mercury contamination in our Great Lakes owing to our industrial past and the perpetual violations of Massey Energy with regard to their Mountain Removal coal mining (that led to the deaths of 17 miners a few months ago), to name but a few examples. Do you see any of the corporation CEOs living near these sites? Would they? No. Because given the money they will move far away from the very environmental degradation that they help to create. This is the hard reality. It is called ‘Environmental Justice’- the very real, scientifically proven fact that the people that are paying the price with regard to environmental degradation are the poorest members of our society because they are the ones to welcome any corporation, any job, without understanding the long-term consequences of those choices. What good is a job if you and your children and your children’s children are dying of cancer? Many of the very jobs people fight for (like those being offered by this proposed plant) don’t even provide adequate health insurance to cover the environmental impact the job they are providing will have on the people working there, more or less all the innocent people who are not working there but nevertheless live in the wake of the facility.

Government agencies like the PA Department of Environmental Protection (DEP) are limited by what they can do. If a corporation turns in the proper paperwork and promises within that paperwork that it will operate safely, the DEP has to issue the permit. The opinions and desires of the community are not taken into account. The only recourse with regard to permitting is to find an issue with the paperwork as providing opposing scientific evidence has no bearing. The preponderance of corporations that pay <u>DAILY</u> fines to the DEP and the EPA owing to environmental violations (case in point the recent ruling against Erie Coke) provides the reality behind the smoke screen issued as part of the permitting process: corporations pollute and they don’t care about the impact of that pollution on the surrounding community- they care about profit, even if that profit comes at the expense of people and of the Earth, our life-giving planet.

This is reality. It is the cold, hard, bare truth based upon science and history. We, as a people, have to see it, have to face it, and have to move forward with this understanding. This proposed plant does not represent a move forward- it is not even renewable energy since half of a tire is petroleum-based- it is a move back to our industrial and dirty past. With the facts and the lessons-learned as our foundation it is time to move forward by staving-off the temptation that this plant offers and looking for a truly renewable energy source and the clean jobs that come with it.

****

Dr. Sherri A. Mason is an Associate Professor of Chemistry, coordinator of the Environmental Sciences program, and coordinator of Community-Based Research at SUNY-Fredonia. Having recently spent her sabbatical leave at the Air Pollution Research Center on the University of California at Riverside campus, her research is focused upon the influence of combustion emissions on local-to-regional scale atmospheric chemistry. Her work has been supported by the Great Lakes Commission, the National Science Foundation, and the NASA Earth System Science Fellowship program.

TIRES AS A FUEL SUPPLEMENT: FEASIBILITY STUDY

Report to the Legislature
January 1992

CALIFORNIA INTEGRATED WASTE MANAGEMENT BOARD

Preface

This report is on the feasibility of using waste tires as a fuel supplement for cement kilns, lumber operations, and other industrial processes. It has been written in consultation with the California Air Resources Board (CARB) and the California Energy Resources Conservation and Development Commission (CEC) to fulfill the reporting requirement of Assembly Bill 1843 of 1989 (Chapter 35, Statutes of 1990, now codified as Public Resources Code §42800 *et seq.*).

Disclaimer

The statements and conclusions of this report are those of the California Integrated Waste Management Board. The report was made available for public review and comment (at a workshop held on December 18, 1991) before adoption by either the California Integrated Waste Management Board or the State of California. The State makes no warranty, express or implied, and assumes no liability for the information contained in the succeeding text. Any mention of commercial products or processes shall not be construed as an endorsement of such products or processes.

with virgin rubber. Also, reclaimed rubber has lower elastic properties. Because of these factors, little reclaimed rubber is used by the tire manufacturing industry where about 70 percent of all the virgin rubber produced is consumed. Until the quality can be improved, the majority of the reclaimed rubber produced will be used as a filler material or by industries with lower quality requirements than tire manufacturers (Sladek, et al., 1989). Because overall demand will be low without the tire manufacturing market, the use of reclaimed rubber is not likely to account for a significant number of tires.

The addition of tire rubber to asphalt binders or asphalt concrete may impede or prevent these asphalt pavements from being recycled. Asphalt pavement is recycled by being ground for use as an aggregate in new asphalt concrete. The effects of tire rubber in recycled asphalt concrete is a concern of both the Federal Highway Administration and CalTrans (Doty, 1991).

3.3 POTENTIAL ENVIRONMENTAL IMPACTS

Potential impacts on public health and the environment are impediments to the uses of waste tires. The potential impacts include air emissions from the combustion of tire rubber, surface and ground water contamination from harmful constituents leached from tire rubber, and wastes and by-products from combustion or processing. Much of the following discussion on air emissions was provided by the CARB.

3.3.1 Air Pollutant Emissions

The emissions from substituting tires for a portion of the fuel burned in new or existing facilities are likely to vary depending on the type and design of facility, type of primary fuel being burned, percent of primary fuel being replaced with tires, air pollution control equipment, and other factors (see Malcolm Pirnie, 1991). In cement kilns, where the fuel is burned in contact with the cement feedstock (lime, silica, alumina, and iron), emissions are also affected by the feedstock components.

Burning tires can result in emissions of criteria pollutants such as carbon monoxide (CO), nitrogen and sulfur oxides (NOx and SOx), particulate matter (PM), hydrocarbons (HC); and noncriteria pollutants such as arsenic, cadmium, chromium, lead, zinc, dioxins and furans, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), benzene, and other organic compounds. These pollutants are also emitted from combustion of other fuels, such as coal, the primary fuel for cement kilns. The quantity of emissions from burning tires as a supplemental fuel, and the relative emissions compared to operating the facility without this supplemental fuel, can only be determined by emissions testing. Comparing the composition of fuels, however, can give an indication of likely relative emissions. Refer to Appendix A for a comparison of the compositions of tires, western coal, MSW and RDF, and biomass.

The heating value of tires is comparable to that of coal and two to three times that of MSW, RDF, or biomass. Tires typically have higher sulfur concentrations than these other fuels, with the exception of many mid-western and eastern coals. Chlorine, a precursor to hydrogen chloride (HCl) and dioxin emissions, is higher in tires than in western coal, but lower than in MSW or RDF. Of the metals found in MSW and RDF, all metals except zinc appear to be in lower concentrations in tires. Tires and western coal are more similar in metal content, although zinc and lead are substantially higher in tires, and some other metals such as arsenic are somewhat lower in tires. The effect on emissions of these differences in fuel composition can be moderated by the volatility of the metal, percent of each type of fuel burned, the pollution control equipment, facility design and other factors, and can only be confirmed by emissions testing.

Cement Kilns

Dry process kilns built since 1979 are commonly of the preheating and precalcining design. This type of system allows the sensible heat in the kiln exhaust gases to dry, and to partially calcine, the raw material before it enters the kiln. In this type of system, fuel is fired in both the precalciner as well as the kiln. Because heat transfer in a preheater is much more efficient than in the preheating zone of a kiln, preheating and precalcining type systems are also much more energy efficient.

Particulate matter is the primary emission from the manufacture of Portland cement. Emissions also include the normal products of combustion of the fuel used in the kiln and drying operations. The largest single source of emissions is the kiln, which may be considered to have three units: the feed system, the fuel firing system, and the clinker cooling and handling system. The most desirable method of disposal of the dust collected by a particulate control system is injection into the kiln combustion zone for inclusion in the clinker. If the alkali content of the raw material is too high, however, some of the collected dust is treated before its return to the kiln, or sold as a by-product, or discarded. Due to the complexity of modern kiln operation, and the large volume of materials being handled, many types of particulate matter control systems are used. Typical control systems include cyclones and baghouses or electrostatic precipitators. Refer to Figure 2-1 for an illustration of a typical cement kiln process.

Three cement kilns in the state have burned tires as a supplement to coal. Calaveras Cement in Redding burns tires on a permanent basis. The other two (RMC Lonestar, Davenport, and Southwestern Portland, Victorville) have performed test burns as part of the permit modification process and to obtain data needed to decide whether it is feasible and cost effective to burn tires. Each of these existing coal-fired cement kilns is of the preheating and precalcining design. To best evaluate the impact of burning waste tires as a supplement to coal-firing, data is needed during both fuel-firing scenarios at each facility (i.e. coal-only and coal-with-tires). Although coal-only data is not available for the Calaveras Cement facility, data is available for both fuel-firing scenarios for the remaining two facilities. Both facilities were required to conduct testing for certain toxic air pollutants pursuant to the requirements of the Air Toxics "Hot Spots" Act (Health and Safety Code §44300 *et seq.*). This testing was conducted in 1990 at both facilities while firing coal only. Since that time each facility has repeated the testing while firing both coal and tires simultaneously. Descriptions of each facility and summaries of the available test data appear in Appendix B.

The results of air pollutant emissions testing at RMC Lonestar and Southwestern Portland indicate that burning 18 to 25 percent tires (on a total heat input basis) as a supplement to coal in a precalcining type of cement kiln does not result in any appreciable difference in toxic air emissions. The results of criteria pollutant testing were also similar for both firing scenarios. The tests showed a 22 percent decrease in NOx emissions with the use of tires as a supplement to coal; however, the variation of NOx emissions is significant during normal operations. Long-term continuous emissions monitoring is necessary to verify the criteria pollutant emissions. While no coal-only data are available from Calaveras, continuous emissions monitoring for January to August, 1991, indicate that criteria pollutant emissions from co-firing about 22 percent TDF with coal at this facility are in the expected range (see Appendix F). Table 3-1 presents criteria pollutant emissions obtained during coal-only, and coal-with-tires firing scenarios for RMC Lonestar and Southwestern Portland.

In order to provide a preliminary assessment of the potential public health impact of burning tires as a supplemental fuel, the CARB used the Lonestar and Southwestern data in a screening air quality dispersion model and health risk assessment procedure. This assessment was a screening analysis only, not a refined risk assessment. The results of these analyses indicate no significant difference in risk from burning tires as compared to coal-only firing at these facilities. The results of the screening risk analyses are included in Appendix C.

Wood Fired Boilers

Several wood fired boiler facilities in California have tried using chipped tires as a supplemental fuel. For various reasons, none of these facilities has used tires on a regular basis. Most of the

TABLE 3 - 1

COMPARISON OF EMISSIONS FROM CALIFORNIA CEMENT KILNS

	RMC Lonestar Davenport, 1			Southwestern Victorville, 2		
	Coal Fired	TDF Co-Fired	Percent Change	Coal Fired	TDF Co-Fired	Percent Change
Test Date	4/90	12/90		3/90	4/91	
Percent TDF (of total heat input)	0	18		0	25	
NOx (as NO_2)						
lb/hr	207	162	-22	626	488	-22
lb/ton clinker	2.1	1.6		5.3	4.2	
lb/MMBTU	0.59	0.46		1.5	1.2	
Permit Limit	250 lb/hr (24 hr. ave.)			(note 1)		
SO_2						
lb/hr	43	45	+5	4.0	0.3	-93
lb/ton clinker	0.43	0.45		0.034	0.0026	
lb/MMBTU	0.12	0.13		0.0096	0.00072	
Permit Limit	250 lb/hr (24 hr. ave.)			(note 1)		
CO						
lb/hr	257	244	-5	250	538	+115
lb/ton clinker	2.5	2.4		2.1	4.6	
lb/MMBTU	0.73	0.70		0.60	1.3	
Permit Limit	NA[2]	NA		(note 1)		
Total Particulates						
lb/hr	NA	NA	NA	11.0	6.3	-43
lb/ton clinker	NA	NA		0.094	0.054	
lb/MMBTU	NA	NA		0.026	0.015	
Permit Limit	40 lb/hr			(note 1)		
THC (as methane)						
lb/hr	NA	NA	NA	11.5	6.40	-44
lb/ton clinker	NA	NA		0.098	0.05	
lb/MMBTU	NA	NA		0.028	0.02	
Permit limit	NA	NA		(note 1)		

Notes: 1 Facility permit limits are for combined emissions which include kilns 1, 2, 8 and 9.
2 NA means data are not available.

problems were related to increases in particulate matter emissions; however, one traveling grate boiler experienced operational problems due to slag formation from the steel wire in tires. There are little emissions data available from these operations.

One evaluation was performed in 1982 of the impact of supplementing hogged-fuel with shredded rubber tires in various percentages of fuel input at Roseburg Lumber Company in Anderson. A summary of test results appears in Appendix D. The addition of as little as three percent shredded tires caused PM emissions to almost double, with the majority of the increase attributable to lead and zinc oxides. The addition of tires also resulted in increased nitrogen oxide and sulfur oxide emissions. Although the increases were appreciable, the increase in particulate matter was the limiting factor in permitting long-term operation. Subsequent to this evaluation, the facility's permit was modified to burn three to five percent of fuel as tires. According to the facility operator, however, they stopped burning tires in 1987 because of environmental reasons (CARB, 1991b).

Staff of the air pollution control districts who were contacted have indicated that other biomass facilities which have tried burning small amounts of chipped tires experienced similar problems with particulate emissions; however, facility and equipment descriptions are not available, and operating parameters are unknown. There are no California biomass facilities known to be currently burning tires as a supplemental fuel.

Comparative air emissions of some criteria pollutants and metals from two U.S. pulp and paper mills are summarized in Appendix E. Emissions of nitrogen oxides, sulfur oxides, particulate matter, and total hydrocarbons showed no significant change when burning up to 14.5 percent dewired TDF during tests conducted in 1989 at Champion International in Bucksport, Maine (refer to Section 2.4.2 for facility information). The primary fuels used are a combination of fuel oil, biomass, coal, and non-Kraft process wastewater sludge. Particulate emissions are controlled by an ESP. Emissions of beryllium and chromium decreased, while emissions of cadmium and zinc increased.

Emissions of PM and some PAH showed significant increases at Port Townsend Paper Company in Port Townsend, Washington, during tests conducted in 1986. Air pollution control equipment included a multiclone and a venturi scrubber, but no higher-efficiency particulate controls such as a baghouse or an ESP. The primary fuels burned are a combination of wood and fuel oil. When oil was replaced with about five percent TDF (by heat input), an increase of 26 percent in particulate emissions was observed. Emissions of barium, cadmium, chromium, lead, and vanadium, however, were reduced by 36 to 99 percent. Zinc emissions dramatically increased as expected. Most PAH emissions showed no significant change with the exception of four compounds.

Performance and air pollutant emissions tests will need to be conducted prior to using tires as a fuel supplement at any facility. Results of these tests would be used to determine whether or not TDF is a compatible fuel for these facilities, with consideration for process performance, economics, and environmental impacts. It may be possible for some biomass facilities which are equipped with adequate emissions controls to burn a small amount of TDF without significant environmental impacts (refer to Section 2.4.3). Future studies to analyze such impacts should be closely coordinated with the local air pollution control district and the CARB.

Asphalt Production

Another potential source of air emissions associated with waste-tire rubber use is hot mix asphalt facilities. Tire rubber is heated and mixed with the bitumen binder often with the addition of additives (US EPA, 1991). Air pollutant emissions from the production of asphalt concrete may be increased due to the addition of tire rubber (or any petroleum derivative) to the bitumen binder. Emissions are also released during the application of asphalt concrete (with or without tire rubber). Further testing is needed to determine if any significant difference exists between RUMAC or AR and conventional asphalt concrete.

According to the Congressional Record, the Canadian Government has completed a study on AR and RUMAC (unavailable at this time) that indicates no additional risk due to the use of tire rubber (Congressional Record, 1991).

The Asphalt Rubber Producers Group supported an ambient air sampling program to evaluate emissions from asphalt-rubber paving. Data was compared to background concentrations of the South Coast Air Basin compiled by the South Coast Air Quality Management District. The following conclusions are based on the documentation from the sampling program (Roberts Environmental Services, 1989).

- Volatile organic sample analysis indicated low or average concentrations compared to background concentrations.
- Formaldehyde and sulfur dioxide samples collected represent "good air quality" in the South Coast Air Basin.
- Numerous exceedances in opacity, based on South Coast Air Quality Visible Emissions rule 401, were recorded.
- Meteorological conditions during the tests appeared quite typical of conditions expected for higher emissions in the South Coast Air Basin.

Transportation and Processing

Waste tire use can also indirectly cause air emissions from the increased amount of transportation needed to haul tire material to processors and also from the equipment required to process whole tires. Traditional types of aggregate are often acquired locally for each paving job.

Emissions from the transportation of waste tires are attributable to internal-combustion-engine exhaust (mainly diesel engines). Tractor trailer hauling is the most common form of transportation for tires (whole or shredded). Much transportation, however, is done by light and medium trucks, and rail hauling is also an alternative.

Similarly, the emissions from tire processing equipment result from diesel engine exhaust from shredders and chippers. Types of emissions generated are carbon monoxide, nitrogen oxides, sulfur oxides, particulate matter, and other products of incomplete combustion.

3.3.2 Surface and Ground Water Contamination

Many uses of waste tires may create potentially harmful constituents (primarily metals and PAH) which can be leached into the environment (surface and ground water supplies). Potential sources include tires used in reefs and break waters, road base, bulking agents in sludge composting, playground cover, and soil amendments.

As mentioned in Section 2.3.2, a study conducted for the Minnesota Pollution Control Agency found that metals and PAH are leached from tire rubber under certain conditions. Metals were leached in the highest concentrations under acidic conditions, while PAH were leached in the highest concentrations under basic conditions. Water samples collected for the study were found to exceed the recommended allowable limits for barium, cadmium, chromium, and lead, while background samples did not (Twin City Testing Corp., 1990). Asphalt materials, however, may leach higher concentrations of the constituents under certain conditions.

As discussed in Section 2.3.3, the EPA evaluated tire chips as an alternate bulking agent in sewage sludge composting. According to the EPA, "Heavy metal levels increased during composting with raw primary sludge and rubber chips as a result of the concentrating effect of organic matter decomposition. In addition, the shredded rubber chips contributed Zn and Fe [zinc and iron] to the finished compost." The levels would not limit the use of tire chips in sewage sludge composting (Higgins, 1987).

The Tire Pond, a North Haven, Connecticut firm, stores waste tires in a 30-acre lake. Twice a year, the water quality of the lake and surrounding ground water is determined through sampling of the lake and three wells. Based on reports from 1988 and 1989, there do not appear to be any significant changes in surface or ground water quality attributable to the stored tires. Test samples showed increased levels of iron, zinc, and sulfate; but, because of the high degree of industrialization in the area, it was difficult to determine the source of contaminants (Environmental Consulting Laboratory, 1988-1989; Tire Salvage, Inc., 1990).

Due to the differences in test subjects, methods, and objectives, no factual conclusions can be determined except that potentially harmful constituents from tire rubber can leach into the environment under specific conditions.

3.3.3 Wastes and By-Products

Industries other than cement kilns which use waste tire rubber as a fuel may generate wastes or by-products which are contaminated. Bottom ash and fly ash generated at combustion facilities using waste tire rubber may be contaminated with heavy metals or other constituents.

Because fly and bottom ash from biomass combustion facilities are often used as a soil conditioner on agricultural land, potential contamination due to tire-rubber combustion may limit the use of the ash. If found to be contaminated, the ash may be classified as hazardous waste and require treatment or disposal in a Class 1 landfill. Because of these and other concerns, biomass facility owners may be hesitant to use a significant amount of waste tire rubber as a fuel supplement.

Wastes and by-products are also generated by waste-tire processing industries including buffing and granulated rubber production. Due to the nature of production buffing operations, the tire carcass is not used and requires disposal. Granulated rubber production, using ambient or cryogenic processing, leaves the steel and fabric for recycling or disposal.

3.4 ECONOMIC ISSUES

Economic impediments to the use of waste tire rubber are the costs of collection, transportation, preparation, and capital and operating expenses. Development of markets for new products and competition with existing processes, materials, and products have also economically impeded waste tire use.

Scrap tires should be considered a resource rather than a waste material. Technically, there are many methods available to recycle tires. There must, however, be a consideration of economics, which is strongly driven by market conditions, because a reuse or recycling option will only be realistic if it is economically competitive with other products or materials.

3.4.1 Collection and Transportation Costs

Tires are collected from dealers and service stations by tire jockeys (people who collect, sell, and dispose of used tires) for a fee of $.35 to $1.25 for light-duty tires and $.65 to $6.00 for heavy-duty tires (NTDRA, 1990). The tire jockeys sell as many tires as possible to tire retreaders and other tire processors to generate another source of income. Ultimately, the remaining tires are landfilled, stockpiled, exported, or illegally dumped.

The cost of transportation to a waste tire user may be an economic barrier to the use of waste tires. Due to factors such as labor, truck maintenance, fuel requirements, and profit margins, trucking firms may charge as much as $.75 per tire. Maak tire, a Spokane, Washington-based firm, charges approximately $.50 per tire, or about $500 per semi-load (Pyro Recovery and Huston Trust, 1990). Calaveras Cement Company in Redding, California, pays approximately $1.35 per mile for delivery of a load of whole or shredded tires (Siemering, 1991). Consolidated Environmental Industries (CEI), a West Sacramento-based mobile tire shredding company, is charged $65 per hour (about $.06/tire/hour) for transportation of ten tons of shredded tires to either a company-owned monofill or a public landfill. CEI must also pay a tipping fee of $75 per load (about $.07/tire) at the monofill, or $140 per load (about

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Project Summary

Air Emissions from Scrap Tire Combustion

Joel I. Reisman

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

This Project Summary was developed by the National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

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

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

Open Tire Fires

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

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

Table 1 lists 34 target compounds representing the highest potential for inhalation health impacts from open tire fires. The list was developed by analyzing laboratory test data and open tire fire data collected at nine tire fires. The list can be used to design an air monitoring plan in order to evaluate the potential for health risks in future events.

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

Other Impacts from Open Tire Burning

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

Controlled Combustion

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

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

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

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

Conclusion

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

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

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

Table 1. Target Compounds by Criteria

Target Compound	*Criteria*			
	CA	*TLV*	*Subchronic RfC*	*Chronic RfC*
Acenaphthene	*X*			
Acenaphthylene	*X*			
Arsenic	*X*			
Barium				*X*
Benz(a)anthracene	*X*			
Benzene	*X*			
Benzo(a)pyrene	*X*			
Benzo(b)fluoranthene	*X*			
Benzyl chloride	*X*			
Butadiene	*X*			
Carbon Monoxide		*X*		
Carbon Tetrachloride	*X*			
Chloroform	*X*			
Chromium	*X*			
Chrysene	*X*			
Coal Tar Pitch	*X*	*X*		
Cumene			*X*	*X*
Dibenz(a,h)anthracene	*X*			
1,2-Dichloropropane	*X*		*X*	*X*
Dibenz(a,h)anthracene	*X*			
Ethylene Dichloride	*X*			
Hexachloroethane	*X*			
Hexane			*X*	*X*
Lead	*X*			
Methylene Chloride	*X*			
Nickel	*X*			
Phenol	*X*			
Styrene	*X*			*X*
Sulfur Dioxide		*X*		
Sulfuric Acid		*X*		*X*
Toluene (Methyl Benzene)			*X*	*X*
1,1,2-Trichloroethane	*X*			
Trichloroethylene	*X*			
Vanadium		*X*		
Xylene, o		*X*		

CA = Suspected or Confirmed Human Carcinogen.
TLV = Reported Value is 33% of Threshold Limit Value.
RfC = Inhalation Reference Concentration.

Table 2. Summary of Criteria Pollutant Emission Data at Utilities Using TDF

Power Plant	Particulates (Total)		Sulfur Oxides		Nitrogen Oxides		Carbon Monoxide	
	g/MJ	lb/MMBTU	g/MJ	lb/MMBTU	g/MJ	lb/MMBTU	g/MJ	lb/MMBTU
Facility A								
100% Tires	9.5×10^{-7}	2.2×10^{-6}	6.0×10^{-6}	1.4×10^{-5}	4.2×10^{-5}	9.8×10^{-5}	3.1×10^{-5}	7.2×10^{-5}
Facility B (Coal)								
0% TDF	0.09	0.21	0.606	1.41	0.34	0.78	NT	NT
5% TDF	0.0064	0.015	0.774	1.8	0.25	0.58	NT	NT
10% TDF	0.004	0.009	0.658	1.53	0.13	0.3	NT	NT
Facility C (Coal)								
0% TDF	0.22	0.52	0.49	1.14	0.34	0.79	0.65	1.52
7% TDF	0.06	0.14	0.37	0.87	0.39	0.91	3.12	7.26
Facility D (Coal)								
0% TDF	0.027	0.063	2.28	5.3	0.258	0.601	NT	NT
5% TDF	0.031	0.0717	2.46	5.73	0.219	0.51	NT	NT
10% TDF	0.0242	0.0564	2.46	5.71	0.188	0.436	NT	NT
15% TDF	0.035	0.0815	2.35	5.47	0.191	0.443	NT	NT
20% TDF	0.0195	0.0453	2.3	5.34	0.166	0.387	NT	NT
Facility E (Wood)								
0% TDF	0.036	0.083	0.009	0.021	0.009	0.021	NT	NT
7% TDF	0.133	0.31	0.032	0.074	0.054	0.125	NT	NT
Facility F (Coal)								
2% TDF	0.073	0.17	2.49	5.78	NT	NT	NT	NT

NT = Not tested or data not available.
Note: Above data taken directly from reference; no adjustment was made to significant digits.

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The complete report, entitled "Air Emissions from Scrap Tire Combustion," (Order No. PB98-111701; Cost: $28.00, subject to change) will be available only from:
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16. ABSTRACT

The report discusses air emissions from two types of scrap tire combustion: uncontrolled and controlled. Uncontrolled sources are open tire fires, which produce many unhealthful products of incomplete combustion and release them directly into the atmosphere. Controlled combustion sources (combustors) include boilers and kilns specifically designed for efficient combustion of solid fuel. Very little data exist for devices that are not well-designed and use scrap tires for fuel. These sources include fireplaces, wood stoves, small kilns, small incinerators, or any device with poor combustion characteristics. Air emissions from these types of devices are likely between that of open burning and a combustor. However, there is a serious concern that the emissions are much more similar to those of an open tire fire than a combustor. Open tire fires are discussed. Data from a laboratory test program on uncontrolled burning of tire pieces and ambient monitoring at open tire fires are presented and emissions are characterized. Mutagenic emission data from open burning of scrap tires are compared to mutagenic data for other fuels from both controlled and uncontrolled combustion. A list of 34 target compounds representing the highest potential for health impacts from open tire fires is presented. The list can be used to design an air monitoring plan to evaluate risk potential.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Fireplaces	Pollution Control	13B
Emission	Wood	Stationary Sources	14G 11L
Tires	Stoves	Scrap Tires	13F
Combustion	Incinerators	Wood Stoves	21B
Boilers	Monitors		13A
Kilns			

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APPENDIX: EMISSIONS DATA FROM CONTROLLED TIRE BURNING

Table A-1a. Facility A - Dedicated Tires-to-Energy Power Plant

Source Description

Facility Name, Location:	Modesto Energy Company Westley, CA
Facility Type:	Utility - Dedicated Tires-to-Energy
Source Type:	Two Boilers (designed for 100% TDF).
Test Dates:	December 4-5, 1987, January 9 - 12, 1988, October 9-11, 1990
Other fuel(s):	None
Air pollution control device(s) used:	NO_x: Selective non-catalytic reduction (ammonia injection). PM: Fabric filter with Gore-Tex® bags. SO_x: Wet scrubber with lime injection.
Test Conditions:	100% TDF
Test Methods:	CARB Methods 5, 8, 100, 421, Method 5 (metals), Modified Method 5 (Semi-VOST), Modified Method 6 (NH_3)
Fuel Handling/Feeding:	Whole tires up to 4 feet in diameter, 350 to 400 tires per hour feed rate (assuming 20 lb/tire; approximately 7,000 to 8,000 lbs/hr), total energy feed rate 190 MMBtu.
Testing Company:	Radian (1988), The Almega Corp. (1990)
Environmental Agency:	Stanislaus County APCD (now San Joaquin Valley Unified APCD)

Source Test Data Evaluation

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

Table A-1b. Facility A - Dedicated Tires-to-Energy Power Plant

Pollutant	Limit		1988		October 9-11, 1990[a]		October 9-11, 1990[a]	
	kg/day	lb/day	kg/day	lb/day	kg/day	lb/day	g/MJ	lb/MMBtu
Criteria								
CO	157.4	346.4	112.6	247.8	141.6	311.5	3.1×10^{-5}	7.2×10^{-5}
NO_x	227.2	500.0	174.7	384.3	193.0	424.6	4.2×10^{-5}	9.8×10^{-5}
PM	51.36	113.0	14.2	31.2	42.32	93.12	9.4×10^{-6}	2.2×10^{-5}
SO_x	113.6	250.0	57.7	127	28.1[b]	61.9[b]	6.0×10^{-6}[(b)]	1.4×10^{-5}[(b)]
HC	67.44	148.4	0.294	0.646	NT	NT	NT	NT
Metals								
Lead	N/A	N/A	0.012	0.026	0.003[c]	0.006[c]	5.5×10^{-7}[(c)]	1.3×10^{-6}[(c)]
Cadmium	N/A	N/A	0.00082	0.0018	0.0073	0.016	1.6×10^{-6}	3.7×10^{-6}
Chromium (total)	N/A	N/A	0.00050	0.0011	0.0091	0.020	2.0×10^{-6}	4.7×10^{-6}
Mercury	N/A	N/A	<0.00001	<0.00003	0.001	0.003	2.9×10^{-7}	6.7×10^{-7}
Arsenic	N/A	N/A	0.0012	0.0026	ND	ND	ND	ND
Zinc	N/A	N/A	3.52	7.75	0.283	0.623	6.0×10^{-4}	1.4×10^{-4}
Chromium (hex)	N/A	N/A	NT	NT	ND	ND	ND	ND
Copper	N/A	N/A	0.0068	0.015	0.015[c]	0.032[c]	3.2×10^{-6}	7.5×10^{-6}
Manganese	N/A	N/A	0.011	0.023	0.003	0.007	6.9×10^{-7}[(c)]	1.6×10^{-6}[(c)]

(Continued)

Table A-1b. Facility A - Dedicated Tires-to-Energy Power Plant (Cont.)

Pollutant	Limit		1988		October 9-11, 1990[a]		October 9-11, 1990[a]	
	kg/day	lb/day	kg/day	lb/day	kg/day	lb/day	g/MJ	lb/MMBtu
Nickel	N/A	N/A	NT	NT	0.012[c]	0.027[c]	2.7 x10^{-6}[c]	6.3 x10^{-6}[c]
Tin	N/A	N/A	NT	NT	0.0082	0.018	1.8 x10^{-6}	4.2 x10^{-6}
Aluminum	N/A	N/A	0.13	0.28	0.0459[c]	0.101[c]	9.9 x10^{-6}[c]	2.3 x10^{-5}[c]
Iron	N/A	N/A	0.28	0.62	0.144[c]	0.316[c]	3.1 x10^{-5}[c]	7.3 x10^{-5}[c]
Beryllium	N/A	N/A	NT	NT	ND	ND	ND	ND
<u>Organics</u>								
	N/A	N/A	<10.1	<22.3	NT	NT	NT	NT
Dioxin and Furan	N/A	N/A	1.9 x10^{-7}	4.2 x10^{-7}	NT	NT	NT	NT
PAH	N/A	N/A	0.0054	0.012	NT	NT	NT	NT
PCB	N/A	N/A	2.60 x10^{-4}	5.71 x10^{-4}	NT	NT	NT	NT
Naphthalene	N/A	N/A	NT	NT	0.002[c]	0.005[c]	5.1 x10^{-7}[c]	1.2 x10^{-6}[c]
Acenaphthylene	N/A	N/A	NT	NT	ND	ND	ND	ND
Acenaphthene	N/A	N/A	NT	NT	1.1 x10^{-5}[c]	2.4 x10^{-5}[c]	2.4 x10^{-9}[c]	5.6 x10^{-9}[c]
Fluorene	N/A	N/A	NT	NT	3.3 x10^{-5}[c]	7.2 x10^{-5}[c]	7.3 x10^{-9}[c]	1.7 x10^{-8}[c]
Anthracene	N/A	N/A	NT	NT	2.2 x10^{-5}[c]	4.8 x10^{-5}[c]	4.7 x10^{-9}[c]	1.1 x10^{-8}[c]
Fluoranthene	N/A	N/A	NT	NT	3.3 x10^{-5}[c]	7.2 x10^{-5}[c]	7.3 x10^{-9}[c]	1.7 x10^{-8}[c]

(Continued)

Table A-1b. Facility A - Dedicated Tires-to-Energy Power Plant (Cont.)

Pollutant	Limit		1988		October 9-11, 1990[a]		October 9-11, 1990[a]	
	kg/day	lb/day	kg/day	lb/day	kg/day	lb/day	g/MJ	lb/MMBtu
Pyrene	N/A	N/A	NT	NT	4.4 x10^{-5}[(c)]	9.6 x10^{-5}[(c)]	9.5 x10^{-9}[(c)]	2.2 x10^{-8}[(c)]
Benz(a)anthracene	N/A	N/A	NT	NT	ND	ND	ND	ND
Chrysene	N/A	N/A	NT	NT	ND	ND	ND	ND
Benzo(b)fluoranthene	N/A	N/A	NT	NT	1.1 x10^{-5}[(c)]	2.4 x10^{-5}[(c)]	2.4 x10^{-9}[(c)]	5.6 x10^{-9}[(c)]
Benzo(k)fluoranthene	N/A	N/A	NT	NT	ND	ND	ND	ND
Benzo(a)pyrene	N/A	N/A	NT	NT	ND	ND	ND	ND
Dibenzo(a,h) anthracene	N/A	N/A	NT	NT	ND	ND	ND	ND
Benzo(g,h,i)perylene	N/A	N/A	NT	NT	ND	ND	ND	ND
Indeno (1,2,3-cd)pyrene	N/A	N/A	NT	NT	ND	ND	ND	ND
Phenanthrene	N/A	N/A	NT	NT	1.1 x10^{-4}[(c)]	2.4 x10^{-4}[(c)]	2.4 x10^{-9}[(c)]	5.6 x10^{-9}[(c)]
Phenol	N/A	N/A	NT	NT	ND	ND	ND	ND
Formaldehyde	N/A	N/A	NT	NT	0.334[c]	0.735[c]	7.3 x10^{-5}[(c)]	1.7 x10^{-4}[(c)]
Benzene	N/A	N/A	NT	NT	ND	ND	ND	ND
Monochlorobiphenyl	N/A	N/A	NT	NT	ND	ND	ND	ND

(Continued)

Table A-1b. Facility A - Dedicated Tires-to-Energy Power Plant (Cont.)

Pollutant	Limit		1988		October 9-11, 1990[a]		October 9-11, 1990[a]	
	kg/day	lb/day	kg/day	lb/day	kg/day	lb/day	g/MJ	lb/MMBtu
Dichlorobiphenyl	N/A	N/A	NT	NT	ND	ND	ND	ND
Trichlorobiphenyl	N/A	N/A	NT	NT	ND	ND	ND	ND
Tetrachlorobiphenyl	N/A	N/A	NT	NT	ND	ND	ND	ND
Pentachlorobiphenyl	N/A	N/A	NT	NT	ND	ND	ND	ND
Hexachlorobiphenyl	N/A	N/A	NT	NT	ND	ND	ND	ND
Heptachlorobiphenyl	N/A	N/A	NT	NT	ND	ND	ND	ND
Nonachlorobiphenyl	N/A	N/A	NT	NT	ND	ND	ND	ND
Decachlorobiphenyl	N/A	N/A	NT	NT	ND	ND	ND	ND
Vinyl chloride	N/A	N/A	NT	NT	ND	ND	ND	ND

[a] Assumed 24 hr/day operation.
[b] As sulfur trioxide; sulfur dioxide not reported.
[c] MQL or trip blank showed significant measurement.
N/A = Not applicable.
NT = Not tested or data not available.
ND = Data not determined.

Table A-10a. Facility J - Cement Kiln

Source Description

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

Source Test Data Evaluation

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

Table A-10b. Facility J - Cement Kiln

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

(Continued)

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

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

NA = Not applicable.
ND = Not detected.

Hazards of Burning Tires

From Dr. Neil Carman regarding kiln emissions, stack tests and combustion upsets.6//97

Hazards of tires. It is highly inaccurate to state that TDF..."does not contain hazardous materials,"

A. Tires are mfg from petrochemical feedstocks such as styrene and butadiene, which are both being classified as human carcinogens. Styrene is a benzene derivative and burning tires releases styrene and several benzene compounds.
Butadiene is a highly carcinogencic four-carbon compound that may also be released from the styrene-butadiene (SBR rubber its called) polymer form during combustion.

Chemical composition tests on waste rubber show that it contains numerous toxic and hazardous air pollutants and once burned, these can become airborne. I have lab results somewhere on tests that I helped to perform as a state official, and we were surprised that waste rubber from SSBR was not classified as a hazardous waste. M, P and O-Xylenes may also be found in TDF which are benzene derivatives and carcinogenic.

Tires-older tires-used to be made from chloroprene, a chlorine-containing petrochemical used less and less today in tire mfg.

Polybutadiene is another polymer used to make synthetic rubber for tires.

Aromatic extender oils comprise about 25% of most tires and are known to cause cancer in lab animals as well as being suspected human carcinogens. These are highly aromatic-multiple benzene-containing chemicals-petroleum waste materials with complex ring structures that are even more difficult to burn than benzene, which has a highly stabile ring structure that makes good combustion far more difficult than burning natural gas or straight chain carbon compounds. Anything with benzene will require higher combustion temperatures, higher residence times and higher oxygen to break apart the six-carbon ring with electron clouds above and below that protect the ring from easy chemical breakdown. The thick black oil and black smoke that one sees when tires are burning outdoors is due solely to the aromatic extender oils; they too require higher combustion temperatures, higher residence times and higher oxygen to break down fully to CO_2 and water.

Do cement kilns really provide higher combustion temperatures, higher residence times and higher oxygen? These are complex process questions that can be debated by different technical experts to give very different sets of answers, and because there are generally two different kinds of cement kilns such as 1} old, energy inefficient wet process kilns and 2}newer, more energy efficient dry process cement kilns. Generally cement kilns run at higher combustion temperatures than incinerators, but I think it is highly questionable that anyone can make an absolute blanket statement supported by solid scientific proof that cement kilns provide longer residence times and adequate oxygen (i.e. as excess air) to give complete combustion.

Why? a) Cement kilns when stack tested show products of incomplete combustion (PICs) just like incinerators and other combustors demonstrating that perfect combustion is not achieved. So something is not right with combustion.

b) Turbulence for good combustion may not be as perfect as some experts claim in cement kilns due to the extraordinarily large volumes of solid materials in the kiln being used to make clinker and then cement product, in part since a cement kiln is a giant oven used to bake rock and turn it into clinker. c) cement kilns typically run on the lower limits of excess air for good combustion due to the huge quantities of air required to be heated from ambient temps to 3,000 degrees F, and to heat this much air to such high temps requires tremendous energy costs. So every single pound of air heated in a cement kiln exacts certain operating costs in fuel use and thus cement kilns try to keep the excess air (and oxygen) at the borderline of safe combustion.

But during stack tests of TDF, cement kilns will do several things to make emissions and combustion look good-to-decent for such facilities: a) run at higher excess air to improve combustion efficiency, b) control kiln parameters more precisely, c) prevent kiln solid ring formation and buildup that creates havoc for good combustion of any fuels, d) burn lower TDF levels during stack tests than they may be seeking to burn operationally, e)operate and maintain their ESPs or baghouses in top condition to keep particulate emissions to a reduced level, and f) miscellaneous tricks.

B. Older tires may contain much higher amounts of lead when leaded gasoline was being used, according to Dr. Jerome Nriagu of the University of Michigan's School of Public Health. Burning these older tires means that some of the lead will go back into the environment as airborne contamination.

C.Metals. TDF does contain metals and the amounts vay somewhat. They may be cleaner than real dirty coal or they may be worse than some cleaner types of coal. One also has to be skeptical about self-reported metal levels in coal, such as mercury, because coal users want to show less mercury emissions than is the case.

D.Combustions upsets. This is a serious public health issue near cement kilns.
Cement kilns certainly do have combustion upsets and smoke may be emitted during such events. Cement kilns are not designed or required to have major fail-safe combustion devices such as large afterburners that all state-of-the-art incinerators must have by federal law today (all medical, municipal, and hazardous waste incinerators can not operate without their afterburner or secondary combustion chambers in normal operation). The afterburner is required because of the potential for flame outs and total combustion failure in the primary burn chamber, which is all that cement kilns possess. Cement kilns have no fail safe combustion devices which is unthinkable today in all incinerators.

E. Other kinds of upsets. Cement kilns are subject to a variety of problems, including a type of meltdown of the kiln when the ID fans lose power or fail to operate, without adequate air flow to control kiln temperatures at or below 3,000 degrees F, the kiln temperature may skyrocket quickly to 4,000 degrees F and the kiln is so hot that the steel shell sags toward the ground effectively destroying the kiln. Kiln meltdowns are not rare events and have happened here in Texas at several plants in the last ten years. Cement companies do not like to talk about this problem.

These are just a few of the technical issues surrounding combustion problems observed in cement kilns. The bottom line is that they are not designed, not built and not operated as state-of-the-art incineration devices, but are basically old model-T versions (especially old wet process kilns) of first generation incinerators of the 1950's-mid 60's which had no afterburners.

Local Issues **Alberni Environmental Coalition**

Cement kilns must be continuously monitored and adjusted in order to achieve the "complete" combustion of the basic components of tires that is possible in theory. (The cement plant in Buda does not have the necessary continuous monitors.) "Complete combustion" does not eliminate toxic metals – or other elements like chlorine which are free to leave the stack or combine with other elements to make new toxic substances like dioxins and furans.

Background Paper On the Burning of Rubber Tires

by Dr. Jacob Greenberg, PhD

There are two primary problems in burning tires. These are (A), the need for greater amounts of oxygen as combustion proceeds and (B), the use of chemical reactants to neutralize the release of sulfur dioxide.

A. Variable Oxygen Requirements

The presence of varied hydrocarbons demands that the oxygen requirements for complete combustion must change drastically.

If a rubber tire were thrown onto an open bonfire, there would be four distinct phases of combustion:

1. *White smoke.* This is the low temperature evaporation of water. The same reaction occurs whether burning a log in a fireplace or sewage sludge.
2. *Flickering Flame.* This is the oxidation of volatile hydrocarbons which are released when the material loses water and its temperature rises.
3. *Black Smoke.* This is caused by the thermal disintegration of long chain hydrocarbons that are not receiving sufficient air oxygen to burn completely to carbon dioxide and water.
   To illustrate how radical this can be, let us compare the burning of two common fuels, propane and gasoline.

Propane C_3H_8 44 grams (one mole)	+	$5 O_2$ 160 grams (approx. 20,000 cubic feet of air)	→	$3 CO_2 + 4 H_2O$
gasoline component m Octane $2C_8H_{18}$ 228 grams	+	$25 O_2$ 800 grams (approx. 100,000 cubic feet of air)	→	$16 CO_2 + 18 H_2O$

Moving from a hydrocarbon with 3 carbon atoms (Propane) to one containing 8 carbon atoms changes the oxygen requirement by a factor of FIVE.

This translates to a demand from 20.000 cubic feet of air to over 100,000 cubic feet of air.

Rubber consists of chains of isoprene $(C_5H_8)_m$ where m = 40,000 to 50,000. When these chains thermally disintegrate the need for oxygen to complete combustion will vary dramatically.

(Over)

Prepared by Wimberley S.A.F. E., under the direction of their resident chemist, Dr. Greenberg
P. O. Box 576, Wimberley, TX 78676
March 11, 1996

Cement kilns must be continuously monitored and adjusted in order to achieve the "complete" combustion of the basic components of tires that is possible in theory. (The cement plant in Buda does not have the necessary continuous monitors.) "Complete combustion" does not eliminate toxic metals – or other elements like chlorine which are free to leave the stack or combine with other elements to make new toxic substances like dioxins and furans.

This problem is compounded by the fact that rubber tires contain approximately 30% of crude oil. Heat treatment will release a range of hydrocarbons from propane to gasoline to asphalt. In addition, crude oil has significant concentrations of toxic metals, particularly chromium.

4. *Final Burning Phase of Tires*
This is the high temperature glowing carbon. Just as in a barbecue, the highest temperature is not obtained from the flame but from the residual carbon.

The reason for burning coal with tires is that coal contains metal oxides (ash) that can react with sulfur dioxide.

B. Chemical Reactants to Neutralize the Release of Sulfur Dioxide

Sulfur is the most often used hardening agent in the manufacture of rubber tires. In the presence of oxygen at elevated temperatures, sulfur is converted to SO2 (sulfur dioxide). This material is the major component of aid rain. The destruction of forests, lakes and the degradation of marble structures have led to restrictions on the sulfur content of fuels.

Sulfur dioxide reacts with metal oxides such as lime (calcium oxide) which is the active ingredient in cement. The reaction between the gas, sulfur dioxide, and a solid particle of calcium oxide is totally dependent upon operating conditions.

These conditions must ensure that these components can collide. This means that variations in residence time, size of particles, temperature, and concentration must be carefully monitored.

From the reaction given, it can be seen that without intimate mixing with *excess* lime it will be difficult to trap the gaseous sulfur dioxide.

$2CaO$	+	$2SO_2$	+	O_2	$\rightarrow$	$2CaSO_4$
Lime		sulfur dioxide		air oxygen		calcium sulfate
(solid)		(gas)		(gas)		ash must be disposed

Prepared by Wimberley S.A.F. E., under the direction of their resident chemist, Dr. Greenberg
P. O. Box 576, Wimberley, TX 78676
March 11, 1996

EPA/600/P-03/002F
November 2006

An Inventory of Sources and Environmental Releases of Dioxin-Like Compounds in the United States for the Years 1987, 1995, and 2000

National Center for Environmental Assessment Office of Research and Development U.S. Environmental Protection Agency Washington, DC 20460

3.6. TIRE COMBUSTION

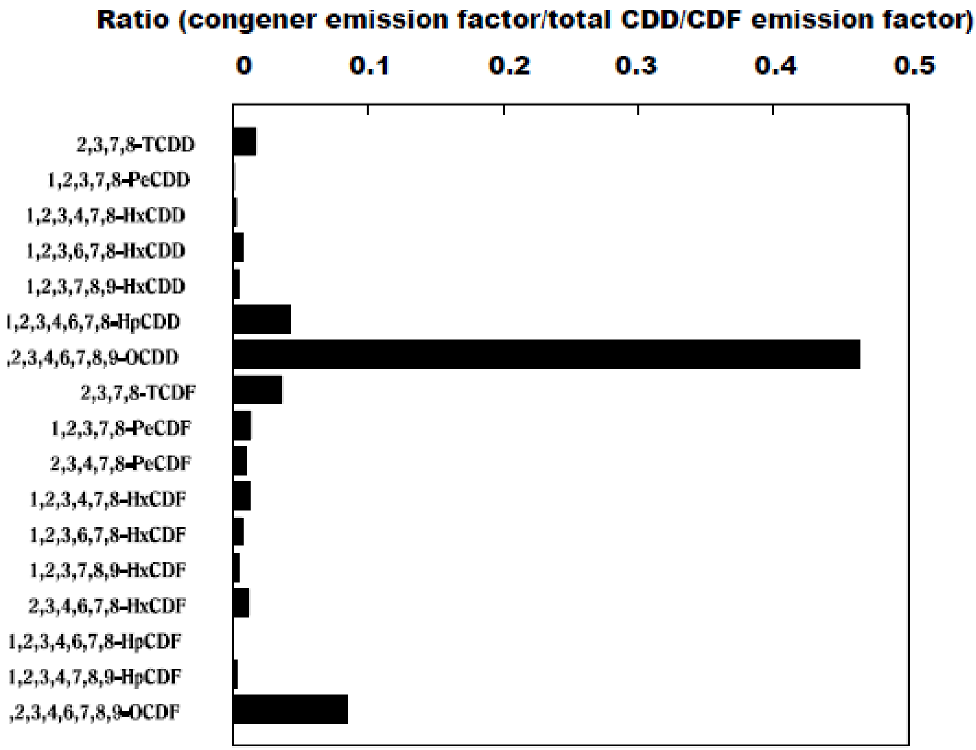
Most discarded tires are combusted in dedicated tire incinerators or cement kilns. Some are combusted as auxiliary fuel in industrial boilers and in pulp and paper mill combustion facilities. Additionally, tires may be unintentionally burned in an uncontrolled fashion at landfills (open burning). This section addresses the total TEQ emissions that may result from the combustion of tires in dedicated tire incinerators, industrial boilers, and pulp and paper mill combustion facilities, but excludes cement kilns (addressed in Section 5.1). The open burning of tires is not discussed in this report due to the lack of information.

Emissions of CDDs/CDFs from the incineration of discarded automobile tires were measured at a dedicated tire incinerator tested by the California Air Resources Board (CARB, 1991). The facility consists of two excess air furnaces equipped with steam boilers to recover the energy from the heat of combustion. Whole tires were fed to the incineration units at rates ranging from 2,800 to 5,700 kg/hr during the three test days. The facility was equipped with a DS and an FF for the control of emissions prior to exiting the stack. Table 3-27 presents the congener-specific emission factors for this facility. Figure 3-20 presents CDD/CDF congener

Table 3-27. CDD/CDF air emission factors for a tire combustion facility

Congener/congener group	**Mean facility emission factor (ng/kg)**	
	Assuming nondetect set to zero	**Assuming nondetect set to ½ detection limit**
2,3,7,8-TCDD 1,2,3,7,8-PeCDD 1,2,3,4,7,8-HxCDD 1,2,3,6,7,8-HxCDD 1,2,3,7,8,9-HxCDD 1,2,3,4,6,7,8-HpCDD OCDD	0.149 0.006 0.018 0.055 0.036 0.379 4.156	0.149 0.026 0.023 0.062 0.048 0.379 4.156
2,3,7,8-TCDF 1,2,3,7,8-PeCDF 2,3,4,7,8-PeCDF 1,2,3,4,7,8-HxCDF 1,2,3,6,7,8-HxCDF 1,2,3,7,8,9-HxCDF 2,3,4,6,7,8-HxCDF 1,2,3,4,6,7,8-HpCDF 1,2,3,4,7,8,9-HpCDF OCDF	0.319 0.114 0.086 0.103 0.059 0.036 0.1 0.0 0.027 0.756	0.319 0.118 0.091 0.111 0.09 0.068 0.148 0.166 0.095 0.756
Total 2,3,7,8-CDD Total 2,3,7,8-CDF Total I-TEQ_{DF} Total TEQ_{DF}-WHO_{98}	4.799 1.6 0.282 0.281	4.843 1.962 0.312 0.320
Total TCDD Total PeCDD Total HxCDD Total HpCDD Total OCDD Total TCDF Total PeCDF Total HxCDF Total HpCDF Total OCDF	0.153 0.032 0.391 0.695 4.156 1.204 0.737 0.71 0.119 0.802	0.153 0.032 0.391 0.695 4.156 1.204 0.737 0.71 0.186 0.802
Total CDD/CDF	8.999	9.067

Source: CARB (1991).



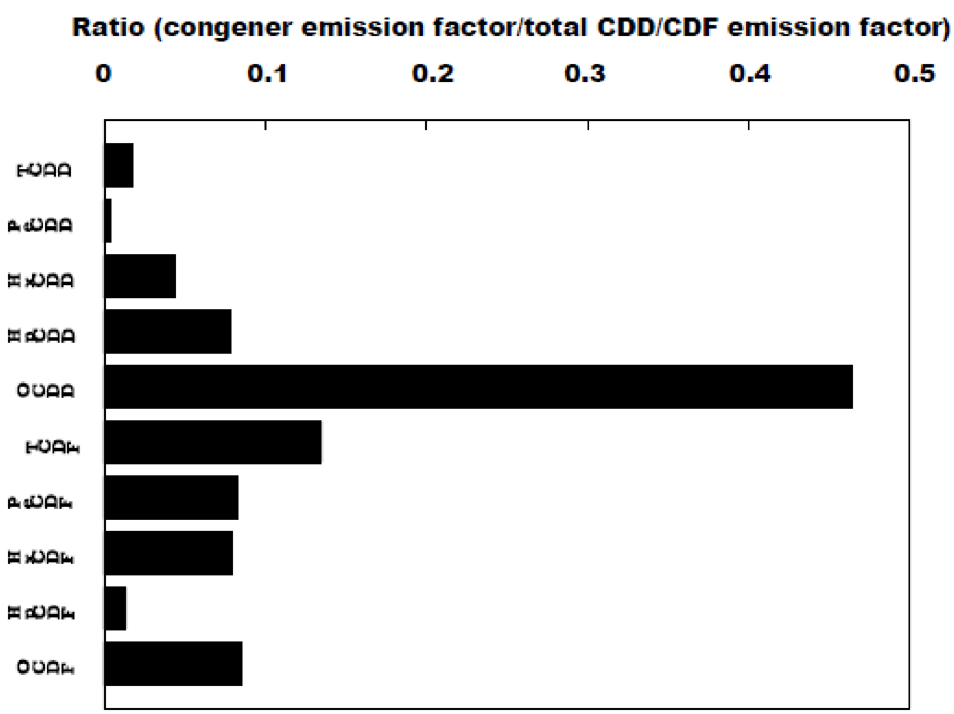


Figure 3-20. Congener and congener group profiles for air emissions from a tire combustor.

and congener group profiles based on these TEQ emission factors. From these data, the average emission factor is estimated to be 0.281 ng TEQDF-WHO98/kg (0.282 ng I-TEQDF/kg) of tires incinerated (when all nondetect values are treated as zero). This emission factor was used to estimate annual TEQ releases from the tire combustion source category for the years 1987, 1995, and 2000.

EPA assigned a low confidence rating to the estimated TEQ emission factor because it is possible that it is not representative of TEQ emissions from all tire combustion facilities. It is also possible that this emission factor is an underestimation of emissions from this source category because it was derived from the emissions of a facility equipped with very advanced air pollution control technology specific for the control of dioxin emissions. These devices (DS/FF) are capable of greater than 95% reduction and control of dioxin-like compounds prior to discharge from the stack into the air. Because other facilities may not be equipped with similar air pollution control systems, the TEQ emissions could be higher than the estimates shown above. For example, Cains and Dyke (1994) reported much higher emission rates for two tire incinerators in the United Kingdom that were equipped with only simple grit arrestors. These emissions produced emission factors of 188 and 228 ng I-TEQDF/kg of tires combusted.

EPA estimated that approximately 500 million kg of tires were combusted in 1990 (U.S. EPA, 1992b). Of this total, 23% (115 million kg) were combusted in cement kilns, and it is assumed that the remaining 385 million kg were combusted in dedicated tire combustion facilities, industrial boilers, and pulp and paper mill combustion facilities. This activity level was adopted for the years 1987 and 1995 and is assigned a medium confidence rating.

The Rubber Manufacturers Association (2002) reported that 281 million scrap tires weighing approximately 5.68 million metric tons were generated in the United States in 2001. Approximately 115 million of these scrap tires were combusted as tire-derived fuel, or roughly

2.32 million metric tons (2.32 billion kg) of tires. Subtracting the 23% of the tires burned in cement kilns yields a total of 1.8 billion kg of tires estimated to have been combusted in facilities other than cement kilns in 2001. This figure is used to represent the activity level for tire combustion in 2000. This activity level is assigned a medium confidence rating.

Annual emissions for the reference years were estimated by multiplying the activity level times the TEQ emission factor. The TEQ emission factor of 0.281 ng TEQDF-WHO98/kg (0.282 ng I-TEQDF /kg) of tires combusted was used to estimate annual emissions for all years. Multiplying the emission factor by the activity level (385 million kg of tires) yields an estimate of 0.11 g TEQDF-WHO98/yr (0.11 g I-TEQDF/yr) emitted to the air in 1987 and 1995. Using the same emission factor multiplied by the estimated activity level of 1.8 billion kg tires combusted in 2000 gives an estimate of 0.51 g TEQDF-WHO98/yr (0.51 g I-TEQDF/yr). The estimated TEQ emissions to air from tire combustion for 1987, 1995, and 2000 are given a low confidence rating because of the low confidence rating of the emission factor.

(Pages 3-83 through 3-87. Document available at
http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=159286#Download)

 Tire Incineration FP 40

SPECIAL ARTICLE

Fine-Particulate Air Pollution and Life Expectancy in the United States

C. Arden Pope III, Ph.D., Majid Ezzati, Ph.D., and Douglas W. Dockery, Sc.D.

ABSTRACT

BACKGROUND

Exposure to fine-particulate air pollution has been associated with increased morbidity and mortality, suggesting that sustained reductions in pollution exposure should result in improved life expectancy. This study directly evaluated the changes in life expectancy associated with differential changes in fine particulate air pollution that occurred in the United States during the 1980s and 1990s.

METHODS

We compiled data on life expectancy, socioeconomic status, and demographic characteristics for 211 county units in the 51 U.S. metropolitan areas with matching data on fine-particulate air pollution for the late 1970s and early 1980s and the late 1990s and early 2000s. Regression models were used to estimate the association between reductions in pollution and changes in life expectancy, with adjustment for changes in socioeconomic and demographic variables and in proxy indicators for the prevalence of cigarette smoking.

RESULTS

A decrease of 10 μg per cubic meter in the concentration of fine particulate matter was associated with an estimated increase in mean (±SE) life expectancy of 0.61±0.20 year ($P=0.004$). The estimated effect of reduced exposure to pollution on life expectancy was not highly sensitive to adjustment for changes in socioeconomic, demographic, or proxy variables for the prevalence of smoking or to the restriction of observations to relatively large counties. Reductions in air pollution accounted for as much as 15% of the overall increase in life expectancy in the study areas.

CONCLUSIONS

A reduction in exposure to ambient fine-particulate air pollution contributed to significant and measurable improvements in life expectancy in the United States.

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Since the 1970s, the United States has made substantial efforts and investments to improve air quality. As these efforts continue, a fundamental question remains: Do improvements in air quality result in measurable improvements in human health and longevity? Associations between long-term exposure to fine-particulate air pollution and mortality have been observed in population-based studies[1-3] and, more recently, in cohort-based studies.[4-11] Daily time-series and related studies,[12-15] natural intervention studies,[16-18] and cohort studies[10,19] all support the view that relatively prompt and sustained health benefits are derived from improved air quality.

We directly assessed associations between life expectancy and fine-particulate air pollution in 51 U.S. metropolitan areas, comparing data for the period from the late 1970s to the early 1980s with matched data for the period from the late 1990s to the early 2000s. We hypothesized that temporal changes in fine-particulate air pollution between 1980 and 2000 would be associated with changes in life expectancy. Specifically, we hypothesized that metropolitan areas with the largest declines in fine-particulate pollution would have the largest increases in life expectancy, even after adjustment for changes in various socioeconomic and demographic characteristics and proxy variables for status with regard to smoking.

METHODS

DATA COLLECTION AND STUDY AREAS

For the years 1979 through 1983, the U.S. Environmental Protection Agency (EPA) maintained the Inhalable Particle Monitoring Network for research purposes. The network sampled particulate matter in the air using dichotomous samplers with 15-μm and 2.5-μm cutoff points. On the basis of these data, from 1979 through 1983, mean concentrations of particulate matter with an aerodynamic diameter less than or equal to 2.5 μm ($PM_{2.5}$) were calculated for 61 U.S. metropolitan areas and used in the reanalysis and extended analyses of the American Cancer Society prospective cohort study.[6,7] (Metropolitan-area–specific means are presented in Appendix D of the American Cancer Society reanalysis report.[6]) After 1983, no broad-based monitoring network systematically and routinely collected $PM_{2.5}$ data until the promulgation of the National Ambient Air Quality Standard for $PM_{2.5}$ in 1997.[20] As required by the new $PM_{2.5}$ standard, many sites began measuring $PM_{2.5}$ in 1999. Daily $PM_{2.5}$ data were extracted from the EPA's Aerometric Information Retrieval System database for 1999 and the first three quarters of 2000. Data for the four quarters were averaged when more than 50% of the samples and 45 or more total sampling days were available for at least one of the two corresponding quarters in each year. Measurements were averaged first by monitoring site and then by metropolitan area. These calculated mean concentrations of $PM_{2.5}$ were available for 116 U.S. metropolitan areas and were used as part of the extended analysis of the American Cancer Society study.[7] There were 51 metropolitan areas with matching $PM_{2.5}$ data for the early 1980s and the late 1990s.

As part of a nationwide analysis of disparities in mortality across the counties, standard life-table techniques[21] were used to estimate annual life expectancies for more than 2000 individual or merged county units, on the basis of individual death records from national mortality statistics and population data from the U.S. Census, as described in more detail elsewhere.[22] For the purposes of this study, life expectancy for the 215 county units that were part of the 51 metropolitan areas with matching $PM_{2.5}$ data were included. The metropolitan areas were distributed throughout the United States (Fig. 1). For each county unit, life expectancy was calculated with the use of pooled death and population data for the 5-year periods 1978 through 1982 and 1997 through 2001. Because borough-specific death statistics were unavailable for the five boroughs of New York for the earlier period, the boroughs were treated as a single unit, resulting in 211 distinct county-level observations. As described elsewhere,[22] U.S. Census data were used to collect information on county-level socioeconomic and demographic variables, including population, income, and proportions of persons in the population who were high-school graduates, had urban residences, had not lived in their current county of residence 5 years before the census (5-year immigration), and reported that they were white, black, or Hispanic. Income was adjusted for inflation (base year, 2000).

In accordance with previous analyses,[23,24] age-standardized death rates for lung cancer and chronic obstructive pulmonary disease (COPD) were used as indicators of accumulated exposure

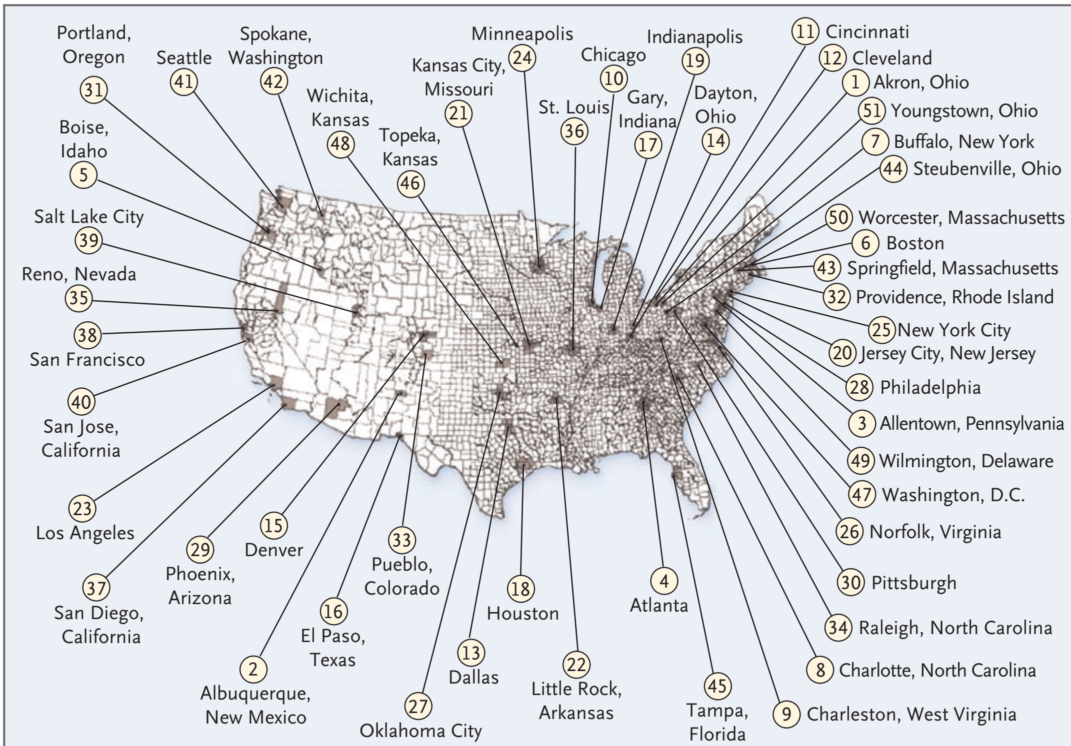

Figure 1. Distribution of Study Areas.

The locations of the counties included in the study are shown in gray, and the dots represent the approximate locations of the 51 metropolitan areas in the study. The metropolitan areas are coded by number as follows: 1 — Akron, Ohio; 2 — Albuquerque, New Mexico; 3 — Allentown, Pennsylvania; 4 — Atlanta; 5 — Boise, Idaho; 6 — Boston; 7 — Buffalo, New York; 8 — Charlotte, North Carolina; 9 — Charleston, West Virginia; 10 — Chicago; 11 — Cincinnati; 12 — Cleveland; 13 — Dallas; 14 — Dayton, Ohio; 15 — Denver; 16 — El Paso, Texas; 17 — Gary, Indiana; 18 — Houston; 19 — Indianapolis; 20 — Jersey City, New Jersey; 21 — Kansas City, Missouri; 22 — Little Rock, Arkansas; 23 — Los Angeles; 24 — Minneapolis; 25 — New York City; 26 — Norfolk, Virginia; 27 — Oklahoma City; 28 — Philadelphia; 29 — Phoenix, Arizona; 30 — Pittsburgh; 31 — Portland, Oregon; 32 — Providence, Rhode Island; 33 — Pueblo, Colorado; 34 — Raleigh, North Carolina; 35 — Reno, Nevada; 36 — St. Louis; 37 — San Diego, California; 38 — San Francisco; 39 — Salt Lake City; 40 — San Jose, California; 41 — Seattle; 42 — Spokane, Washington; 43 — Springfield, Massachusetts; 44 — Steubenville, Ohio; 45 — Tampa, Florida; 46 — Topeka, Kansas; 47 — Washington, D.C.; 48 — Wichita, Kansas; 49 — Wilmington, Delaware; 50 — Worcester, Massachusetts; 51 — Youngstown, Ohio.

to smoking. There were two reasons for using these indirect indicators of smoking. First, for most study areas, data on the prevalence of smoking are not available for the late 1970s and early 1980s, and second, the measures for lung cancer and COPD indicate the population's cumulative exposure to smoking. The *International Classification of Diseases, 10th Revision* (ICD-10) was used to calculate death rates for lung cancer (ICD-10 codes C33-C34 and D02.1-D02.2) and COPD (ICD-10 code J40-J44). The death rates were based on the underlying cause of death in individual death records from national mortality statistics and population data from the U.S. Census, pooled for the same 5-year periods as life expectancy. Death rates were calculated in 5-year age groups, and were age-standardized for the 2000 U.S. population of adults 45 years of age or older (rates of death from these diseases are unstable among younger adults because there is such a small number of cases). Additional estimates of changes in the prevalence of cigarette smoking were obtained from health surveys for use in sensitivity analyses of a subgroup of the metropolitan areas with data in both periods. The prevalence of smoking among adults in metropolitan areas for the years 1998 through 2002 could be estimated for 50 of the 51 metropolitan study areas from the Behavioral Risk Factor Surveillance System (www.cdc.gov/brfss/technical_infodata/surveydata.htm);

the prevalence for the years 1978 through 1980 could be estimated for 24 of the metropolitan study areas with data from the National Health Interview Survey (www.cdc.gov/nchs/nhis.htm). The change in the prevalence of smoking was estimated for each of 24 metropolitan areas on the basis of data from these sources for both periods.

STATISTICAL ANALYSIS

For both 5-year periods, life expectancies were plotted against $PM_{2.5}$ concentrations, and increases in life expectancy from the first period to the second were plotted against reductions in the $PM_{2.5}$ concentration. Cross-sectional regression models were estimated for both time periods, and first-difference regression models were estimated by regressing increases in life expectancy against reductions in monitored $PM_{2.5}$ concentrations. The sensitivity of the estimates on the pollution-related effect was explored with the use of five different approaches: including combinations of demographic, socioeconomic, and proxy variables for prevalence of smoking in the models, restricting the analysis to counties that had a population of 100,000 or more in 1986 or to the 51 largest counties in each metropolitan area, estimating population-weighted regression models, stratifying the analysis according to the pollution levels for 1979 through 1983 (in order to evaluate the influence of baseline pollution levels), and including direct measures of change in the prevalence of smoking for the subgroup of study areas with adequate survey data on smoking. Because of the potential for lack of statistical independence between counties in the same metropolitan area, clustered standard errors that were robust with regard to within-cluster correlation[25,26] (clustered by the 51 metropolitan areas) were estimated for all models except for the analysis that included only the 51 largest counties in each metropolitan area. Models were estimated with the use of PROC REG and PROC SURVEYREG in SAS, version 9.2 (SAS Institute).

RESULTS

Summary statistics for key study variables are listed in Table 1. In Figures 2 and 3, cross-sectional life expectancies are plotted against air-pollution data for the earlier and later time periods, respectively. At least five observations can be made on the basis of the data presented in these two

Table 1. Summary Characteristics of the 217 Counties Analyzed.*

Variable	Mean Value
Life expectancy (yr)	
1978–1982	74.32±1.52
1997–2001	77.04±1.82
Change	2.72±0.93
$PM_{2.5}$ ($\mu g/m^3$)	
1979–1983	20.61±4.36
1999–2000	14.10±2.86
Reduction	6.52±2.94
Per capita income (in thousands of $)	
1979	15.18±2.64
1999	23.67±5.05
Change	8.49±3.16
Population (in hundreds of thousands)	
1980	3.83±8.47
2000	4.82±10.13
Change	0.99±2.26
5-Year in-migration (proportion of population)†‡	
1980	0.25±0.10
2000	0.24±0.08
Change	−0.01±0.06
Urban residence (proportion of population)†	
1980	0.58±0.33
2000	0.78±0.22
Change	0.20±0.18
High-school graduates (proportion of population)†	
1980	0.68±0.11
2000	0.87±0.05
Change	0.19±0.15
Black population (proportion of population)†§	
1980	0.097±0.12
2000	0.115±0.13
Change	0.018±0.06
Hispanic population (proportion of population)†§	
1980	0.035±0.072
2000	0.068±0.093
Change	0.033±0.043
Deaths from lung cancer (no./10,000 population)	
1979–1983	14.38±2.95
1997–2001	16.73±3.27
Change	2.35±2.77
Deaths from COPD (no./10,000 population)	
1979–1983	7.92±1.85
1997–2001	12.37±2.71
Change	4.45±2.43

* Plus–minus values are means ±SD. COPD denotes chronic obstructive pulmonary disease, and $PM_{2.5}$ particulate matter with an aerodynamic diameter less than or equal to 2.5 μm.
† Proportions of the population are based on U.S. Census data.
‡ Five-year in-migration refers to the proportion of the population who did not reside in the county 5 years earlier.
§ Data on race and ethnic group were self-reported.

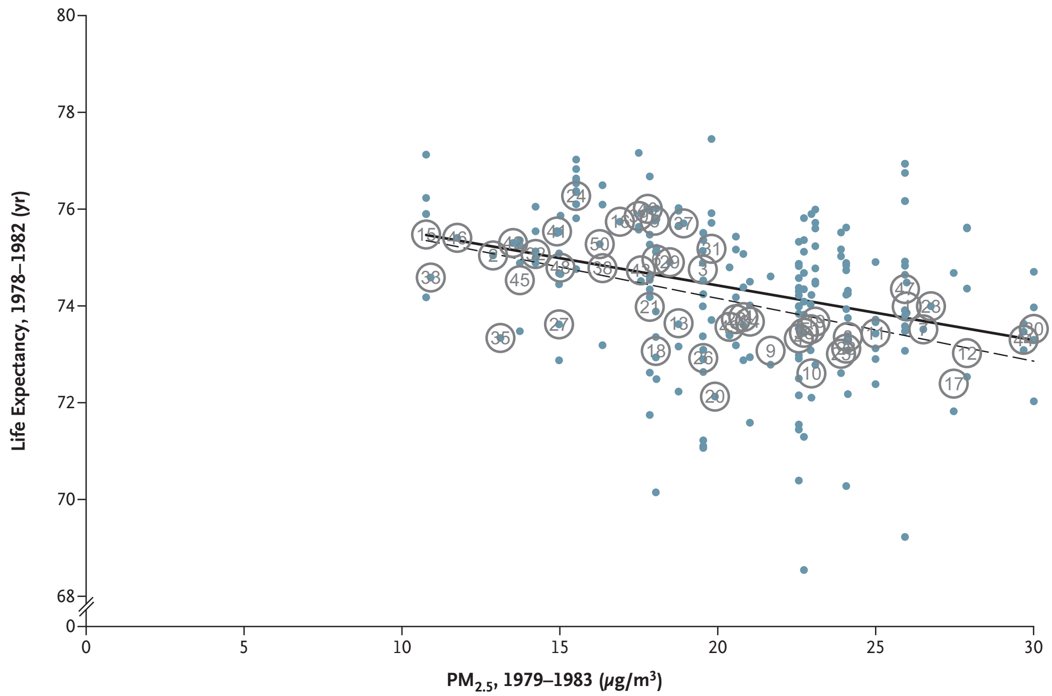

Figure 2. Cross-Sectional Life Expectancies for 1978–1982, Plotted against $PM_{2.5}$ Concentrations for 1979–1983.

Dots and circles labeled with numbers represent population-weighted mean life expectancies at the county level and the metropolitan-area level, respectively. The solid and broken lines represent regression lines with the use of county-level and metropolitan-area–level observations, respectively. The metropolitan areas are coded by number as follows: 1 — Akron, Ohio; 2 — Albuquerque, New Mexico; 3 — Allentown, Pennsylvania; 4 — Atlanta; 5 — Boise, Idaho; 6 — Boston; 7 — Buffalo, New York; 8 — Charlotte, North Carolina; 9 — Charleston, West Virginia; 10 — Chicago; 11 — Cincinnati; 12 — Cleveland; 13 — Dallas; 14 — Dayton, Ohio; 15 — Denver; 16 — El Paso, Texas; 17 — Gary, Indiana; 18 — Houston; 19 — Indianapolis; 20 — Jersey City, New Jersey; 21 — Kansas City, Missouri; 22 — Little Rock, Arkansas; 23 — Los Angeles; 24 — Minneapolis; 25 — New York City; 26 — Norfolk, Virginia; 27 — Oklahoma City; 28 — Philadelphia; 29 — Phoenix, Arizona; 30 — Pittsburgh; 31 — Portland, Oregon; 32 — Providence, Rhode Island; 33 — Pueblo, Colorado; 34 — Raleigh, North Carolina; 35 — Reno, Nevada; 36 — St. Louis; 37 — San Diego, California; 38 — San Francisco; 39 — Salt Lake City; 40 — San Jose, California; 41 — Seattle; 42 — Spokane, Washington; 43 — Springfield, Massachusetts; 44 — Steubenville, Ohio; 45 — Tampa, Florida; 46 — Topeka, Kansas; 47 — Washington, D.C.; 48 — Wichita, Kansas; 49 — Wilmington, Delaware; 50 — Worcester, Massachusetts; 51 — Youngstown, Ohio. $PM_{2.5}$ denotes particulate matter with an aerodynamic diameter less than or equal to 2.5 μm.

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figures: $PM_{2.5}$ concentrations generally declined during the 1980s and 1990s; life expectancies increased between the two periods; in both periods there were cross-sectional negative associations between life expectancies and pollution levels; similar negative associations were observed when analyses were performed with the use of county-level or metropolitan-area–level observations; and there was substantial variation, or scatter, around the regression line, indicating that the association with air pollution explains only part of the cross-sectional variation — clearly, other important factors influence life expectancy.

Estimates of the associations between $PM_{2.5}$ and life expectancies with the use of cross-sectional regression models were sensitive to the inclusion of socioeconomic and demographic variables and proxy variables for the prevalence of cigarette smoking and especially the proportion of high-school graduates, which was highly correlated with per capita income. For example, the association between $PM_{2.5}$ concentrations and life expectancy was stronger in the period with less pollution, without adjustment for any covariates. On the basis of regression models without any covariates, an increase in the $PM_{2.5}$ concen-

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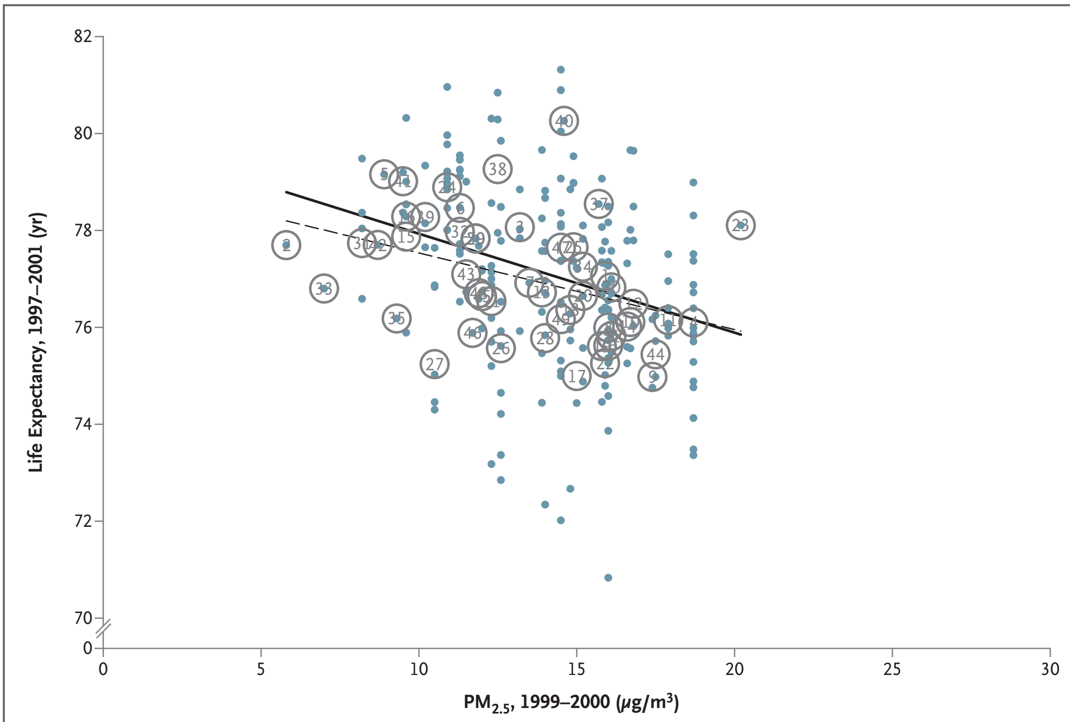

Figure 3. Cross-Sectional Life Expectancies for 1997–2001, Plotted against $PM_{2.5}$ Concentrations for 1999–2000.
Dots and circles labeled with numbers represent population-weighted mean life expectancies at the county level and the metropolitan-area level, respectively. The solid and broken lines represent regression lines with the use of county-level and metropolitan-area–level observations, respectively. The metropolitan areas are coded by number as follows: 1 — Akron, Ohio; 2 — Albuquerque, New Mexico; 3 — Allentown, Pennsylvania; 4 — Atlanta; 5 — Boise, Idaho; 6 — Boston; 7 — Buffalo, New York; 8 — Charlotte, North Carolina; 9 — Charleston, West Virginia; 10 — Chicago; 11 — Cincinnati; 12 — Cleveland; 13 — Dallas; 14 — Dayton, Ohio; 15 — Denver; 16 — El Paso, Texas; 17 — Gary, Indiana; 18 — Houston; 19 — Indianapolis; 20 — Jersey City, New Jersey; 21 — Kansas City, Missouri; 22 — Little Rock, Arkansas; 23 — Los Angeles; 24 — Minneapolis; 25 — New York City; 26 — Norfolk, Virginia; 27 — Oklahoma City; 28 — Philadelphia; 29 — Phoenix, Arizona; 30 — Pittsburgh; 31 — Portland, Oregon; 32 — Providence, Rhode Island; 33 — Pueblo, Colorado; 34 — Raleigh, North Carolina; 35 — Reno, Nevada; 36 — St. Louis; 37 — San Diego, California; 38 — San Francisco; 39 — Salt Lake City; 40 — San Jose, California; 41 — Seattle; 42 — Spokane, Washington; 43 — Springfield, Massachusetts; 44 — Steubenville, Ohio; 45 — Tampa, Florida; 46 — Topeka, Kansas; 47 — Washington, D.C.; 48 — Wichita, Kansas; 49 — Wilmington, Delaware; 50 — Worcester, Massachusetts; 51 — Youngstown, Ohio. $PM_{2.5}$ denotes particulate matter with an aerodynamic diameter less than or equal to 2.5 μm.

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tration of 10 μg per cubic meter was associated with mean (±SE) reductions in life expectancy of 1.19±0.27 years from 1978 to 1982 and 2.02±0.50 years from 1997 to 2001 (P<0.001 for both comparisons). However, models that controlled for income, population, cross-county migration, and the proportion of the population that was black or Hispanic or had an urban residence and that also included proxy variables for the prevalence of smoking showed smaller associations, especially in the second period. An increase of 10 μg per cubic meter in the $PM_{2.5}$ concentration was associated with a reduction in life expectancy of 0.46±0.22 year (P=0.039) from 1978 to 1982 and 0.37±0.20 year (P=0.091) from 1997 to 2001.

In Figure 4, increases in life expectancies are plotted against reductions in $PM_{2.5}$ concentrations from approximately 1980 to 2000. Several additional important observations can be made on the basis of these data: on average, life expectancy increased more in areas with larger reductions in air pollution; similar positive associations were observed between gains in life expectancy and reductions in $PM_{2.5}$ concentrations at the county level and the metropolitan-area level; and there was substantial variation, or scatter, around the

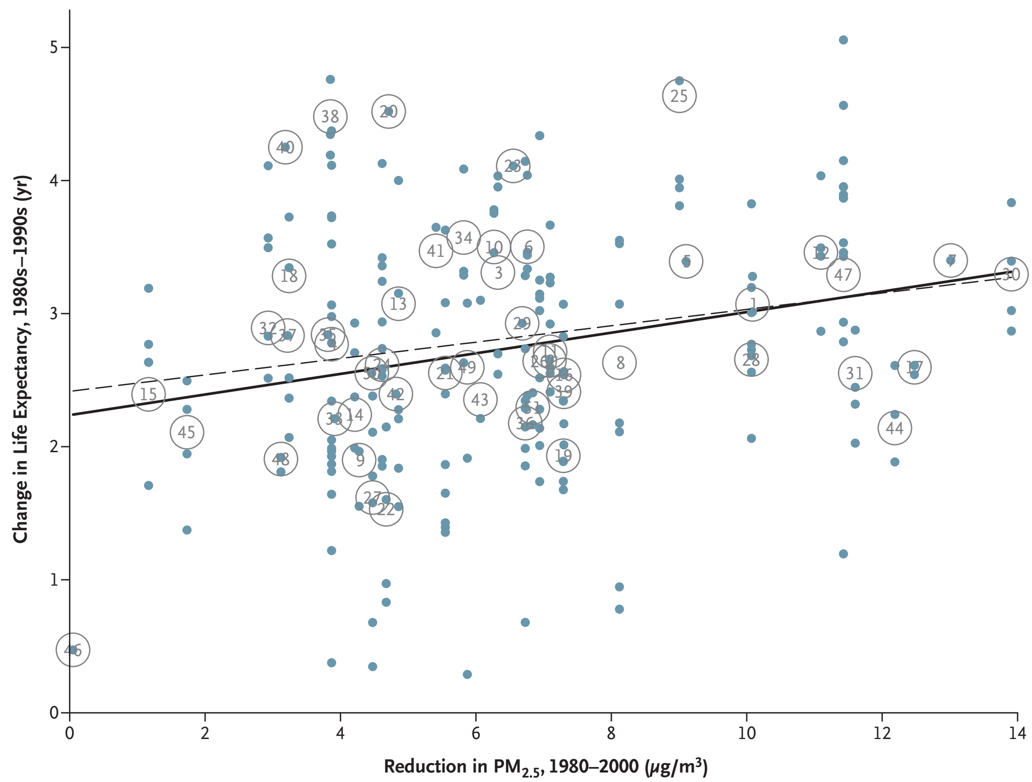

Figure 4. Changes in Life Expectancy for the 1980s–1990s, Plotted against Reductions in $PM_{2.5}$ Concentrations for 1980–2000.

Dots and circles labeled with numbers represent changes in population-weighted mean life expectancies at the county level and metropolitan-area level, respectively. The solid and broken lines represent regression lines with the use of county-level and metropolitan-area–level observations, respectively. The metropolitan areas are coded by number as follows: 1 — Akron, Ohio; 2 — Albuquerque, New Mexico; 3 — Allentown, Pennsylvania; 4 — Atlanta; 5 — Boise, Idaho; 6 — Boston; 7 — Buffalo, New York; 8 — Charlotte, North Carolina; 9 — Charleston, West Virginia; 10 — Chicago; 11 — Cincinnati; 12 — Cleveland; 13 — Dallas; 14 — Dayton, Ohio; 15 — Denver; 16 — El Paso, Texas; 17 — Gary, Indiana; 18 — Houston; 19 — Indianapolis; 20 — Jersey City, New Jersey; 21 — Kansas City, Missouri; 22 — Little Rock, Arkansas; 23 — Los Angeles; 24 — Minneapolis; 25 — New York City; 26 — Norfolk, Virginia; 27 — Oklahoma City; 28 — Philadelphia; 29 — Phoenix, Arizona; 30 — Pittsburgh; 31 — Portland, Oregon; 32 — Providence, Rhode Island; 33 — Pueblo, Colorado; 34 — Raleigh, North Carolina; 35 — Reno, Nevada; 36 — St. Louis; 37 — San Diego, California; 38 — San Francisco; 39 — Salt Lake City; 40 — San Jose, California; 41 — Seattle; 42 — Spokane, Washington; 43 — Springfield, Massachusetts; 44 — Steubenville, Ohio; 45 — Tampa, Florida; 46 — Topeka, Kansas; 47 — Washington, D.C.; 48 — Wichita, Kansas; 49 — Wilmington, Delaware; 50 — Worcester, Massachusetts; 51 — Youngstown, Ohio. $PM_{2.5}$ denotes particulate matter with an aerodynamic diameter less than or equal to 2.5 μm.

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regression line, indicating that factors other than changes in air pollution were influencing the changes in life expectancy.

Table 2 shows regression coefficients for the association between increases in life expectancy and reductions in $PM_{2.5}$ for models with various combinations of socioeconomic and demographic variables and proxy variables for the prevalence of smoking. Table 2 includes models that are restricted to counties with a population of 100,000 or more in 1986 or to the 51 largest counties in each metropolitan area. In all models, increased life expectancies were significantly associated with decreases in $PM_{2.5}$. According to model 4, a decrease of 10 μg per cubic meter in $PM_{2.5}$ was associated with an adjusted increase in life expectancy equal to 0.61±0.20 year. The estimated effect of reduced $PM_{2.5}$ on life expectancy was not highly sensitive after adjustment for changes in socioeconomic and demographic variables and

Table 2. Results of Selected Regression Models, Including Estimates of the Increase in Life Expectancy Associated with a Reduction in $PM_{2.5}$ of 10 μg per Cubic Meter, Adjusted for Socioeconomic, Demographic, and Proxy Indicators for Prevalence of Smoking.*

Variable	Model 1	Model 2	Model 3	Model 4	Model 5†	Model 6‡	Model 7‡
				years			
Intercept	2.25±0.21§	0.80±0.19§	1.78±0.27§	1.75±0.27§	2.02±0.34§	1.71±0.51§	2.09±0.36§
Reduction in $PM_{2.5}$ (10 μg/m³)	0.72±0.29¶	0.83±0.20§	0.60±0.20§	0.61±0.20§	0.55±0.24¶	1.01±0.25§	0.95±0.23§
Change in income (in thousands of $)	—	0.17±0.02§	0.13±0.02§	0.13±0.01§	0.11±0.02§	0.15±0.04§	0.11±0.02§
Change in population (in hundreds of thousands)	—	0.08±0.02§	0.05±0.02§	0.06±0.02§	0.05±0.02§	0.04±0.02	0.05±0.02¶
Change in 5-yr in-migration (proportion of population)‖**	—	0.19±0.79	1.28±0.80	—	—	−0.02±1.83	—
Change in high-school graduates (proportion of population)‖	—	0.17±0.56	−0.11±0.53	—	—	−0.90±0.86	—
Change in urban residence (proportion of population)‖	—	−0.76±0.32¶	−0.40±0.25	—	—	0.03±1.88	—
Change in black population (proportion of population)‖††	—	−1.94±0.58§	−2.74±0.58§	−2.70±0.64§	−2.95±0.78§	−5.06±2.12§	−5.98±1.99§
Change in Hispanic population (proportion of population)‖††	—	1.46±1.23	1.33±1.10	—	—	2.44±2.22	—
Change in lung-cancer mortality rate (no./10,000 population)	—	—	−0.07±0.02§	−0.06±0.02§	−0.07±0.03¶	0.01±0.03	0.02±0.03
Change in COPD mortality rate (no./10,000 population)	—	—	−0.07±0.02§	−0.08±0.02§	−0.09±0.03§	−0.15±0.06§	−0.19±0.05§
No. of county units	211	211	211	211	127	51	51
R^2‡‡	0.05	0.47	0.55	0.53	0.60	0.76	0.74

* Plus–minus values are regression coefficients ±SE. COPD denotes chronic obstructive pulmonary disease, and $PM_{2.5}$ particulate matter with an aerodynamic diameter less than or equal to 2.5 μm.
† This model included only counties with populations of 100,000 or more in 1986.
‡ This model included only counties with the largest 1986 population in the statistical metropolitan area.
§ For these values, P<0.01.
¶ For these values, P<0.05.
‖ Proportions of the population are based on U.S. Census data.
** Five-year in-migration refers to the proportion of the population who did not reside in the county 5 years earlier.
†† Data on race and ethnic group were self-reported.
‡‡ R^2 denotes the coefficient of determination.

proxy variables for the prevalence of smoking or to data restricted to large counties.

In a variety of related sensitivity analyses, the effect estimate for a change in $PM_{2.5}$ was quite robust. In stepwise regressions, a reduction in $PM_{2.5}$ generally entered the model, after changes in per capita income and proxy indicators for prevalence of smoking were introduced; the effect estimate was stable with the inclusion of other variables. When models 4 and 7 in Table 2 were reestimated with the use of weighted regression (weighting by the square root of the average population for the two periods), similar results were observed, with a decrease of 10 μg per cubic meter in $PM_{2.5}$ associated with an estimated increase in life expectancy equal to 0.58±0.20 year for model 4 and 0.86±0.24 year for model 7. Stratified estimates of model 4 in Table 2 were calculated for the 44 counties in the 15 least-polluted metropolitan areas in the earlier period ($PM_{2.5}$, <17 μg per cubic meter) (Fig. 2) as compared with all the other, more-polluted areas. A reduction of 10 μg per cubic meter in $PM_{2.5}$ was associated with an increased life expectancy of 0.95±0.57 for the least-polluted areas and 0.57±0.26 year for other areas; there was no significant difference in the pollution effect for areas that initially had relatively low or high levels of pollution ($P \geq 0.15$).

Similarly, the effect estimate for the change in $PM_{2.5}$ was not highly sensitive to the inclusion of survey-based estimates of metropolitan-area–level changes in the prevalence of cigarette smoking. For example, when model 4 in Table 2 was reestimated with the use of data from the 136 counties in the 24 metropolitan areas with matching survey data for the prevalence of smoking, a reduction in $PM_{2.5}$ of 10 μg per cubic meter was associated with an estimated increase in life expectancy of 0.61±0.22 year without inclusion of the change in the variable for smoking prevalence ($P = 0.011$) and 0.64±0.22 year with its inclusion ($P = 0.007$). When model 7 in Table 2 was reestimated with data restricted to the 24 largest counties in the 24 metropolitan areas with matching survey data for the prevalence of smoking, a reduction of 10 μg per cubic meter in $PM_{2.5}$ was associated with an estimated increase in life expectancy of 0.94±0.32 year without inclusion of the change in the variable for smoking prevalence ($P = 0.007$) and 1.00±0.34 years with its inclusion ($P = 0.008$). When added to these models, the change in the prevalence of smoking was not significant ($P > 0.15$), and the estimated effect of a change in the rate of death from COPD was largely unaffected. These results indicate that county-level changes in the rate of death from COPD were more robustly associated with county-level changes in life expectancy than metropolitan-area–level estimates of changes in the prevalence of smoking based on limited survey data.

DISCUSSION

Improvements in life expectancy during the 1980s and 1990s were associated with reductions in fine-particulate pollution across the study areas, even after adjustment for various socioeconomic, demographic, and proxy variables for prevalence of smoking that are associated with health through a range of mechanisms. Indirect calculations point to an approximate loss of 0.7 to 1.6 years of life expectancy that can be attributed to long-term exposure to fine-particulate matter at a concentration of 10 μg per cubic meter, with the use of life tables from the Netherlands and the United States and risk estimates from the prospective cohort studies.[27,28] In the present analysis, a decrease of 10 μg per cubic meter in the fine-particulate concentration was associated with an estimated increase in life expectancy of approximately 0.61±0.20 year — an estimate that is nearly as large as these indirect estimates.

For the approximate period of 1980 through 2000, the average increase in life expectancy was 2.72 years for the counties in this analysis. Reduced air pollution was only one factor contributing to increased life expectancies, with its effects overlapping with those of other factors. On the basis of the average reduction in the $PM_{2.5}$ concentration (6.52 μg per cubic meter) in the metropolitan areas included in this analysis and the effect estimate from model 4 in Table 2, the average increase in life expectancy attributable to the reduced levels of air pollution was approximately 0.4 year (6.52×0.061). Multicausality and competing risk issues make it difficult to quantify changes in life expectancy attributable to single risk factors, but these results suggest that the individual effect of reductions in air pollution on life expectancy was as much as 15% of the overall increase. In metropolitan areas where reductions in $PM_{2.5}$ were 13 to 14 μg per cubic meter, the contribution of improvements in air quality to increases in life expectancy may have been as much as 0.82 year (13.5 × 0.061).

In previous cross-sectional analyses, investigators have observed associations between mortality rates and particulate-air pollution,[1-3] but the size of these associations was sensitive to efforts to control the analyses for potential confounders. Our analysis showed similar sensitivity for the strictly cross-sectional associations with life expectancy. The primary strength of this analysis, however, is the additional use of temporal variations. The availability of data on changes in pollution exposure across metropolitan areas from 1980 to 2000 provides the opportunity for an assessment that is similar to a natural experiment. Cross-sectional characteristics that do not change over time are controlled as if by design. Characteristics that affect life expectancy and that change over time — but not in correlation with changes in pollution — are unlikely to confound the results. Even with underlying spatial correlations, if the temporal changes in these characteristics are relatively less correlated, adjusted effect estimates from temporal regression models are likely to be more robust. In this analysis of differences in temporal changes, the estimated effects of reduced $PM_{2.5}$ exposure on increases in life expectancy were robust in analyses adjusted for socioeconomic, demographic, and proxy variables for the prevalence of smoking, as well as in an analysis restricted to large counties.

From an analytic perspective, it would have been informative if pollution had actually increased in some of the areas that were initially less polluted. However, pollution did not increase in any of the metropolitan areas, and the potential for reducing pollution was greater in the areas that were more polluted initially than in those that were less polluted. Stratified analyses showed no significant differences in pollution effects for the areas that initially had low or high pollution, which is consistent with previous findings on the effects of $PM_{2.5}$ even at relatively low concentrations.[7,10,11,15,19]

An appealing aspect of this analysis is that it is a simple, direct, and transparent exploration of the association between life expectancy and air pollution, with the use of available monitored data on $PM_{2.5}$ for both the first and second time periods. However, limited monitoring of data on $PM_{2.5}$ air pollution, especially for the period from 1979 through 1983, reduced both the number of metropolitan areas that could be included in the analysis and our ability to evaluate spatial and temporal associations with more specificity. Furthermore, because the analysis was population-based, we were limited in our ability to control for additional potential confounders, especially various individual and community risk factors that may have been affected by policies that were broadly related to environmental regulation.

For example, the three variables in the analysis that were most strongly associated with changes in life expectancy are all proxy variables. Increases in per capita income probably serve as a proxy variable for, or are highly correlated with, such factors as access to medical care, higher-quality diets, and healthier lifestyles. The use of rates of death from lung cancer and COPD as proxy variables was necessitated by the lack of reliable data on smoking, especially for the period from 1978 through 1982, yet these rates reflect the cumulative effects of smoking, which may similarly affect life expectancy. Although the large majority of deaths from lung cancer and COPD are attributable to smoking,[23] pollution may also have an effect (albeit much smaller) on these health outcomes,[7,8] potentially leading to conservative estimates of the effects of pollution when such proxies are used. The $PM_{2.5}$ variable may serve, in part, as a proxy variable for copollutants, and changes in $PM_{2.5}$ may represent estimates of changes in area-wide ambient concentrations based on fixed-site monitoring during the two time periods instead of being a direct measure of changes in personal exposures. Nevertheless, U.S. air-quality standards and related public policies are designed to restrict ambient pollutant concentrations in an effort to protect human health.[20] Previous prospective cohort studies, using measures of ambient concentrations of pollutants and controlling for smoking and other individual risk factors, have suggested similar improvements in survival and life expectancy, on the basis of indirect estimates.[4-11] The results of our population-based analysis, which showed similar improvements in life expectancy associated with public-policy–related reductions in ambient pollutant concentrations, corroborate these previous findings.

In conclusion, the results of this analysis are generally good news. Although multiple factors affect life expectancy, our findings provide evidence that improvements in air quality have contributed to measurable improvements in human health and life expectancy in the United States.

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Evaluating the Effects of Ambient Air Pollution on Life Expectancy

Daniel Krewski, Ph.D.

Air pollution is an important determinant of population health. In this issue of the *Journal*, Pope et al.[1] provide data that once again reinforce this fundamental concept. In an analysis that correlates reductions in fine particulate matter (i.e., particles less than 2.5 μm in aerodynamic diameter, or $PM_{2.5}$) in the air with life expectancies, the investigators found that a decrease in the concentration of $PM_{2.5}$ of 10 μg per cubic meter is associated with an increase in life expectancy of 0.77 year. Their analysis is based on correlating reductions in particulate air pollution over the past several decades with increases in life expectancy in 217 counties in 51 metropolitan areas in the United States. Although ecologic in nature (i.e., reflecting associations between air pollution and life expectancy at the county rather than the individual level), these results appear to be robust with respect to adjustment for changes in socioeconomic, demographic, and smoking patterns occurring over the same period.

The finding is comparable with previous predictions of reductions in life expectancy of 1.11 years in the Netherlands,[2] 1.37 years in Finland,[3] and 0.80 year in Canada[4] resulting from increases in ambient $PM_{2.5}$ concentrations of 10 μg per cubic meter. However, the strength of the study by Pope et al. resides in its ability to demonstrate an increase in life expectancy resulting from actual reductions in particulate air pollution. This finding provides direct confirmation of the population health benefits of mitigating air pollution and greatly strengthens the foundation of the argument for air-quality management.[5]

This work could be extended to take into account quality of life. For example, Coyle et al.[4] estimated that an increase of 10 μg per cubic meter in $PM_{2.5}$ concentrations would lead to a quality-adjusted reduction in life expectancy of 0.60 year, as compared with the unadjusted reduction of 0.80 year. The work by Pope et al. represents an important contribution to the large and growing body of evidence linking ambient air pollution with adverse health outcomes. At the global level, the World Health Organization[6] estimates that 1.4% of all deaths and 0.8% of disability-adjusted life-years are the result of particulate air pollution.

The short-term health effects of particulate and gaseous air pollutants have been well documented, largely through time-series studies relating short-term elevations in ambient levels of such pollutants to increases in morbidity and mortality from cardiorespiratory conditions. A recent combined analysis of time-series data from 124 of the largest cities in North America and Europe produced an estimated increase in the rate of death from any cause ranging from 0.2 to 0.6% for an increase in ambient PM_{10} concentrations of 10 μg per cubic meter,[7] depending on the assumed lag time between exposure to particulate matter and death and on the method used for seasonality control, the form of the temporal smoothing function, and degree of smoothing. Risk estimates for Europe and the United States were similar but were higher in Canada.

The long-term effects of exposure to "criteria" air pollutants (particulate matter, ozone, sulfates, sulfur dioxide, nitrous oxides, and carbon monoxide) have been documented in large-scale cohort studies, including the Harvard Six Cities Study[8] and the American Cancer Society Cancer

Table 1. Estimates of Increased Mortality Associated with an Increase in $PM_{2.5}$ Concentrations of 10 μg per Cubic Meter Based on Extended Follow-up of the American Cancer Society Cancer Prevention Study II.*

Cause of Death	Krewski et al., 2000†	Pope et al., 2002‡		Krewski et al., 2008§	
	$PM_{2.5}$ Monitoring 1979–1983, Follow-up 1989	$PM_{2.5}$ Monitoring 1979–1983, Follow-up 1998	$PM_{2.5}$ Monitoring 1999–2000, Follow-up 1998	$PM_{2.5}$ Monitoring 1979–1983, Follow-up 2000	$PM_{2.5}$ Monitoring, 1999–2000, Follow-up 2000
	percent increase in mortality (95% CI)				
All causes	4.8 (2.2 to 7.6)	3.1 (1.5 to 4.7)	3.2 (1.2 to 5.3)	2.8 (1.4 to 4.3)	3.6 (1.7 to 5.4)
Cardiopulmonary disease	10.1 (6.1 to 14.3)	7.1 (4.8 to 9.5)	9.2 (6.3 to 12.3)	7.0 (4.9 to 9.2)	10.0 (7.3 to 12.9)
Ischemic heart disease	12.2 (6.6 to 18.1)	13.0 (9.4 to 16.6)	14.3 (9.9 to 19.0)	13.3 (10.0 to 16.7)	15.5 (11.3 to 19.9)
Lung cancer	5.3 (−3.7 to 15.0)	8.9 (3.1 to 15.1)	11.6 (4.1 to 19.7)	7.5 (2.1 to 13.2)	10.9 (3.9 to 18.5)
All other causes	−0.2 (−4.2 to 4.0)	−1.9 (−4.3 to 0.5)	−4.7 (−7.6 to 1.8)	−2.1 (−4.3 to 0.0)	−4.7 (−7.3 to 2.0)

* Estimates are based on a Cox regression analysis stratifying the baseline hazard function by age (1-year groupings), sex, and race. All analyses of $PM_{2.5}$ (particulate matter with an aerodynamic diameter less than 2.5 μm) for the years 1979 through 1983 were conducted using the same 342,521 study subjects. Follow-up year is the most recent year of follow-up for the American Cancer Society (ACS) study cohort available at the time of analysis. $PM_{2.5}$ monitoring data were compiled from publicly available data sources independently of the ACS study. All analyses of $PM_{2.5}$ for the years 1999 through 2000 were conducted using the same 488,370 subjects. Adapted from Krewski et al.[9]
† Data are from Krewski et al.[10]
‡ Data are from Pope et al.[11]
§ Data are from Krewski et al.[9]

Prevention Study II.[9] The American Cancer Society cohort, which includes more than 1.1 million people followed since the time of enrollment in 1980, has provided consistent evidence of an association between increased mortality and ambient air pollution in follow-up analyses through 1989,[10] 1998,[11] and 2000[9] (Table 1). Further analyses of the data, using refined estimates of exposure to ambient $PM_{2.5}$ and follow-up through 2004, are under way.

The effects of ambient air pollution on population health can be addressed within the broader context of risk assessment and management. Population-health risk assessment involves the systematic assessment of genetic, environmental, and social determinants of health; identified health risks can be addressed using a combination of regulatory, economic, advisory, community-based, and technological risk-management interventions.[12] Craig et al.[5] recently produced a document on how scientific evidence on the effects of ambient air pollution on population health can be used in developing strategies for air-quality management.

Research priorities for airborne particulate matter have been identified by the National Research Council, and progress toward their achievement was monitored from 1998 through 2004.[13] The goal of the research was to increase scientific understanding of the health effects of particulate air pollution, including the biologic mechanisms by which particulate matter in ambient air can lead to increased mortality in the general population. Recent scientific evidence suggests that increased mortality from cardiopulmonary disease is due to increased formation of atherosclerotic plaque, which in turn is due to the induction of systemic inflammation and oxidative stress mediated by cytokines after inhalation of $PM_{2.5}$.[14]

The National Research Council also provided a framework for evaluating the benefits of air-quality regulations.[15] Whereas analyses of regulatory benefits are based on predictions of the health benefits resulting from air-pollution control, Pope et al. provide documented evidence of such benefits as a consequence of actual reductions in air-pollution concentrations occurring over the past several decades in the United States. Hedley et al.[16] have attempted to document improvements in population health resulting from reductions in exposure to airborne particulate matter in Hong Kong.

An important component of environmental-health risk management is the evaluation of the effect of a particular intervention.[17] Although ambient air-pollution concentrations in the United States and other developed countries have been declining in recent decades, reflecting efforts to reduce emissions from both point (e.g., smokestacks) and mobile (e.g., cars and trucks) sources, few studies have documented an improvement in population health as a consequence of reductions in exposure to air pollution. The Health Effects Institute has emphasized the need for such evaluations by proposing an accountability framework for air-quality management.[18] This framework tracks the effects of interventions to enhance air quality in terms of emissions reductions, improvements in air quality, reductions in human exposure, and, ultimately, improvements in population health. Because long-term exposure to particulate air pollution has a much greater effect on population health than short-term exposure, the results of the study by Pope et al. are of particular importance within the accountability framework established by the Health Effects Institute.

Pope et al. note that although decreases in fine particulate air pollution ($PM_{2.5}$) could account for as much as 18% of the increase in life expectancy of approximately 2.74 years occurring in the United States between 1980 and 1999, other factors may also be partly responsible. Further analyses of this association, adjusting for changes in individual-level variables such as tobacco use, socioeconomic status, dietary patterns, body-mass index, physical activity, and access to health services, would be of value both in identifying other factors contributing to the increased life expectancy observed over this period and in confirming the ecologic findings of Pope et al. Consideration of the joint effects of copollutants would also be of interest.[9] In the interim, these investigators have made an important contribution to air-quality management through their pioneering attempts to document the population health benefits of reducing ambient air pollution by correlating past reductions in ambient $PM_{2.5}$ concentrations with increased life expectancy.

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Wastes - Resource Conservation - Common Wastes & Materials - Scrap Tires

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Basic Information

Markets and Uses for Scrap Tires | Landfill Disposal | Stockpiles and Illegal Dumping | Scrap Tire Cleanup Guide | State and Local Governments | Health and Environmental Concerns

At the end of 2003, the U.S. generated approximately 290 million scrap tires. Historically, these scrap tires took up space in landfills or provided breeding grounds for mosquitoes and rodents when stockpiled or illegally dumped. Fortunately, markets now exist for 80.4% of these scrap tires-up from 17% in 1990. These markets-both recycling and beneficial use-continue to grow. The remaining scrap tires are still stockpiled or landfilled, however.

In 2003, markets for scrap tires were consuming 233 million, or 80.4 %, of the 290 million annually generated scrap tires:

- 130 million (44.7%) are used as fuel
- 56 million (19.4%) are recycled or used in civil engineering projects
- 18 million (7.8%) are converted into ground rubber and recycled into products
- 12 million (4.3%) are converted into ground rubber and used in rubber-modified asphalt
- 9 million (3.1%) are exported*
- 6.5 million (2.0 %) are recycled into cut/stamped/punched products
- 3 million (1.7%) are used in agricultural and miscellaneous uses

Scrap Tire Promotional Video

- Tire-Derived Aggregate in Civil Engineering Applications (MP4) (5.45 min, 81MB) | en Español
- Video plays on the QuickTime Player and requires you to have the QuickTime Player Plug-in EXIT Disclaimer
- **NOTE:** Download time for the video may vary depending on the speed of your Web connection and other factors.
- To request a DVD of the full-length, 45-minute video, contact Mark Schuknecht, 703-308-7294

Another 16.5 million scrap tires are retreaded. After any retreading has been performed, 290 million scrap tires are generated. About 27 million scrap tires (9.3%) are estimated to be disposed of in landfills or monofills. *(Source: Rubber Manufacturers Association, 2004.)*

*Many scrap tires are exported to foreign countries to be reused as retreads, especially in countries with growing populations of automobile drivers such as Japan and Mexico. According to Mexico's National Association of Tire Distributors, as many as 20% of tires sold in Mexico are imported as used tires from the US and then retreaded for reuse. Some foreign countries also import tires to be shredded and used as crumb rubber, or to be used as fuel. Unfortunately, not all exported tires are reused or recycled. The downside of exporting scrap tires is that the receiving countries may end up with a disproportionate amount of tires, in addition to their own internally-generated scrap tires.

Markets and Uses for Scrap Tires

Scrap tires are used in a number of productive and environmentally safe applications. From 1990 through 2003, the total number of scrap tires going to market increased from 11 million (24.5%) of the 223 million generated to 233 million

"Over 75% of scrap tires are recycled or are beneficially used

(80.4%) of the 290 million generated.

for fuel or other applications."
- Rubber Manufacturers Association, 2003

The 3 largest scrap tire markets are:

- Tire-derived fuel
- Civil engineering applications
- Ground rubber applications/rubberized asphalt

Many uses have been found for recycled tires including whole tires, tires chips, shredded tires, and ground rubber. Retreading also saves millions of scrap tires from being disposed of as scrap each year.

More information on scrap tire markets and uses.

Landfill Disposal

Even with all of the reuse and recycling efforts, almost one quarter of scrap tires end up in landfills each year. Landfilling scrap tires can cause problems due to their uneven settlement and tendency to rise to the surface, which can harm landfill covers. To minimize these problems, many states require chipping or grinding of tires prior to disposal. Sometimes scrap tires are also incorporated into the landfill itself as part of daily cover, or in a landfill cap.

In recent years, the placement of shredded scrap tires in monofills-a landfill, or portion of a landfill, that is dedicated to one type of material-has become more common. Monofills may be used where no other markets are available and municipal solid waste landfills do not accept tires. Monofills are preferable to above ground storage of tires in piles, due to fire hazards and human health hazards.

State landfill regulations:

- 38 states ban whole tires from landfills.
- 35 states allow shredded tires to be placed in landfills.
- 11 states ban all tires from landfills.
- 17 states allow processed tires to be placed into monofills.
- 8 states have no restrictions on placing scrap tires in landfills.

(Source: Rubber Manufacturers Association, 2003)

Stockpiles and Illegal Dumping

In 1994, the estimated number of scrap tires in stockpiles in the US was 700 to 800 million. Since that time, millions of tires have been removed from stockpiles primarily due to aggressive cleanup through state scrap tire management programs. 275 million tires were estimated to be in stockpiles (Source: Rubber Manufacturers Association, 2004.)

Tire Stockpiles

- A tire's physical structure, durability, and heat-retaining characteristics make these stockpiles a potential threat to human health and the environment. The curved shape of a tire allows rainwater to collect and creates an ideal habitat for rodents and mosquitoes.
- Prone to heat retention, tires in stockpiles also can ignite, creating tire fires that are difficult to extinguish and can burn for months, generating unhealthy smoke and toxic oils. Illegal tire dumping pollutes ravines, woods, deserts, and empty lots. For these reasons, most states have passed scrap tire regulations requiring proper management.

Scrap Tire Cleanup Guidebook

To help state and local governments reduce the economic burdens and environmental risks associated with scrap tire piles on their landscapes, U.S. EPA Region 5 and Illinois EPA, with input from members of the national Resource Conservation Challenge Scrap Tire Workgroup, have collaborated to create the Scrap Tire Cleanup Guidebook. The guidebook brings together the experience of dozens of professionals in one resource designed to provide state and local officials with the information needed to effectively clean up scrap tire piles. The guidebook discusses starting a cleanup program, working with contractors to clean up sites, and implementing prevention programs that will reduce scrap tire dumping.

To order, send an email to nscep@bps-lmit.com and ask for publication #530-R-06-001.

Scrap tire piles are not treated as hazardous waste. However, once a tire fire occurs, tires break down into hazardous compounds including gases, heavy metals, and oil which may then trigger Superfund cleanup status.

Tire piles/dumps can be found in big cities, small towns, and the countryside. Cleaning up these nuisance piles is time consuming and expensive. In an effort to limit dumping and stockpiling, most states have passed scrap tire regulations requiring proper management.

State Survey

Based on a survey of state agencies conducted by the Rubber Manufacturers Association in 2001, 91% of all scrap tires stockpiled in the US are concentrated in eleven states. For additional information, see the 2003 RMA study on scrap tire markets EXIT Disclaimer.

Many states have cleaned up large numbers of tire stockpiles. Minnesota, Wisconsin, and Maryland are three states which report having cleaned up all scrap tire stockpiles.

For more information about illegal dumping, consult EPA's Illegal Dumping Prevention Guidebook (PDF) (33 pp, 1.1MB, About PDF)

State and Local Governments

Scrap tires, as a solid waste, are regulated primarily by state governments. Currently, 48 states have laws or regulations specifically dealing with scrap tires. While each state has its own program, some common features include:

- a source of funding for the program
- licensing or registration requirements for scrap tire haulers, processors and some end users;
- manifests for scrap tire shipments;
- limitations on who may handle scrap tires;
- financial assurance requirements for scrap tire handlers; and
- market development activities.

Local municipalities help educate the public about illegal dumping and enforce anti-tire dumping laws. Local agencies are also usually responsible for tire pile cleanup

Some local jurisdictions encourage proper disposal by allowing local citizens to drop off limited numbers of tires at recycling centers, or conduct tire amnesty days where any local citizen can bring a limited number of tires to a drop-off site free of charge. State scrap tire programs may provide financial help to fund such events.


Magic Johnson Park, Los Angeles, California. Poured in-place rubber made from recycled scrap tires.

Local municipalities also play big role in procuring products made with scrap tires including playground/park applications. And in many states, local government agencies are also large users of rubberized asphalt in public paving projects. The Federal government is also a large purchaser of products made with recycled rubber, and has established purchasing guidelines.

For more information about state scrap tire programs, consult EPA's State Scrap Tire Reference Guide (PDF) (53 pp, 262K, About PDF).

Health and Environmental Concerns

Tire piles-legal or illegal-pose two major health threats: pests and fire.

Disease carrying pests such as rodents may live in tire piles. Mosquitoes can also breed in the stagnant water that collects inside tires. Several varieties of mosquitoes can carry deadly diseases, including encephalitis and dengue fever. Mosquito control and eradication programs-short of removing tire piles-are difficult. For more information on mosquito-borne diseases, visit the Centers for Disease Control and Prevention.


Burning Pile of Tires

Fire presents a second concern. Scrap tire fires are difficult to extinguish, and can burn for long periods. Tire fires release thick black smoke and can contaminate the soil with an oily residue. Tire fires generally start either as a result of arson or accident. More information on tire fires.

Wastes - Resource Conservation - Common Wastes & Materials - Scrap Tires

You are here: EPA Home Wastes Tires

Markets/Uses

Bulldozer Pushing Scrap Tires

Scrap Tire Markets

The 3 largest scrap tire markets are:

- Tire derived fuel
- Civil engineering applications
- Ground rubber applications/rubberized asphalt

Other applications include:

- Whole Tires and Cut, Stamped, and Punched Products
- Reuse-Retreading
- Pyrolysis

Both recycling and beneficial use of scrap tires has expanded greatly in the last decade through increased emphasis on recycling and beneficial use by state, local and Federal governments, industry, and other associations.

Unfortunately, even with all of the reuse and recycling efforts underway, not all scrap tires can be used beneficially. More information on scrap tire disposal.

Whole Tires and Cut, Stamped, and Punched Products

Scrap tires may be recycled by cutting, punching, or stamping them into various rubber products after removal of the steel bead. Products include floor mats, belts, gaskets, shoe soles, dock bumpers, seals, muffler hangers, shims, and washers.

Whole tires may be recycled or reused as highway crash barriers, for boat bumpers at marine docks, and for a variety of agricultural purposes.

For additional information on reuse and recycling of scrap tires, see:

- Comprehensive Procurement Guidelines (CPG)
  The site includes EPA's list of designated products and the accompanying recycled-content recommendations. In order to find out some of the products that can be made from recovered scrap rubber, review the appropriate product guidelines such as floor tiles and patio blocks, playground surfaces, running tracks, and retreaded tires.

- Environmentally Preferable Purchasing (EPP)
  This Web site includes an online searchable database of environmental information for environmentally preferable products including tires and products made from recycled tires.

- Product Stewardship/Extended Product Responsibility: Vehicles
  Product stewardship is a product-centered approach to environmental protection. Also known as extended product responsibility (EPR), product stewardship calls on those in the product life cycle-manufacturers, retailers, users, and disposers-to share responsibility for reducing the environmental impacts of products.

Reuse-Retreading

Another market for scrap tires is retreading. Retreading involves removing the outside, or tread, of the tire and adding a new tread. Retreading saves millions of gallons of oil each year, because it takes only 7 gallons of oil to retread a used tire compared to 22 gallons to produce a new tire.

Retread tires not only offer considerable environmental and economic benefits, but they also provide quality, comfort, and safety comparable to that of new tires.

The Tire Retread Information Bureau estimates that about 24 million tires are retread and sold each year in the U.S. and Canada, combined. The Rubber Manufacturing Association estimates that in the US, about 16 million scrap tires were retreaded in 2001. Most are used by the trucking, aircraft, construction, and agriculture industries, and on US government vehicles. Benefits of retreading are that it:

- Saves resources by requiring 70% less oil for production.
- Contains 75% post-consumer material.
- Costs 30% to 70% less than making a new tire.
- Saves landfill space.

The 290 million scrap tires generated in 2003 do not include the 16.5 million scrap tires that were retreaded.

Pyrolysis

Background

Pyrolysis is a method to break down tires into potentially usable end products. Called by a variety of names, such as thermal distillation and destructive distillation, pyrolysis is the heating of organic compounds in a low oxygen environment.

Products

Pyrolysis of waste tires generates combustible gases, oil, and char products. The quantity and quality of each product depends on variables including temperature, pressure, and residence time. Outputs for a typical pryolysis process are:

- **Oil:** Usually varies in quality from saleable fuel oil that may need processing to lower-value oil blend stock.
- **Char:** Contains a mixture of carbon black, titanium dioxide, zinc, steel and other trace inorganic compounds present in tires.
- **Gas:** May be used to fuel the pyrolysis process or be combusted in a flare.

Market Trends

Although many attempts have been made over the past several decades, EPA is not aware of any commercial pyrolysis systems operating continuously in the U.S. According to the U.S. Rubber Manufacturer's Association's 2007 Edition, Scrap Tire Markets in the United States , tire pyrolysis did not play a role in the management of scrap tires in the United States as of late 2007. One reason for this is that the value of the pyrolysis-derived oil, char, and gas has thus far has been lower than the overall cost of the pyrolysis process that produced them. The technology continues to be explored for commercial feasibility, and there are a limited number of pilot operations that have been built.

Practical Considerations

When investigating the pyrolysis process, some of the practical considerations include:

- Challenges of operating in an oxygen-limited, high temperature environment with complex equipment and an abrasive feedstock (scrap tires);
- Environmental considerations such as the need for air emission control systems and disposal of products or byproducts that may be unmarketable. In addition, zinc and sulfur, both found in tires, are not destroyed or decomposed thermally and may remain in one or more of the pyrolysis products;
- It is difficult to optimize quality and yields of the pyrolysis-derived gas, oil, and char since conditions that favor one often have a negative impact on another. Refining end products may add costs if it is necessary to meet customer needs and may require additional pollution controls;
- Markets of sufficient size and price that support the pyrolysis operation must be developed for pyrolysis-derived oil, char and gas. The quality and thus value of these end products may be different from the commercially available materials against which they are competing;
- Products may have regulatory requirements that need to be met in order to be sold (i.e., Toxic Substance Control Act (TSCA); and
- The need to ensure availability of a steady and adequate supply of tires within an affordable haul distance.

Additional Information

The Manufacture of Carbon Black From Oils Derived From Scrap Tires

4.24 Pyrolysis, Ex Situ Soil Remediation Technology, Remediation Technologies Screening Matrix and Reference Guide, Version 4.0 (FRTR)

2007 Edition, Scrap Tire Markets in the United States (U.S. Rubber Manufacturers Association, May 2009)

Wastes - Resource Conservation - Common Wastes & Materials - Scrap Tires

Laws/Statutes

The City of Modesto Amnesty Program allows Modesto, California residents the opportunity to drop-off waste tires for recycling at no charge. Tires of all sizes are accepted.

Scrap tires are managed primarily at the state level. About 48 states have laws or regulations specifically dealing with the management of scrap tires. While each state has its own program, some typical features include:

- Funding via taxes or fees on automobiles or tires.
- Market development activities.
- Licensing or registration requirements for scrap tire haulers, processors and some end users.
- Manifests for scrap tire shipments.
- Requirements regarding who may handle scrap tires.
- Financial assurance requirements for scrap tire handlers, storage facilities, and disposers.
- Tire pile clean-up.

In 1985, Minnesota enacted the first state law for the management of scrap tires. By now, 48 states have enacted laws that address scrap tire management. Alaska and Delaware do not have any scrap tire laws or regulations.

Each state makes its own scrap tire laws and regulations. These laws typically set the stage for rules for scrap tire storage, collection, processing, and use. States also establish programs to clean up old scrap tire stockpiles, and the funding needed to accomplish that goal. More information about state tire programs.

In recent years, scrap tire legislation has been a priority in many states. This is an indication that the majority of legislatures recognize that creating viable markets for scrap tires is an integral component of each state's environmental and recycling policies.

Tire Fees

Many states collect fees to fund scrap tire management programs or stockpile cleanup Tire fees are typically assessed on the sale of new tires or on vehicle registrations. Fees generally range from $0.50 to $2 per passenger car tire, and truck tire fees range from $3 to $5.

Some scrap tire fees also help local communities establish market programs, create licensing/enforcement systems, and host tire collection programs/amnesty events. States and municipalities may also use money generated by scrap tire fees to offer grants or loans to scrap tire processors and end users of tire-derived materials.

Tire Roundtable

In New York, representatives from the scrap tire industry, tire manufacturers, environmental groups, scrap tire end-users, and the municipal recycling/solid waste sector formed a roundtable group to address the state's scrap tire problem. In January 2000, the roundtable developed a consensus document that was eventually turned into a legislative package. Key elements included:

- Dedicated tire fee to be used to fund initiatives.
- Short- and long-term market development programs.
- Consumer education programs.
- Creation of a stockpile remediation and abatement program.

Additional Information

- State Scrap Tire Programs – A Quick Reference Guide: 1999 Update (53 pp, 262K, About PDF)
- Rubber Manufacturers Association Table of State Legislation of Scrap Tires EXIT Disclaimer
- Rubber Manufacturers Association State Scrap Tire Fees and Point of Collection EXIT Disclaimer

California IWMB

California's Integrated Waste Management Board is using a multi-tiered approach to tackle the state's tire problems:

- Identify illegal tire piles for cleanup and provide the funds to accomplish the job.
- Develop markets—enhance end products through the establishment of special recycling zones and grants.
- Conduct balanced enforcement action through scrap tire hauler licenses, public education and by targeting recyclers, collectors, and processors that are not in compliance.
- Enforce requirements regarding pile size, storage time, and fire prevention at permitted tire storage sites.

Montanans Against Toxic Burning
NoToxicBurning.org

Issues Associated with Burning Waste Tires in Holcim's Trident Cement Kiln

Public health risk

- Cement plants are among the largest producers of dioxin in the United States.
- EPA research shows that burning tires in cement kilns leads to greatly increased emissions of hazardous air pollutants, including dioxin, arsenic, lead, cadmium, chromium, chloromethane, xylene, styrene, and toluene. These toxic substances enter our bodies through inhalation and through the consumption of locally produced dairy products, meat, and other agricultural products.
- These pollutants cause serious health problems, including reproductive impairment, developmental delay, and cancer. Children are especially vulnerable to these pollutants.

Food/agriculture issues

- The area surrounding the Trident plant is used for farming, livestock grazing, and dairy production.
- 35% of the state's milk is produced downwind of the Trident plant.
- Wheat Montana's fields are adjacent to the Holcim facility.
- Local farmers and ranchers could experience decreased productivity, as well as difficulty marketing their goods.
- Local fish and game populations would suffer negative impacts from toxic emissions.

Fallacy of the "recycling" issue

- Burning tires is not recycling.
- State government studied the issue of waste tires in Montana and found that "Montana does not have a problem with waste tire management."
- Holcim plans to burn 1.13 million scrap tires per year, far more than Montana generates in a year. The facility would need to import tires from surrounding states, making the Gallatin Valley the incineration site of other states' wastes.
- If Holcim sources tires from Montana, several other businesses that actually do recycle tires into useful products will be negatively impacted.

Incompatibility with current economic development

- More than 90 small high-tech companies, paying high salaries, are doing business in the Gallatin Valley because of its relatively clean environment and high quality of life.
- In the 2004 State of the Rockies study, Gallatin County was identified as the healthiest county in the Rockies largely because of the lack of toxic air emissions in our valley. Waste incineration at the Trident plant would undermine that status and jeopardize the economic viability of our community.

Problems associated with burning tires in cement kilns

- Cement kilns are not designed to be waste incinerators; they lack the technology necessary for complete destruction of toxic by-products.
- Old, wet-process kilns, like the one at Trident, have a proven track record of noncompliance when burning scrap tires.

Holcim's poor compliance record here and elsewhere

- Holcim's Trident plant is an antiquated facility that experiences frequent equipment failures, breakdowns, and malfunctions. In 2002, the facility exceeded its permitted emissions limits more than 6% of operating time. In 2003, Holcim was fined for violating its permitted operating limits. During January and February of 2005, the Trident kiln experienced serious malfunctions every week and exceeded its permitted emissions limits more than 6.5% of operating time.
- Holcim facilities in other states have received hefty fines for major violations of air quality regulations, and several are currently involved in enforcement actions. Holcim's facility in Ada, Oklahoma, which operates a wet-process kiln burning whole tires, has been out of compliance for several years running. In September 2005, EPA took a second enforcement action against the Oklahoma facility, issuing a fine of $321,000 and classifying the facility as a "high-

priority violator." In July 2006, EPA cited Holcim's Dundee, Michigan, facility (Holcim's other wet-process kiln burning whole tires) as a "high-priority violator" for repeated violations of the Clean Air Act.

If Holcim is permitted to burn tires, incineration of other industrial wastes will surely follow.

- All other U.S. Holcim facilities that have been permitted to burn tires have subsequently added other industrial wastes as "alternative fuels." For example, soon after the Holcim plant in Dundee, Michigan, was permitted to burn tires, it submitted a list of more than seventy different industrial wastes to be used as "alternative fuels," including paints, plastics, and waste products from animal rendering, auto manufacturing, and petroleum refining, all of which were eventually approved by the Michigan DEQ.
- The Montana DEQ has allowed the Holcim Trident facility to burn toxic slag from the Superfund site at the Asarco lead smelter in East Helena, although Holcim failed to apply for a permit to do so. In addition, DEQ has recently made the determination that as long as Holcim pays (virtually any dollar amount) for a waste, the facility does not need a solid waste permit to use that waste. Thus, it appears that the current permitting action (that is, tire incineration) is the de facto threshold for a practically unlimited waste stream for the Trident plant.

Other points to consider

- The DEQ received approximately 1,200 comments from the public on the draft permit and draft EIS, the vast majority of which opposed permitting Holcim to burn waste tires. The 55 comments in support were largely from Holcim employees and industry lobbyists.
- The permit would not create a single new permanent job.
- Some local officials have suggested that we should let Holcim "try" burning tires, and if the facility has problems, DEQ would step in and stop the process. However, in its entire history, the DEQ has never revoked an air quality permit—even when there have been egregious violations at major industrial sources. The agency has said that it prefers to "work with facilities" to help bring them into compliance. No one should expect that the DEQ will "pull" Holcim's permit if the facility experiences significant problems after being permitted to burn waste tires.
- Holcim has stated that it needs to burn tires to remain economically competitive, yet the company recently reported record profits—more than $1.2 billion in 2006.

CITIZENS FOR CLEAN AIR

June 1993 315 WEST MISSION SPOKANE, WA 99204

CLOSE-UP ON SPOKANE

TIRE BURNING: OUT OF THE FRYING PAN, INTO THE FIRE?

We've delayed the release of this issue of the CFCA newsletter in order to report on recent and ongoing developments involving a proposal to burn discarded tires in the WTE plant. Despite Solid Waste Disposal Project Director Phil Williams' protestations in the Spokesman-Review ("I don't want to burn tires...I hate to sit here and recommend this to you because it's going to be unpopular."), he is doing just that. The May 19th article by Bruce Krasnow indicated the Solid Waste Advisory Committee (SWAC) recommended public officials move ahead with a plan for incineration of some of the area's estimated 8 million stockpiled tires "if other disposal methods prove inadequate." But at the June 8th SWAC meeting, without having first determined whether "other disposal methods" might be adequate, Williams recommended seeking approval to incinerate "up to 3% by weight allowable tire inputs from October through March." Other recommendations were made to "work with local recyclers to maximize other reuse options, seek City and County ordinances prohibiting the continued stockpiling of whole tires, and require owners to develop and implement binding pile reduction plans with interim targets." All of the recommendations passed, although the vote to incinerate tires was not unanimous. Evidence strongly suggests that incineration is one of the least desirable methods of dealing with the troublesome glut of discarded tires, but Williams and public officials are apparently too anxious to use tire burning to partially finance their proposed 3rd boiler to take the time to explore "other disposal methods."

CCHW's Science Director, Stephen Lester, wrote a 1991 article in Everyone's Backyard entitled Burnin' Rubber: The Dangers of Tire Incineration. In response to the question "Why not burn tires?" He wrote "The main problem with burning tires is the toxic emissions they generate. No form of incineration is 100% effective. Whatever chemicals exist in the tires will end up in the emissions." [Has it not yet occurred to our local officials that the winter months ("from October through March") are Spokane's inversion season? Do we really need to compound the problem by adding more noxious emissions to already notoriously poor winter air quality?] Lester went on to say "Not only do air emissions include toxic chemicals present in the original waste, but they also produce new chemicals that were not in the original waste. These are called "Products of Incomplete Combustion" or PICs. Dioxins and furans are the most common PICs. These chemicals are found not only in the emissions gases, but also in other pollution sources generated by the plant. These include the oily fluid that remains after the burning is completed...residual ash, particulate ash captured by air pollution control equipment and as ash quench water."

In order to convince SWAC members that incineration should be part of the solution to our tire problem, Phil Williams indicated that test burns of tires resulted in no significant increases in toxic emissions. Carl Reller, in his recent review of the City's study of incineration risks, came to a somewhat different conclusion. He found that during the 1992 tire test burn, Spokane County Air Pollution Control Authority (SCAPCA) permit conditions were ignored; the effects of burning tires on dioxin emissions were not reported (you may recall from our May newsletter that dioxin is widely believed to be one of the most toxic compounds ever produced - the EPA concluded after a 1991 study that there is already enough dioxin present in the environment to produce observable effects on human cells), nor were the effects of tire burning on opacity (smoke bursts) or acid (hydrochloric and hydrofluoric) gas emissions. Levels of nitrogen oxides (a contributor to acid rain) were found to have exceeded permit conditions. He also found that levels of certain other airborne toxins increased dramatically; PCBs (polychlorinated biphenyls, fat soluble, highly persistent toxic compounds) by up to 150%, PAHs (polycyclic aromatic hydrocarbons, a family of potent carcinogens resulting from incomplete combustion) by up to 400%, and mercury (acknowledged to be one of the heavy metals most dangerous to human health) by up to 2,300%! Carl reports that "Unfortunately air monitoring equipment set up to test the air near homes and schools does not test for PCBs, PAHs, or mercury (Radian 1992)," and notes that although "Rubber tires are made of 1,3 butadiene, a potent carcinogen (Dahl 1991)...The Spokane garbage incinerator does not monitor butadiene.".

Particularly troubling was the gross underreporting of mercury emissions during the test burn; It appears this was accomplished in the City study by substituting a higher baseline for a lower one, then using figures which reflected average instead of maximum emissions (Is this what they call "fake science?"). Although there are trace amounts of mercury in tires, an increase of this magnitude apparently would not generally be expected from tire burning. Project officials later agreed that mercury levels rose during the tire test burn, but Wheelabrator plant manager Steve Wotruba commented (in a June 20th Spokesman-Review article by Karen Dorn Steele) that the mercury spikes were from batteries and thermometers thrown in with "normal garbage, not from the tires. We get mercury spikes all the time." (A revelation which is somehow less than comforting...) Dr. Jeff Corkill, an EWU instructor and chemist, recently looked at the project's emission figures, and found a pattern of spikes and drops in levels of mercury, lead and SOx (sulphur dioxide) for which there was not a satisfactory explanation. Dr. Corkill suggested that a more thorough monitoring would be appropriate (on various combinations of tires and garbage in several 3-hour intervals), in order to get a clearer picture of the impact of burning tires in the Wheelabrator incinerator.

In the same article, Phil Williams said "If critics are opposed to burning tires, they should suggest better disposal alternatives." Our City/County officials, however, have ignored some suggestions. A local engineer has been suggesting for years that he has a better alternative. He also suggests that tires shouldn't even be considered waste; that they are a resource which can generate needed cash instead of incurring handling costs. He has developed a tire recycling technology, which he says is a "closed, environmentally friendly," process. He claims the process could transform discarded tires from a costly liability into a valuable cash resource, in contrast to the process of tire incineration, in which "the handling costs would be twice the amount of electrical revenues generated." And he states that tires should be excluded from the City's Flow Control Ordinance, (which appears to be of questionable legality to begin with), based on their viability as a resource.

Other alternatives which are in use now include fuel derived from tire pyrolysis, reuse and recycling as retreads and other materials, backfill and ground cover from shredded tires, and road paving with a mixture of asphalt and crumb rubber. Shredded or baled tire material may be landfilled, but whole tires in landfills are extremely problematic, so that is not an option. None of these alternatives are perfect; all have drawbacks and costs, and present markets for some of the materials are limited. But we live in an imperfect world, one in which costs and consequences of consumption and waste are a reality. Phil Williams demonstrated his ignorance of this reality, (as well as the basic laws of ecology, one of which is "There is no "away"") when he said of tires "Where can we send them? We've been looking for a silver bullet, and we haven't found it." Project officials may have to accept along with the rest of us that "there is no free lunch," and no "silver bullet" to be found for the complex issues of waste disposal. And there are costs involved in tire incineration, costs which would undoubtedly be passed on to ratepayers. Among these is the cost of frequent replacement of pollution control equipment, which some say can become rapidly clogged when burning tires. As Carl Reller has stated "Garbage incinerators are designed to burn garbage, not to be used as a disposal facility for petrochemicals."

Our local officials are likely to point to the dangers of tire piles as a justification for burning them at the WTE plant. The dangers are real, and of serious concern. Tire piles are breeding grounds for mosquitos and other vermin, and tire fires, which are environmental and health disasters, are a constant worry due to volatile gases trapped in the piles. But clearly, disposing of tires by incineration could cause as many problems as those it's intended to solve. Other options should be tried in earnest before incineration is even considered. State Senate Bill #5591, passed in 1991, gives first preference to recycling in waste tire handling, and money is being set aside to explore reuse/recycling options as a result of existing RCWs. In addition, Dorn Steele's article indicates not only is SCAPCA approval necessary before the project can proceed, but also that state air toxics regulations which went into effect after the project gained permission to operate would be triggered by initiating tire incineration, requiring more tests and more stringent adherence to tougher regulations than they now follow. Any attempt to circumvent State envrironmental regulations or SCAPCA approval should be brought immediately to the attention of the Spokane public. If past history is any indication of the behavior of our local officials, it may be necessary to embarrass them into doing the right thing.

In the interim, it may be possible to store the tires in such a way that they are no longer a ticking time bomb. Shredding or baling the stockpiled tires could drastically reduce the space needed to store the tires, and also the dangers of infestation and fire created by the structure of tires stacked whole. By neglecting to consider such measures, the City is creating a sense of urgency which need not exist in order to justify their continued "rush to burn."

While we at CFCA share the concern over the dangers presented by stockpiles of excess tires, rushing to burn them is unacceptable without having attempted or even explored other handling methods, some of which may contribute to the value of tires such that they become resources rather than handling headaches. In the final analysis, burning tires to avoid tires burning seems as nonsensical as "jumping from the frying pan into the fire."

We need your help again! Please voice your concern over this development to our City/County officials. I've included on the back page the form letter from our last issue, amended to respond to Williams' recent tire burning recommendation (and the inevitable future proposals of hazardous/medical waste burning, or taking additional refuse from outside the area). Please take a moment to sign it, tear it off and send it directly to SPOKANE CITY COUNCIL, City Hall, W. 808 Spokane Falls Boulevard, Spokane, WA 99201. (If you sent in the last letter, THANK YOU. If you can, please send this letter as well, since it has been amended to address recent developments).

TO MAYOR BARNARD, CITY COUNCIL MEMBERS AND COUNTY COMMISSIONERS:

As a concerned citizen of greater Spokane, I am writing to express my strong opposition to consideration of the addition of a third boiler to the existing regional solid waste incinerator. Such an addition would pose unnecessary environmental risks to the Spokane area, and needlessly increase already unacceptable levels of health risks to its residents. The 40 million dollar anticipated expenditure would be financially imprudent, given the multimillion dollar losses already incurred by the project after only 20 months of operation, the premature depletion of the Rate Stabilization Fund, and rapidly rising garbage collection fees. "Throwing good money after bad" will not solve our waste problems, and there are more acceptable alternatives to more burning. This amended letter reflects recent discussions and recommendations concerning the burning of tires, hazardous and medical wastes, and refuse from outside the area in the municipal incinerator. I emphatically oppose such ill-advised practices, any of which would compound the above-mentioned risks, expose Spokane citizens to even greater short and long term costs, and in so doing, render an unacceptable approach to waste management even more unacceptable.

Such important issues warrant a public forum and a serious study of alternatives, conducted by an appropriate, disinterested party. The passing of Proposition 4 in 1987 mandates a citizen vote on project proposals exceeding 1 million dollars. Spokane's citizens are not prepared to accept exclusion from discussions and decisions which fundamentally affect them.

Sincerely,

____

CITIZENS FOR CLEAN AIR
315 West Mission
Spokane, WA 99204

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Permit No. 4

CCHHW
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Clean Air and Water for Alachua County

2603 N. W. 13th Street #318 - Gainesville, FL 32609 - (352) 375-6451

Dr. Leonard Smith
720 SW 2nd Ave
Gainesville, FL 32601

Dear Dr. Smith,

I have spoken to you of our concern about the proposed Florida Rock Industries Portland cement plant. We feel that we have adequate grounds for opposing the plant simply from a public policy point of view. Florida Rock used misleading information in applying for the permit, and now proposes to emit massive amounts more pollution than they described in their application to the county.

Beyond specific defects in the permit application, we feel that our Comprehensive Plan was violated in approving the introduction of smokestack industry to our urban fringe. We as citizens had trusted in our Comprehensive Plan and our elected representatives to preserve the things that we value here.

But as a physician, you have expressed your concern about the potential health effects. The construction and operation of this tire-incinerating plant would have serious long-term health consequences for the population of this county.

The use of cement kilns as disposal facilities, as Florida Rock proposes, is not appropriate. The design and operation of these kilns is to make Portland cement, not to be a clean-burning incinerator.

The tremendous amounts of fine particulates (inhalable dust, PM10 - PM2.5) produced in such a plant, contaminated with the toxic constituents of the gas stream from the low-oxygen combustion process, will serve as an effective vector to carry these toxins directly into lung tissue.

Consider the proposed incineration of 3.6 million old tires per year as 30% of the plant's "fuel mix". Burning of tires and other man-made materials is associated with elevated emissions of toxic heavy metals and organic poisons such as dioxins and furans.

Dioxins and furans are endocrine disrupters and estrogen mimics, as well as effective carcinogens. These chemicals do not break down in the environment. Tissue levels build up in exposed populations and move up the food chain. The effect of this accumulation are only beginning to be researched, but current body burdens in the general population are already at levels where these serious health impacts can be expected.

The effects of low-level exposure to heavy metals can be very serious, particularly in sensitive populations such as infants and young children. Permanent impairment of mental functions is a common result.

For these and many other reasons, we ask your support for our efforts to educate the public about the importance of reversing the County Commission decision to approve this polluting industry, in the interests of our future health and well-being.

Yours truly,

Thomas D. Bussing, PhD
President

LEONARD SMITH, M.D., P.A.
General & Vascular Surgery
Nutritional Medicine

720 S. W. 2nd Avenue, Suite 202
Gainesville, Florida 32601

(352) 378-6262
(352) 378-0779 FAX

August 19, 1996

Dear Colleague,

I have been communicating with Dr. Thomas Bussing about the proposed cement plant near Newberry. Dr. Bussing received his PhD degree in Materials Science and Engineering at the University of Florida in 1991. He has been researching the issues involved quite thoroughly over the past year and I have reviewed some of this information myself.

I am sharing this with you because I have become convinced that the public health implications of the proposed plant would be quite serious, and I feel that it is important that we as physicians speak out on the serious health impact that can be anticipated if the plant is constructed and operated.

A review of the epidemiological catchment area study conducted by the Natural Resources Defense Council (NRDC) released in May 1996 ("BREATH-TAKING: Premature Mortality Due to Particulate Air Pollution in 239 American Cities") documents the effects of chronic inhalation of fine particulate matter, which would constitute a large portion of the proposed plant's pollution emissions.

Cement kilns contribute a substantial portion of the dioxin released into our environment, in fact a greater amount than Hazardous Waste incinerators.

Heavy metals from coal or tire burning are, like dioxin, cumulative in the environment and in living tissue, and like dioxins are toxic at concentrations or body burden levels that would be considered minute.

For these and other reasons, I am asking that you give an earnest review to these materials, and that you give serious consideration to signing the attached communication to the Alachua County Board of County Commissioners. You may send the signed document to my office by mail, or by placing it in my box, or by FAXing it to me at 378-0779.

It is of great importance that the voice of the physician community be heard on this issue. Thank you for your attention to this matter.

Sincerely,

Leonard Smith MD

Attachments:
From Dr. Bussing : Letter to Dr. Leonard Smith
Letter for Signature

Please return signed letter to Dr. Smith (or by FAX: 378-0779) for presentation to the Alachua County Commission.

SIERRA CLUB

LONE STAR CHAPTER

P. O. Box 1931
Austin, TX 78767

October 25, 1996

Mr. Jeff Hammer
1474 County Road 72
Helena, Ohio 43435

RE: Proposed Permit to Burn Tire-Derived Chip Fuel
Redland Ohio Inc.'s Millersville Lime Plant in the #1 Kiln

Dear Jeff,

As requested by concerned citizens of Millersville, Sandusky County, Ohio, I have reviewed the proposal by Redland Ohio Inc. to begin tire chip fuel (TCF) use. These comments are prepared on behalf of Millersville citizens to provide several technical objections to the incineration of chipped tires in lime kilns (citing scrap tire burn information for facilities such as cement kilns and other sources). Redland Ohio Inc. submitted a PTI/PTO application for a Tire Chip Fuel System at its #1 Kiln Millersville dated November 27, 1995 (prepared by Robert J. Cox, environmental coordinator) to the Ohio EPA. Division of Air Pollution Control. Generally TCF use is referred to as energy recovery and recycling by industry and regulatory officials, but may also be described as a type of commercial waste incineration.

According to company document-- "Emissions Activity Category Form Process Information"-- in an application for OEPA Emissions Unit Id 0372000081 P005, Redland Ohio plans to burn a maximum 42.85% chipped tires (7,878 lbs/hr of 18,383 lbs/hr total fuel including 10,505 lbs/hr coal & pet coke) as replacement fuel for coal and petroleum coke. Table 1, Millersville Kiln #1: Current and Projected Average Emissions (application page 7) references zinc emissions based on 27.5% TCF: "e. 11.16 tons/hr x 550 #TCF/ton ..." which equals 27.5% tire chip fuel. Table 2 (application page 8) refers to 550 #TCF/ton or 27.5%. The exact percentage of TCF may not be as clearly represented as it needs to be in the application since two different figures may be calculated (27.5% and 42.85%). The highest TCF figure (42.85%) needs to be used in the emission rate tables, especially if Redland Ohio intends to try to burn more than 27.5% TCF.

Attached are three recent documents of special interest to your community and neighboring residents who are concerned about local industrial air pollution impacts: 1) August 23, 1996 letter from Communities for a Better Environment (CBE) sent to the Bay Area Air Quality Management District (San Francisco area) on Kaiser Cement Company's Tire Burning project at Cupertino, California which raises major health and environmental impacts due to toxic chemicals in TDF use; 2) September 11, 1996 U.S. EPA report on environmental health threats to children; and 3) October 23, 1996 reports (Sacrificing Science for Convenience) on the lack of good science being used to develop air quality standards for permit technical reviews (i.e., tire burning projects in states like Ohio), air modeling, and ambient air monitoring/sampling studies. A summary is given here of the three documents.

Attachment 1) The public concern about significant health and environmental impacts from toxic chemicals attributed to tire burning is expressed in the August 23, 1996 letter from the CBE group sent to the BAAQMD (San Francisco area) on Kaiser Cement Company's Tire Burning project at Cupertino, California.

• CBE's letter references a May 23, 1996 report prepared for the Kaiser Cement Company (called the CARNOT report) on toxic emissions associated with tire burning at the Kaiser facility evidently increased according to stack measurements and samples conducted during stack testing when tires were actually being burned in the cement kiln.

• The CARNOT report cites increased dioxin emissions of almost 100% and increased lead emissions by 1000% when tires are burned.

• CBE obtained through the Public Records Act earlier confidential data prepared by Kaiser Cement that estimated that benzene emissions alone would increased an average of 299% and could increase as much as 744%. Although the CARNOT report showed benzene emissions increasing by 12%, this is considered quite significant due to the huge amount of benzene already released by Kaiser according to previous calculations.

• Other toxic emissions also increased by burning tires. For example, a study conducted by two environmental consultants contracted by Kaiser Cement, Radian Corporation (now a subsidiary that is owned by Dow Chemical) and CARNOT, reported that hexavalent Chromium emissions would increase 937% from tire burning. PAHs (polyaromatic hydrocarbons) would increase 88% and earlier data prepared by the Air District staff estimated that PAHs would increase 1300%. Lead would increase by 700%. Mercury would increase by 15% over already high levels.

• Burning tires at other California cement kilns also indicated drastic increases in the emissions of air toxics. CBE cites stack tests at RMC Lonestar Davenport Cement Plant when burning 30% tires: chromium emissions increased by 727%, lead by 388%, PAHs by 2190%, and benzene by 126%.

• California Portland Cement Company, burning only 3.6% tires, increased its emissions of benzene by 744%.

Technical Questions about Redland Ohio Application to Burn TCF

The importance of the above information alone (and more on the following pages) is that it helps to refute (or at least call into question) some of information in the Redland Ohio application which seems to be suggesting air toxics are an insignificant issue in burning tires, either whole or chipped material. For example, the Redland Ohio application (see page 6, last paragraph) states that "Arsenic, beryllium, mercury, and nickel do not exist in detectable amounts in TCF. [6] Therefore, burning TCF in place of coal/coke has no probability of increasing the emissions of these metals." I have a question about the mercury detection limit which was not listed in the Redland Ohio application, since it was citing a reference 6 (apparently not sent to me). The CBE letter's Attachment B emphasizes that mercury and nickel emissions were detectable with the mercury showing a small increase (nearly 15%) with tire burning while nickel decreased 27%; but arsenic, beryllium and cadmium were non-detectable. Of course, the larger issues are the the other known heavy metals including lead, chromium, and cadmium that Redland Ohio will emit, but suggests these emissions will not increase with tire burning.

1. Sulfur emissions and need for exact permit representations

Sulfur dioxide emissions may decrease compared to 100% coal/pet coke, but if the tires have a higher content than the coal/pet coke, it is possible for sulfur dioxide emissions to actually increase. Thus, this representation may be correct or it may be inaccurate. Redland Ohio needs to precisely represent the sulfur % of its coal (currently used) and where the coal originates from, since sulfur % are generally known for different coal sources across the nation. Recommendation is that Redland Ohio needs to stack test for sulfur dioxide emissions during TCF use and then precisely represent the sulfur % in its coal, petroleum coke and TCF fuels. Continuous emissions monitors (CEMS) for sulfur dioxide need to be installed and operated 24-hours a day, if they are not currently installed.

2. Nitrogen Oxides and need for permit representations

Nitrogen oxides emissions may decrease compared to 100% coal/pet coke firing and this is probably correct. Recommendation is that nitrogen oxides be stack tested also during TCF use and that NOx CEMS be required to carefully track compliance status during operations.

3. Carbon Monoxide

Carbon monoxide (CO) emissions may decrease or increase compared to 100% coal/pet coke firing depending upon combustion parameters. CO frequently increases in cement kilns burning tire fuels, but the lime kiln process appears to operate at a higher temperature. Texas Lehigh Cement Company at Buda, Texas recently requested a major CO increase and this was mainly in response to tire fuel use. Recommendation is that carbon monoxide be stack tested also during TCF use and that CO CEMS be required to carefully track compliance status during operations.

4. Particulate Matter

Redland Ohio estimates that particulate matter, or PM10 (particulate matter ten microns or less in diameter), will not increase with TCF use. Once again, PM10 measurements need to be conducted during a stack test to determine actual emission rate for comparison to coal/pet coke, and it is possible for the toxic chemicals attached to the PM10 to change in composition and volume with the TCF use. Unfortunately, as a general rule, the chemical composition of PM10 is not evaluated in stack testing protocols so the residents of Millersville will not learn if the PM10 emissions from Redland Ohio's stack have changed or not with respect to these characteristics.

Why are PM10 and fine particles (PM2.5) a major public health issue? Nitrogen oxides, sulfur dioxide, ammonia, particulate matter, VOCs and water vapor are all involved in the chemistry of the production of fine particulate matter

(PM2.5 or particles 2.5 microns or less in diameter). This fine particulate matter (PM2.5) is different from PM10, for which a national ambient air quality standard exists. From research articles and data presented to date, the processes leading to PM10 and PM2.5 are different.

Health studies indicate that significant health problems are associated with PM10 concentrations lower than the national EPA standard as well as with fine particle levels for which there are no current national standards (but US EPA may proposed a PM2.5 standard by late November 1996). Both PM10 and fine particles have been linked with human mortality in several important, peer-reviewed articles prepared by a group of researchers from the Harvard School of Public Health. Premature mortality has been conclusively linked to various increments of particulate air pollution, as have chronic respiratory diseases, hospital admissions and emergency room visits, aggravation of asthma symptoms, restricted activity days, acute respiratory symptoms and bronchitis in children.

At any rate, the PM10 air pollution and potential PM2.5 air pollution are additional significant health issues for the Millersville community. I doubt if any PM2.5 ambient air monitoring has been performed in the Millersville area.

5. Volatile Organic Compounds

These components appear to be remarkably low in the Redland Ohio stack emissions and may be correct assuming the combustion temperature remains high. Upset conditions in which temperatures drop sharply or oxygen levels drop significantly may be circumstances where combustion will be far from ideal. Was dioxin produced during coal/pet coke use? Redland Ohio makes no reference to dioxin testing, but coal has elemental chlorine and chlorides in it so coal combustion typically results in dioxin formation. The presence of heavy metals in the waste gas stream may act as catalysts to spur dioxin formation. Cement companies claim that dioxin is not created in tire burning, but a number of stack tests confirm that it can be formed depending upon parameters. Dioxin stack testing should be conducted to determine of dioxin is detectable in the stack gases.

6. Hydrogen Chloride

Hydrogen chloride (HCl) have been observed in stack tests from cement kilns and anecdotal reports by citizens of metal surfaces like copper, for example, turning green near kilns burning hazardous waste. Most chlorine in coal or tires would result in HCl formation and I concur that much of it will be scrubbed out, but it is possible for HCl emissions to escape from the stack exits without being 100% scrubbed. Stack tests should include HCl emissions characterization to confirm if HCl is emitted during TCF use.

7. Metals

Some preliminary comments have already been made with respect to metal emissions. Additional comments are provided later in this letter. Metals are a potential major environmental and health impact from this facility. Redland Ohio suggests that (see application page 5) ..."chromium, cadmium, lead and zinc are volatilized at kiln temperatures and become entrained in the kiln dust and product."

This may be correct, but I question if 99% of these volatilized metals will be consistently caught by the venturi scrubbers with 99% removal efficiency--unless they are well maintained 100% of the time. Do residents in Millersville have lime dust or related dust problems associated with Redland Ohio's operations? Dust emissions could be from point stack source and/or fugitives from roads and miscellaneous areas. Have soil samples been collected and analyzed for chromium, cadmium, lead and zinc? I recommend that such soil samples be collected to determine if there is a build up of these metals in soils around Millersville.

Lead emissions may be potentially large from Redland Ohio. Lead contamination is perhaps the most widespread environmental and public health problem in the nation, since lead based paints were used for decades in addition to lead from leaded gasoline and industrial sources like Redland Ohio. Any amount of lead air pollution today may be too much in Millersville, because there is already too much in the environment and from miscellaneous sources annually in the nation. Acceptable levels and standards for lead have been steadily lowered by the U.S. EPA as toxicologists learn more and more about the toxic nature of lead at extremely low levels. Lead air pollution from Redland Ohio could be the most serious environmental threat posed by the facility and more information is needed to more accurately assess the lead pollution in the Millersville area. Certainly the only safe limit of lead air pollution is zero.

Are there any other industrial lead sources in Sandusky County? What is the background lead concentration?

Toxic metals emitted by Redland Ohio are bioaccumulative in the area food chains and in citizens.

Attachment 2) Additional health concerns are raised by the September 11, 1996, U.S. Environmental Protection Agency Administrator Carol Browner announced the release of a major, new report – Environmental Health Threats to Children. The EPA's children report is important since it outlines actions the Clinton Administration is taking to protect the nation's children from hazardous chemicals and air, land and water pollution.

The new EPA report confirms what some public health experts have recognized for a long time and that is most modern pollution standards are not designed to safeguard the most vulnerable members of the nation--children--from exposure to pollution. The relevance of this report is it suggests that neither the state of Ohio nor local industry around Millersville are doing the maximum to safeguard the air, water, soil and food of children in your community.

How many children live in the Millersville community and surrounding area? Are there any schools, especially elementary and day care schools, located with one mile of the Redland Ohio facility?

Attachment 3) Two new reports of October 23, 1996 reports, Sacrificing Science for Convenience: Part I. Technical Evaluation of the Texas Natural Resource Conservation Commission's Effects Screening Level System, and Part II. Ethics, Threshold Limit Values, and Community Air Pollution Exposures, focus on the need for sound science in evaluating air toxics exposure experienced by the public and the lack of an adequate system of air toxics standards to assess ambient air exposure by the public. In other words, the EPA Ohio's air standards or guidelines may be inadequately designed to protect public health from toxic air pollution such as Redland Ohio emits.

I recommend that you request a copy of the EPA Ohio's policy and procedure for evaluating air toxics like VOCs and metals, and then compare it to these two new reports.

Tire Chip Fuel Use by Redland Ohio at Millersville, Ohio

Redland Ohio Inc. (ROI), a corporation in the state of Ohio, is seeking a state permit to modify an existing major lime manufacturing plant in Millersville, Ohio, which already emits air contaminants into the atmosphere of the state and into the downwind communities of Millersville.

Air emissions include millions of pounds of air pollutants, some which may be harmful to downwind residences including hazardous substances regulated under the Federal Clean Air Act's Title III, hazardous air pollutants or air toxics. Specifically, incineration of whole scrap or chipped tires (as tire-derived fuel or TDF) in lime kilns and cement kilns creates a broad range of toxic byproducts including dioxins, furans, polyaromatic hydrocarbons (PAH's), polychlorinated biphenyls (PCB's), and heavy metals such as mercury, lead, cadmium, arsenic, hexavalent chromium. Respirable particles are recognized as a health hazard and they are emitted by cement kilns normally in excess of one million pounds per year due to weak EPA and state regulatory standards.

Stack Tests at Southwestern Portland Cement Company During Tire Fuel Use

Stack tests confirms these hazardous air emissions; test burns of coal vs. TDF + coal by Southwestern Portland Cement Company's Victorville, California plant documents toxic byproduct emissions. Most of these pollutants and other harmful byproducts were emitted from the cement kiln stack exhaust, including heavy metals, which were present in the fuels (TDF and coal), kiln dust, clinker dust and raw mill feed. PCB's were not tested for specifically by Southwestern Portland Cement Company.

Stack testing at Southwestern Portland further confirms elevated rates of toxic byproducts including dioxins, furans, PAH's and heavy metals such as arsenic, beryllium, hexavalent chromium as total chromium, cadmium and mercury were released from the kiln stack. The tests were made with TDF replacing 24.6% of total Btu requirements for the kiln system (kiln plus calciner), and 12.83% came from tire chips and only 11.84% from whole tires.

Range of Toxic Byproducts Confirmed in Tire Incineration

The vast range of toxic byproducts including PCB's has been described in publications and other relevant examples of TDF test burn data according to the following articles and sources which may have been already submitted by citizens:

1) EPA report "Burning Tires for Fuel and the Tire Pyrolysis: Air Implications"; identified dioxins, furans, PAH's, PCB's and heavy metals including arsenic, hexavalent chromium and cadmium.

2) "Estimates of Organic Emissions TDF for RMC Lonestar and Southwestern cement kilns burning tires as fuel". Increased emissions of beryllium, cadmium, chromium, lead and mercury were released in some cases by one or more orders of magnitude in TDF/coal firing vs. 100% coal firing at Southwestern Portland Cement Company's Victorville plant; Kiln stack emissions indicated that burning TDF/coal compared to 100% coal produced higher emission levels of six furan congeners and total furans. Higher kiln stack emissions of total furans under TDF/coal firing increased 129%. Kiln emissions indicated burning TDF/coal produced higher emission levels of three dioxin congeners including the most toxic form (2,3,7,8 - tetrachlorodibenzo-p-dioxin) by 151%.

RMC Lonestar stack test data of TDF/coal burning resulted in elevated annual heavy metal levels: 379% (12/90 test) and 620% (9/92 test) higher lead emissions; 94% increased arsenic emissions (9/92); 29% higher mercury emissions (9/92); and 96% more zinc (9/92). Annual toxic byproducts were elevated: 2230% (12/90) and 58% (9/92) increased total TCDF emissions; and 1425% (12/90) and 398% (9/92) higher total TCDD emissions. Ten PCB congeners increased annually in 12/90 by 10%, 21%, 30%, 31%, 32%, 82%, 88%, 111%, 143% and 211%, and annually in 9/92 tests increased by 39%, 406%, 548%, 658%, 743%, 975%, 985%, 2955%, 4530% and 44,250%. Benzene was higher by 124% in 12/90 and formaldehyde increased by 1041% in 9/92. Methylene chloride increased by 84% annually in 9/92 and vinyl chloride increased by 79% annually in 9/92 tests.

3) Test burns in incinerators by the California Air Resources Board in which burning tires released dioxins, furans, PCB's, and other toxic byproducts.

4) "Dioxins, furans, arsenic, mercury, cadmium, nickel, PAH's, and PCB's" are released when burning tires.

5) "It has been documented that copper, manganese, mercury, napthalene, phenol, toluene, xylene, chlorobenzene, arsenic, beryllium, nickel, lead, hexavalent chromium, formaldehyde, acetaldehyde, PCB's, dioxin and furan are released into the atmosphere from tire burns".

6) Tire burning creates numerous toxic organic compounds such as polynuclear aromatic hydrocarbons (150 micrograms/gram of bottom ash; 294-420 micrograms/ gram in fly ash), including naphthalene and others, as well as toxic metals such as cadmium. Prof. Ja-Kong Koo and Seol-Wan Kim of the Department of Civil Engineering, Korea Advanced Institute of Science and Technology conducted a detailed analysis and published an article concluding that tire burning produces numerous byproducts of incomplete combustion. "Characterization of Combustible Products and Residue from Full Scale Gasification Processing of Waste Tires."

7) Edward W. Kleppinger, Ph.D., concluded in a scientific paper that tire burning is likely to increase carbon monoxide, particulate, zinc and/or PAH emissions. He recommends that whole tires should not be burned in cement kilns. E. Kleppinger, Ph.D., "Tire Burning by Cement Kilns: An Approach to a Policy."

8) Dr. Kleppinger also issued another paper comparing tire burning to coal in the cement industry for the Ash Grove Cement Company's proposal to burn tires as fuel. Dr. Kleppinger concluded that tire burning increases chromium emissions by almost 500%, nickel emissions by over 450%, lead emissions by an extraordinary 7 to 91 times, and cadmium emissions by five to ten times. EWK Consultants, Inc., E. Kleppinger, "Comments on Ash Grove Cement's Proposal to Burn Tire Derived Fuel." (October 25, 1990); see also, EWK Consultants, Inc., Letter from Dr. E. Kleppinger to Assistant Director for Air Quality Regarding Proposed Operating Permit No. 0381-95 Phoenix Cement Co. (August 10, 1992).

9) Study by RMC Lonestar Davenport Cement Plant, May 1, 1992, at Davenport, Cal. "Preliminary Evaluation of RMC Lonestar Davenport Cement Plant: Proposal to Conduct Testing on the Use of Whole Rubber Tires as a Supplementary Fuel in the Cement Manufacturing Process." RMC's study concluded that burning 30% tires in a cement kiln and 70% coal significantly increased toxic emissions over burning 100% coal. Toxic chemical emissions found to increase when burning tires with coal rather than burning 100% coal include:

a)	Tetrachlorodibenzofuran (TCDF):	2,230% increase;
b)	Tetrachlorodibenzodioxin (TCDD):	1,432% increase;
c)	Total polychlorinated biphenyls (PCBs):	2,608% increase;
d)	Chromium (hexavalent):	727% increase;
e)	Lead:	388% increase;
f)	Naphthalene:	23,938% increase;
g)	Acenaphthylene:	18,836% increase;
h)	Phenanthrene:	1,824% increase;
i)	Anthracene:	2,775% increase;
j)	Pyrene:	1,089% increase;
k)	Flouranthrene:	291% increase;
l)	Total toxic PAH's:	2,190% increase;
m)	Benzene:	126% increase.

This report concluded that potential impacts from long-term tire burning warrant "a more extensive review of health and environment impacts under the California Environment Quality Act (CEQA)." Elevated cancer risk was estimated from the cement kiln when burning tires to approach approximately 5 in a million, a risk far higher (by 77 times) than the California Portland Cement Company's estimate of 0.065 in a million, and 5 times higher than the CAPCOA and California's significance threshold of one in a million. The RMC report further states that the 5 in a million estimate omits consideration of noninhalation cancer risks from the highly toxic chemicals arsenic, cadmium and PCBs.

Kern County Superior Court Judge Roger Randall ruled November 30, 1995 that the local air pollution control district acted improperly by denying citizens a public hearing. The judge signed an injunction ordering Cal Portland to stop burning whole tires and to remove the TDF equipment immediately and until a public hearing is conducted to determine of the project is safe.

10) "U.S. EPA Draft Chapter on Dioxin Risk Characterization" (May 2, 1994). The EPA's draft report, compiled after three years of exhaustive review of existing scientific literature and important new laboratory and epidemiologic studies,

concludes that dioxins (polychlorodibenzodioxins or PCDD's) and related compounds such as PCB's and polychlorodibenzofurans (PCDF's) are definitely much more dangerous than scientists previously believed. The EPA study further establishes that dioxin not only causes cancer in humans, but that it also exhibits reproductive effects at even lower thresholds than for cancer. This information is highly significant because it means that the cancer risks and other health risks from increased dioxin emissions during cement kiln tire burning may be much more serious than previously believed, and that no tire burning cement kiln risk assessment have been carried out, therefore may have significantly underestimated these health risks. The applicant and the state of Ohio have both failed to adequately assess the cancer risks and other health risks associated with increased dioxin emissions during tire burning.

11) "U.S. EPA Health Assessment Document for 2,3,7,8 - Tetrachloro-dibenzo-p-Dioxin (TCDD) and Related Compounds" (August 1994) is a 2,400 page draft compendium reassessing the toxicity of, and human exposure to, dioxin. A team of thirty-nine scientists were appointed to the EPA's Dioxin Reassessment Review Committee to assemble and analyze data on dioxin sources, environmental levels, exposures, and human body burdens. The team of scientists worked three years to compile the most comprehensive scientific study to date of the health effects of chlorinated dioxins (PCDD), chlorinated furans (PCDF), and chlorinated biphenyls (PCB). The study concludes that these chemicals are indeed highly carcinogenic, and that they display disturbing reproductive toxicity at even lower levels than for cancer. The study further concludes that cement kilns and "incineration of ... used tires for power/energy generation" are among the major sources of the release of the highly toxic dioxins and furans. Id. at 9-9 and 9-10.

12) EPA, "A Science Advisory Board Report: A Second Look at Dioxin" (September 1995). The SAB committee concludes the report by emphasizing it ... "agrees that the scientific evidence strongly indicates that current levels of dioxin-like compounds in the environment derive from anthropogenic sources and that the air-to-plant-to-animal pathway is most probably the primary way in which the food chain is impacted and humans exposed" (p. 97). The point is that, if cement kilns burn tires, then they and other anthropogenic sources in Ohio will certainly be important contributors to dioxin-like compounds.

The SAB's report concludes that cumulative impacts is a significant issue for dioxin-like compounds and this type of holistic review is scientifically relevant. "In addressing a broad range of dioxin-like compounds having the common property of binding to the Ah receptor, and producing related responses in cells and whole animals, it creates opportunities for a holistic assessment of the cumulative impacts of these broadly distributed anthropogenic pollutants [emphasis added]. Thus, while the environmental concentrations of each compound alone may be too low to produce effects of concern, the combined exposures may be producing effects that warrant concern" (p. 98) [emphasis added]. The SAB report clearly supports source and exposure reduction and not the creation of new dioxin and dioxin-like emissions. The report succinctly demonstrates why cement kilns like North Texas Cement Company at Midlothian, for example, inappropriately excluded cumulative impacts of air pollutants from its application and why the state of Ohio needs to require a holistic assessment of the cumulative impacts of dioxin-like compounds and all other toxic substances emitted by TDF proposals.

13) Joe Thornton, Greenpeace report, "Chlorine, Human Health and the Environment: The Breast Cancer Warning." (1993) Chlorinated dioxins, PCB's, chlorinated furans and other organochlorines cause significantly increased risk of cancer -- especially breast cancer. (As noted in other studies, cement kiln tire burning increases chlorinated dioxin, chlorinated furan, and PCB emissions). This information is important because it strongly suggests that cement kilns have seriously under estimated health risks posed by the tire burning project, and its releases of dioxins, furans and PCB's. The state of Ohio has failed to conduct an adequate review of the cement kiln tire burning projects by ignoring the relevant health risks correlated with these TDF projects.

14) Memo from Pat Costner to Emilia Guglielmi (June 14, 1994). Tire burning at a Modesto incinerator released quantities of polychlorinated dibenzo-dioxins (PCDD's) and polychlorinated dibenzofurans (PCDF's) at the rate of 0.0236 grams per year of the most toxic congener -- 2,3,7,8 - tetra- chlorodibenzo-p- dioxin. This amount of dioxin exceeds the acceptable lifetime intake for 2 million people, based on U.S. EPA risk calculations.

Pat Costner also concluded that annual emissions of polycyclic aromatic hydrocarbons (PAH's), which include compounds that metabolize to carcinogenic chemicals, increased from 30.35 pounds per year when a cement kiln was burning 100% coal to more than 11,000 pounds per year when 10 - 18% of the coal was replaced by chipped tires -- an increase of 362 times (36,244%). The replacement of 10 - 18% of coal with chipped tires was accompanied by the release of dioxins and furans that were equivalent to 19,790,000,000 picograms of 2,3,7,8 - TCDD (the most toxic dioxin congener) per year. This quantity of dioxin exceeds U.S. EPA's estimated acceptable lifetime intake, for cancer effects alone, for more than 1.8 million people. Emissions increased by 30% in 2,3,7,8 - TCDD equivalents during the same tire substitution. The dioxin increase of 0.0198 grams TEQ per year exceeds the acceptable lifetime intake for more than 1.8 million people, based on the U.S. EPA's risk specific dose estimate.

15) "Report of Air Pollution Source Testing of a Cement Plant Rotary Kiln Fired on Rubber Tires and Coal at Mitsubishi Cement Company, Lucerne Valley, California" with 20% TDF burning (October 21 - 23, 1993). Particulate emissions significantly increased by 419% with TDF use, and recent epidemiologic studies by the Harvard School of Public Health and other researchers conclude that particles (PM10 equal to or less than ten microns) at levels well below the existing EPA and California PM10 standards cause increased mortality rates in a study of over 8,000 adults living in six U.S. cities (D. W. Dockery et al. 1993, "An Association between air pollution and mortality in six U.S. cities," New England Journal of Medicine vol. 329, 1753 - 1759).

The fine particulate emissions from Redland Ohio's proposed cement plant may be unsafe considering that the state of Ohio's environmental protection agency has adopted the same unsafe PM10 standards as the EPA.

Association was made between ambient air pollution data from 151 U.S. metropolitan areas with individual risk factors on 552,138 adults who resided in these areas in which the investigators concluded that particle air pollution was associated with cardiopulmonary (i.e., heart attacks) and lung cancer mortality (C.

A. Pope et al. 1995, "Particulate air pollution as a predictor of mortality in a prospective study of U.S. adults," *American J. of Respiratory and Critical Care Medicine* vol. 151, 660 - 674).

Increases during TDF use were measured in kiln baghouse exhaust stack emissions of PAH's including napthalene, phenanthrene, fluoranthene, benzo-a-anthracene, chrysene, benzo-a-fluor-anthene, benzo-k-fluoranthene, benzo-e-pyrene, and benzo-ghi-perylene. Increases occurred in more than eleven dioxin congeners including TCDD and total dioxins. Several dibenzofuran congeners increased. Metals increased in one or more samples including arsenic, barium, beryllium, cadmium, hexavalent chromium, lead, manganese, mercury, nickel, selenium, thallium and zinc.

16) Research is a suggesting that the vapor phase chemistry of trace metals may not adequately tested including hexavalent chromium, mercury and arsenic. Concluded that significantly higher concentrations of three heavy metals than expected (chromium, lead and arsenic) may remain preferentially entrained in the vapor phase during combustion of fuels and waste derived fuels containing these metals. Stack sampling trains may not adequately collect samples to account for total vapor phase metals using current sampling protocol. New research demonstrates that test burns of TDF may under estimate emissions of chromium, lead and arsenic. Atmospheric pollution of chromium, lead and arsenic from cement plant's cement kilns during tire burning may have under estimated by failing to adequately collect metal samples during test burns.

The combustion of hazardous substances including many chemicals in tires is simple in theory but difficult in practice as cement kilns's and other kiln stack testing demonstrate with TDF/coal firing. Theoretically, if an organic hazardous substance is heated high enough (temperature), for long enough (residence time), with thorough mixing (turbulence), and enough oxygen, complete combustion will occur. The problem with the lime kiln proposal similar to the cement kiln tire burning concept, in some cases to replace coal with TDF, is that they are trying to take a very complex piece of process combustion equipment which was designed to burn powdered coal and use it to burn a cheaper fuel. This typically degrades combustion efficiency.

While chemically coal and TDF are somewhat similar, there are two basic differences in how they each are handled at cement kilns. First, coal is finely pulverized before being blown by hot air into the kiln. TDF may be fed as whole tires or scrap shredded tires. It is well documented that finely divided organic powders mixed with air will combust so rapidly as to be explosive (i.e. grain elevator explosions due to grain dust spontaneous ignition). Whole tire burning is especially bad, but even tires chips two inches by two inches are significantly larger than pulverized coal.

where A R feed

A second difference is that most of the coal feed is to the front end (hot end) of the kiln where residence times and temperatures are higher (thus more efficient combustion), than with the TDF feed into the kiln exit. In fact in some cases, the TDF is not really even fed into the kiln but is introduced into the preheater riser duct of the precalciner/preheater system via a tire slide and two air lock flap gates. A receiving conveyor system, elevator and final conveyor with weigh bridge rollers transport the whole tires into the tire slide chute. The point is basically that with use of TDF, cement kilns are degrading the combustion efficiency of their system.

Lime Kilns and Cement kilns are not designed to burn waste tires:

A clinker production system such as that run by cement kilns (and processes such as lime kilns) are designed to get as much of the heat value (Btu) of the fuel into the product as is possible. It is a common misconception that this design goal means that all (100%) of the fuel is combusted so that there are not environmentally harmful byproducts. In fact, in order to achieve the system's design goal, the amount of air entering the system must be kept to a minimum. This lowers the effective oxygen concentration. Cement kilns typically run at very low excess oxygen levels, contrary to environmentally good combustion. The reason for this is very simple. In order to get a unit of oxygen into the kiln combustion process, you also take four units of inert material like nitrogen. All five units take up heat energy in order to heat up to the combustion temperature. The result is it leaves less heat for clinker production. Adding excess air to get more oxygen also causes the air pollution control equipment performance to degrade, if clinker thru put is not decreased, and puffing of combustion gases from the kiln, as fan capacities are typically limited.

The point is quite simple. The cement kiln system was not, and is not, designed as a combustion device to destroy hazardous substances containing wastes placed in it. The original cement kilns kiln system is being utilized for such projects. Cement companies and state of Ohio emphasize, under the permits that these project do not involve the installation of any new air pollution control equipment or the modification of existing air pollution control equipment.

The cement kiln system was designed to efficiently make a product. It was not designed to burn hazardous substance containing wastes even if TDF is not designated as a hazardous waste. In my view, it is not good public policy to allow hazardous substance containing wastes to be burned in a device simply because of its availability.

Another major flaw in cement kilns tire burning applications is failing to account for the hysteresis effect (temporary retention of organic compounds) during test burns of TDF which may have introduced another significant source of error into the modeling and risk assessment. The hysteresis effect is defined as: "the retention of POHCs [principal organic hazardous constituents] within the combustion system leading to their continued appearance in stack gases for prolonged periods of time after their flow into the combustion system has been stopped" by Costner and Thornton. Complete combustion or destruction removal efficiency of organic compounds may be seriously flawed by this discovery. POHC emissions of two surrogate compounds, carbon tetrachloride and chlorobenzene, have been measured two hours after stopping the flow into a pilot-scale boiler, since the two POHCs were still present in stack gases at concentrations 121 % and 388 %, respectively, of their concentrations in the stack gas samples taken during feeding into the boiler.

In a report "Playing with Fire" by Pat Costner and Joe Thornton, Greenpeace, 1990, they conclude that hazardous waste incinerators are prone to experience a hysteresis effect during trial burns, and propose that cement kilns may be even more prone to hysteresis effect due to the large surface within the furnace and pollution control devices to make POHC retention. Several other studies have confirmed the hysteresis effect as being real and measurable in boilers.

Cement kilns may be particularly susceptible since they typically require seven days or more to reach materials input/output equilibrium according to Southwestern Portland Cement Co. study. Hysteresis was first reported in a study by Mason in 1988 stating that "stack concentrations of waste species continued for several hours after waste firing was curtailed" during trial burns of a boiler. Other researchers are confirming the potential for serious hysteresis effects and significantly underestimating stack emissions during stack tests while burning whole or scrap tires in a cement kiln. Does this occur in lime kilns? Probably.

Dr. Kleppinger also concludes that "the nature of the clinker kiln system results in a significant hysteresis effect. When changing fuels, it takes days for the system to fully equilibrate." The hysteresis effect was completely ignored in the lime kilns's application to burn tires and by state of Ohio in reviewing the application. The conclusion is that the levels of dioxins, furans and polyaromatic hydrocarbons emitted by lime kilns during tire burning may be significantly under estimated in the air modeling and risk assessment for lime/cement kilns seeking to burn tires.

Major industrial upsets pose a significant public health concern to downwind communities since the air pollution from these accidents are prone to adversely affect citizens far more than normal daily plant emissions, and in my opinion this is applicable to the Redland Ohio plant.

Based upon my professional experience as a Texas Air Control Board field investigator inspecting over a dozen major industrial plants (classified as major source air emitters by the Environmental Protection Agency) for nearly twelve years, and since my TACB experience included investigations of about 1,000 citizen complaints of air pollution related to emissions from such facilities, I am aware that industrial facilities--large and small--release air pollution in concentrations and durations sufficient to adversely affect communities at distances of several miles like the nearby community, Millersville, Ohio which is within several miles of ROI's lime plant. Additional communities may also be impacted.

Industrial plant major upsets such as will likely be experienced by the Redland Ohio lime plant can readily produce quantities of emissions that are characteristically several-to-many times worse than normal emissions and are far more likely to result in citizen complaints of air pollution compared to normal emissions.

My state TACB professional experience taught me that--as a General Rule--citizens tended to complain of air pollution, including industrial emissions, when they are being adversely affected even to the point of experiencing health problems and tend not to make complaints if the air pollution is not resulting in nuisance odors, toxic dust or other adverse affects including health.

Industrial incidents I investigated on behalf of the TACB that did result in multiple complaints were, as a general rule, major upset events in which dozens of citizens made phone calls to the TACB, the fire department and/or police primarily because the air pollution was much higher in volume and greater public impacts resulted compared to normal levels of industrial emissions.

I am concerned that Redland Ohio's emissions may cause or contribute to adverse health effects which will reported by nearby residents based upon the facts and my knowledge of air pollution.

Recently in early 1996, Mary Risinger of Midlothian, Texas informed me that she has been experiencing adverse health effects associated with burning tire odors and tire smoke-like smells both inside and outside her home. Her home is located approximately two miles from Holnam's cement plant (single cement kiln with dry process technology) which burns shredded tires in a dry process cement kiln. Her tire odor and tire smoke smell directly contradicts testimony by state officials who do not live at Midlothian, Texas. She has reported a number of air pollution complaints to the Texas Natural Resource Conservation Commission alleging that the tires are not being burned safely at the cement plant, since she is experiencing health problems when the wind blows from the nearby tire burning cement plant. Some of her concerns were expressed in a letter sent to state senators. Apparently other Midlothian residents are also making air pollution complaints to state officials other burning rubber tire odors who live downwind for more than 2 - 5 miles of Holnam's cement plant.

I believe that both the state of Ohio and local cement companies have painted an artificially safe picture of air pollution emitted by cement kilns when they burn rubber tires. My concern is that the same predicament appears to be happening in Ohio and citizens need to be vigilant to protect their health, safety, welfare and environmental quality. Home owners property values may also be deleteriously impacted if the air pollution produced by Redland Ohio is sufficient enough to drive residents away and having to sell their homes and property in a market condition with few interested buyers.

It's my professional opinion that Millersville community residents living downwind of Redland Ohio, even up to several miles, may complain of nuisance air pollution from Redland Ohio's lime kiln due normal plant emissions and even more from major upsets if it is allowed to be granted state permits to incinerate chipped rubber tires.

Respectfully yours,

Neil J. Carman

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STATE OF TEXAS §
§
COUNTY OF TRAVIS §

AFFIDAVIT

BEFORE ME, the undersigned authority, on this day personally appeared NEIL J. CARMAN, Ph.D., the Clean Air Program Director for the Lone Star Chapter of the Sierra Club, since 1992 and a former state field investigator for the Texas Air Control Board (1980-1992) where he inspected industrial facilities (including incineration sources in which he supervised a stack sampling team and observed consultants performing stack testing) for compliance with state and federal air pollution regulations and laws, who being duly sworn, states that he is of sound mind, that he is over 21 years of age, that he has never been convicted of a crime, that he is fully competent to make this affidavit, that he has personal knowledge of the facts stated herein and all such facts are true and correct.

1. Tire-derived fuel use can produce emissions of many types of products of incomplete combustion (PICs) which include a broad range of organic compound species and a broad range of inorganic compounds and elemental substances (especially certain metals). Facilities include boilers, cement kilns, incinerators and other sources.

2. Documents reviewed by myself indicate that one or more PAHs (Poly cyclic Aromatic Hydrocarbons which are organic compounds containing two or more benzene rings) may be produced during incineration of tire-derived fuels. PAHs are sometimes also referred to as PNAs (Poly Nuclear Aromatics).

3. Documents reviewed also indicate that chlorine-containing types of PAHs, including PCBs (Poly Chlorinated Biphenyls which are organic compounds containing two benzene rings with one or more chlorine atoms) may be produced during incineration of tire-derived fuels.

4. PAHs and PCBs are considered products of incomplete combustion and should be tested for during stack performance tests to comprehensively evaluate the types of emissions produced as a result of tire-derived fuel use during combustion and to carefully evaluate the efficiency of the combustion unit along with the air pollution control devices.

5. A 1991 EPA reference document, "Burning Tires for Fuel and Tire Pyrolysis: Air Implications," cites numerous examples of stack tests at different facilities confirming that PAHs and PCBs may be produced and emitted as a result of tire-derived fuel use. The publication number is EPA-450/3-91-024, December 1991, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.

6. Additional references citing PAHs and PCBs being tested for (and generally with one or more PAHs/PCBs being identified) include the following but this is not intended to provide a comprehensive list since there are many other stack tests across the United States and in other nations demonstrating that PAHs and PCBs may be produced from tire-derived fuel burning:

- Ohio Air Quality Development Authority. Air emissions associated with the combustion of scrap tires for energy recovery. May 1991

- The Almega Corporation. Source test data for Modesto Energy Project, Westley, CA. The Oxford Energy Company. October 9-10, 1990.

Affidavit
Neil Carman, PhD

6. Additional references to stack testing for PAHs and/or PCBs:

- Results of Kaiser Cement's Tire-Derived Fuel Demonstration Project, presented at community meeting May 23, 1996 held by the Bay Area Air Quality Management District, DeAnza College, Cupertino, California. Information presented indicated that the Kaiser Cement's Santa Clara County facility performed stack testing and the results showed elevated levels of PAHs (88%), benzene (12% above already high levels of 2.0 lbs/hr) and other organic species like dioxin (100% in TEQ increase) plus rather large increases in several metals such as hexavalent chromium (937%). Lead increased 700%. Mercury increased 15%. PCBs were sampled and analyzed.

- Results of Kaiser Cement's Tire-Derived Fuel Demonstration Project, Report by Radian International, Cupertino, Santa Clara County, California cement plant. Issued April 16, 1996.

- Results of Kaiser Cement's Tire-Derived Fuel Demonstration Project, data in the Carnot Emissions Test Report, Cupertino, Santa Clara County, California cement plant. April 16, 1996.

- Prof. Ja-Kong Koo and Seok-Wan Kim of the Department of Civil Engineering, Korea Advanced Institute of Science and Technology conducted a detailed analysis and published an article concluding that tire burning creates numerous toxic organic compounds such as polynuclear aromatic hydrocarbons (150 micrograms/gram of bottom ash; 294-420 micrograms/gram in fly ash), including naphthalene and others, as well as toxic metals such as cadmium. Koo and Kim, "Characterization of Combustible Products and Residue from Full Scale Gasification Processing of Waste Tires."

- Edward W. Kleppinger, Ph.D., concluded in a scientific paper that tire burning is likely to increase carbon monoxide, particulate, zinc and/or PAH emissions. He recommends that whole tires should not be burned. E. Kleppinger, Ph.D., "Tire Burning by Cement Kilns: An Approach to a Policy."

- "Preliminary evaluation of RMC Lonestar Davenport Cement Plant: Proposal to Conduct Testing on the Use of Whole Rubber Tires as a Supplementary Fuel in the Cement Manufacturing Process: May 1, 1992. Study concluded that burning 30% tires in a cement kiln in addition to coal significantly increased toxic emissions over burning coal alone. PAH species increased including naphthalene (23938%), acenaphthylene (18836%), phenanthrene (1824%), anthracene (2775%), pyrene (1089%), fluoranthene (291%), and total PAHs (2190%).

Affidavit
Neil Carman, PhD

6. Additional references to stack testing for PAHs and/or PCBs:

• Amtest. State of Washington, Depart. of Ecology. Rubber tire chip trial burn. Holnam Inc. Industries. Stack testing and Chemical Analysis. October 15-19, 1990.

• Source test for Boise Cascade Lime Manufacturing Facility, Walluloa, WA. Prepared fir Washington Department of Ecology. Test date: May 20, 1986.

• Memorandum from Clark, C., PES, to Michelitsch, D., EPA/ESD/CTC. November 8, 19091. Site Visit --- Holnam, Inc./Ideal cement.

• Washington State Department of Ecology. Polynuclear Aromatic Hydrocarbons and Metals Emitted from the Burning of Tires at Crown Zellerbach, Port Angeles, WA. June 10 and 11, 1986. Source test 86-10a.

• Washington State Department of Environmental Source Test Summary of Emissions to Atmosphere from Port Townsend Paper Co., Port Townsend, WA. February 25 and March 5 , 1986. Report no. 86-01.

• Drabek, J., and J. Willenberg. Measurement of Polynuclear Aromatic Hydrocarbons and Metals from Burning Tire Chips for Supplementary Fuel. Washington State Department of Ecology. Presented at 1987 TAPPI Environmental Conference. Portland, Oregon. April 26-29, 1987. 12 pp.

• Northern States Power Co. Alternative Fuel Firing in Atmosphere Fluidized-Bed Combustion Boiler. EPRI CS-4023. Final Report. June 1985.

7. It is strongly recommended that a broad range of PAHs and PCBs be sampled and analyzed for during stack tests of tire-derived fuel use in any combustion facility.

FURTHER, AFFIANT SAYETH NOT.

Neil J. Carman

NEIL J. CARMAN, Ph.D.

NEIL J. CARMAN, Ph.D.
Printed or Typed Name of Affiant

SUBSCRIBED AND SWORN TO before me on this the 2nd day of January, 1997, by NEIL J. CARMAN, Ph.D. to certify which witness my hand and seal of office.

Deborah S. Cameron

NOTARY PUBLIC IN AND FOR THE STATE OF TEXAS

NOTARY PUBLIC STATE OF TEXAS
DEBORAH S. CAMERON
Notary Public, State of Texas
My Commission Expires Sept. 8, 1999

STAMPED/PRINTED NAME OF NOTARY

My Commission Expires: ________

EIS ordered on Heartland

By John Torgrimson, Fillmore County Journal (Minnesota)

Friday, January 28, 2005

Opponents of the Heartland tire plant, many of whom testified at the MPCA hearing in St. Paul Tuesday night, celebrate the 6 to 1 vote by the Citizens' Board calling for an environmental impact study. The meeting lasted 7 hours, with more than 100 people in attendance. Photo by John Torgrimson

Every once in awhile David gets lucky and beats Goliath. Such was the case Tuesday night in St. Paul when the Minnesota Pollution Control Agency Citizens' Board rejected a PCA staff recommendation and ordered that an Environmental Impact Statement was necessary before an air permit could be granted to the proposed Heartland tire-burning plant in Preston.

Voting 6 to 1, following seven hours of testimony from more than 40 people, the Citizens' Board passed a resolution stating that the Heartland Energy & Recycling LLC tire plant has the potential for significant environmental effect.

The plant, which would burn 10 million scrap tires annually using fluid bed boiler technology planned to generate 20 megawatts of electricity.

The action by the Citizens' Board reversed nearly two years of PCA findings of fact supporting the technology behind the plant.

On February 25, 2003, the PCA decided that a basic Environmental Assessment Worksheet was sufficient in meeting the plant's obligations for an air permit and that a more thorough EIS was not needed. This decision was challenged by Southeastern Minnesotans for Environmental Protection (SEMEP) in court and on February 17, 2004, Olmsted County District Judge Joseph Wieners remanded the matter back to the PCA saying that the regulatory agency should take a "hard look" at its findings of fact regarding the plant. This resulted in the PCA staff drafting a Supplemental Environmental Assessment Worksheet responding to the Judge's order. This was what the Citizen's Board turned down on Tuesday.

Layer upon layer of testimony was given by a number of people, including representatives from SEMEP, Citizens Against Pollution, Southern Minnesota Action Committee, the League of Women Voters, and the Sierra Club. Resolutions calling for an EIS from several communities, townships and counties were read into the record. Participants came from as far away as Onalaska, Wisconsin and Decorah, Iowa.

Particularly crucial, was testimony from three doctors from the Zumbro Valley Medical Society (ZVMS) which challenged the risk analysis carried out by PCA and Minnesota Department of Health staff. The medical society includes health professionals from Dodge, Fillmore, Houston, Olmsted and Winona counties.

Dr. Roy House, a pediatrician from Rochester, focused on particulate matter less than 2.5 microns in size that would not be captured through pollution control devices.

"This is more like a gas, similar to cigarette smoke that will lodge in the lungs and may cross over into the blood stream," House testified. "Particulate matter has been correlated to decreased lung growth in children."

House said that the Academy of Pediatrics has recommended that health standards regarding particulate matter should be revised and reviewed.

House also talked about the bio-accumulation of lead from emissions.

"There are far too many unanswered health issues. And particulate matter is on top of the list," House said.

House was followed by Dr. Fred Nobrega, the director of the ZVMS, who talked about dioxin and mercury. Nobrega noted that Rochester already has the highest incident of asthma in the state of Minnesota.

“Mercury is an element that vaporizes and is the most difficult to capture from pollution control,” Nobrega said.

Dr. John Hodgson, a specialist in industrial toxicology, then focused on the historical and potential health effects of emissions.

“The criteria (for an air permit) can only be adequately filled by an EIS,” Hodgson concluded.

The motion calling for an EIS, which was presented by Dr. Daniel Foley of the Citizens’ Board, highlighted the fact that there were unresolved issues related to public health and the environment given the nature of the plant.

Foley, referring to the potential Heartland discharge as the “soup down there,” cited in particular:

•the distribution of heavy metals;

•the discharge of particulate matter generated from the plant and diesel transport that would deliver the tires;

•the accumulation of dioxin, furons and mercury;

•the technology surrounding the fluid bed boiler using tire-derived fuel;

•concerns over the storage of hazardous ash residue;

•and the reversibility of pollution, in particular mercury.

PCA Commissioner Sheryl Corrigan, who chaired the meeting, was the only member of the Citizens’ Board to vote against Foley’s resolution.

On two occasions Corrigan recessed the meeting to allow PCA staff time to address specific questions raised in the testimony.

Heartland developer Bob Maust, his attorney Andy Brown, and project consultants, did not testify except to answer specific questions.

When the roll call vote was announced, the room erupted in applause and celebration. Many in attendance seemed stunned by the decision as the Citizens’ Board is not known for going against the recommendations of its staff.

The call for an EIS for Heartland comes almost three years to the day that the Preston City Council voted to grant Heartland a variance for a 210 foot smokestack for the plant. The subsequent publicity led to some of the first challenges to the plant by citizens who started attending council meetings and asking questions. On Tuesday, their hard work and perseverance seems to have paid off.

As one celebrant said after the vote, “this is what democracy is all about.”

Problems with Tire Burning

Tire Incineration and Cement Kilns: Are the Risks Really Worth It?

by MEIC Board Member John W. Ray

One of the pernicious effects of rising energy costs is that industrial plants such as cement kilns are looking around for cheaper sources of energy. Unfortunately, some of the energy sources they will find are very harmful to human health and the environment. Such is the case with the proposal by Holnam Cement Co. to burn waste tires in its cement kiln in Trident, Montana. Burning tires in cement kilns poses severe threats to the environment.

Tires are not benign substances to burn. According to information supplied by both tire manufactures and the cement kilns that burn them in other states, the following is a partial list of what tires contain: aluminum, which is harmful to animal and plant cells; antracene, which is a probable carcinogen; aromatic extender oils, which comprise about 25% of most tires today and which are known carcinogens; arsenic, a known poison; benzene, which can effect the blood and is a carcinogen; benzidine, a carcinogen; beryllium, which harms the respiratory system; butadiene, which is a carcinogen; and cadmium, which harms the liver. The list goes on and on. This list only goes through the letter "C." Tires also contain lead, and have a high sulphur content that, when burned, produces sulfur dioxide.

All these substances are harmful in and of themselves when released into the atmosphere. However, when tires are burned in a cement kiln new and even more deadly compounds are also produced . The most deadly are dioxins. There are no safe levels of exposure to dioxin.

The U.S. EPA says: "Exposure to dioxin, even at minute levels, poses cancer risks and health concerns wider than previously suspected, including possible damage to the immune and reproductive systems." Dioxins are also linked to endometriosis and can diminish intellectual capacity. Most dioxins leave cement kiln stacks without detection. Cement kilns, according to the EPA, account for about 20% of the dioxin emissions in the United States. Burning tires will only increase that production.

In general the United States, according to botany professor Mary O'Brien, is between 10 and 100 times over the safe level of dioxin. She states: "So if one inch were an okay amount of dioxin in the environment, we are somewhere between ten inches and eight feet tall in dioxin." In terms of dioxin, the reasoning is crystal clear:

1. dioxin is a dangerous toxic agent;
2. there are no safe levels of exposure to dioxin;
3. most people have been exposed to about all the dioxin their bodies can tolerate; and
4. cement kilns are a major source of dioxin emissions.

It is important to remember that the EPA in general believes that there are no safe levels of exposure to carcinogens. "EPA considers carcinogens to be non-threshold substances, i.e. any dose or exposure to a carcinogen is assumed to present some increased risk to an individual of developing cancer. As a result there are no safe levels of exposure to carcinogens." (Source: Kathryn Kelly, "Health Risk Assessment of Hazardous Waste Incineration Stack Emissions," Hazardous Waste and Hazardous Materials, Vol. 3.)

Even given state-of-the-art technology, hazardous substances will be emitted from a cement kiln burning tires. Tires contain heavy metals. Heavy metals cannot be destroyed by incineration and the high temperatures in cement kilns can actually lead to more heavy metals being released into the atmosphere. Between 20% and 53% of heavy metals incinerated in facilities such as cement kilns are released into the air. Incineration also makes these heavy metals more bio-available. Heavy metals are major neurotoxins and can damage the lungs, kidneys, liver, and pancreas. Children are particularly at risk from heavy metal contamination.

Another environmental problem posed by incinerating tires in cement kilns is the production of PICs (products of incomplete combustion). "During incineration, fragments of partially burned waste chemicals stabilize or recombine to form new chemicals, called PICs. Although these chemicals are estimated by the EPA to number in the thousands, only approximately 100 have been fully identified." (Source: Pat Costner and Joe Thornton, Playing with Fire.)

The EPA has reported: "Sampling and analysis techniques are not available to identify or quantify many of the potential compounds emitted. It is at present impractical to design a monitoring scheme to identify and quantify the individual toxic compounds in incinerator stack emissions." The PICs identified in kiln emissions are highly toxic, persist in the environment for a very long period of time and, most importantly, are bioaccumulative. The EPA states further: "The complete combustion of all hydrocarbons to produce only water and carbon dioxide is theoretical and could occur only under ideal conditions. . . . Real-world combustion systems always produce PICs some of which have been determined to be highly toxic."

The actual performance of cement kilns indicates that these pollutants will be released into the environment. Even if kilns could be operated at maximum, controlled laboratory efficiency, kilns still would release sizable amounts of pollution into the environment. However, in the real world, kilns never operate at ideal efficiency. Holnam Cement has had documented environmental performance problems in the past and uses the outmoded wet kiln process.

Trial burns, which are used to measure the Destruction and Removal Efficiency (DRE) of kilns, are an inadequate method of predicting performance for the following reasons:

1. trial burns only test for a few emissions;
2. the technology does not exist to measure many of the chemicals that are created and released during a trial burn;
3. the trial burn is conducted under finely controlled conditions that do not exist in real-world operation;
4. trial burns only present a snapshot of incinerator performance and the DRE data of a trial burn is based upon too small a sample to be able to predict with accuracy how the incinerator would perform under normal operating volume (some trial burns only sample 1/650,000th to 1/2,000,000th of a dayÕs incinerator output);
5. trial burns and DREs fail to account for the hysteresis effect, which is the continued existence of hazardous substances in the system even after their introduction into the kiln system has stopped, which leads to their continued emission;
6. Tte DRE measuring system used during the trial burn is scientifically inadequate; and
7. even a DRE of 99.99% efficiency and a capture efficiency of 90%, both of which are impossible to achieve in the real world, would mean significant pollution.

Another problem with the burning of tires in cement kilns is fugitive emissions. "Fugitive emissions. . . may release as much or more toxic material to the environment than direct emission from incomplete waste incineration. . . ." (Source: EPA) The overriding fact is that actual operation of cement kilns never matches the results obtained during the artificially controlled conditions of a trial burn. There are always macro-scale and micro-scale upsets. For both financial and technical reasons, it is impossible to monitor with any great accuracy the actual daily emission of any waste incinerator. Studies have also shown that kilns, in order to cut corners and reduce energy consumption, reduce kiln temperatures, which leads to more toxic emissions.

Given the increasingly high cost of energy, we can expect increased corner-cutting to reduce costs. Given the chemical composition of tires, all of the problems identified above would be likely to occur if Holnam Cement Co. is allowed to burn waste tires. Given that Montana does not have a tire disposal problem, it makes no sense to allow Holnam to burn tires at the Trident kiln. Tire incineration presents an unacceptable risk to human health and the environment.

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Factory plans for burning tires face environmental opposition

Plans for a factory that incinerates tires to fuel cement production have opponents fuming over environmental concerns.
By Steve Raabe
The Denver Post

Posted: 03/15/2009 12:30:00 AM MDT
Updated: 03/15/2009 02:19:22 AM MDT

Scrap tires would be burned to fuel a Pueblo-area cement plant under plans proposed by the facility's owner.

Incineration of tires is becoming a common practice in cement fabrication as a way to reduce the use of coal and natural gas.

The method also provides a partial solution to a major problem: how to deal with the 300 million car and truck tires discarded every year in the U.S.

But it also is creating concern among some Pueblo residents and environmentalists who fear that burning tires will produce odors and toxic emissions.

"It's really like burning hazardous waste," said Ross Vincent, chairman of the Rocky Mountain Sierra Club's Pueblo-based regional arm. "We think fundamentally that it's a bad idea."

Not so, say officials of the plant's Mexican owner, GrupoCementos de Chihuahua and its Denver-based subsidiary, GCC of America.

Burning tires, they say, actually is cleaner than combustion of other fossil fuels and helps reduce landfill use.

Opponents and proponents cite studies and anecdotal information in support of their claims. Yet little peer-reviewed independent research exists for a business practice that has become prevalent only over the past decade.

GCC recently purchased for $2 million the Midway tire landfill south of Fountain as a potential source for the cement plant.

Officials of GCC said they have no immediate plans to burn tires, calling the idea a "medium-term project" that would involve filing for state and local zoning and air-quality permits.

The $300 million cement facility southeast of Pueblo began operations last year and has been using coal in conformance with existing permits.

During production, heat — temperatures of up to 2,800 degrees Fahrenheit — is needed to chemically transform limestone and other minerals into cement.

Coal, petroleum coke and natural gas have been the traditional fuels used in the process.

But today, about one-half of the approximately 100 cement plants in the U.S. have permits to burn "tire-derived fuel," or TDF, according to the Portland Cement Association, an industry trade group.

"The cement industry is very proactive in its effort to reduce energy consumption, particularly fossil fuels," said Enrique Escalante, president of GCC of America. "We understand the benefits to both the economy and the environment of burning tires."

Subject to receiving regulatory approval, GCC proposes to use about 300,000 tires a year, replacing one-third of the plant's coal consumption.

That would account for about 10 percent of the estimated 3 million tires discarded each year in Colorado.

Depending on market prices, tires for fuel can cost about 25 percent more per ton than coal, but the price difference is offset by rubber's 30 percent higher energy content.

Supporters say that burning rubber in place of the more common coal in cement plants produces fewer emissions, slows the depletion of finite fossil fuels and reduces landfill clutter.

Opponents counter that burning rubber contributes to respiratory diseases, causes odors and emits more harmful dioxins and volatile organic compounds than coal or natural gas.

The polarized viewpoints can be partly explained by variations in the effectiveness of incineration and emissions-control systems, said Kirsten King, manager of the stationary sources program of the Colorado Department of Public Health and Environment.

The agency reviews companies' combustion-system

tests and monitors emissions. But violations can occur when equipment malfunctions.

If GCC were to burn tires, it would still use the plant's existing "baghouse" emissions control system that filters out the majority of particulates, nitrogen oxides and sulfur oxides that are created from burning fossil fuels.

Unlike coal, burning tires produces no mercury and fewer heavy metals such as cadmium and chromium, King said. But she added that if rubber is not totally combusted, it can emit other potentially toxic organic compounds.

"The tricky thing about tire-derived fuel — any fuel — is that if you burn it completely, it's a pretty clean process," she said. "But the concerns are when you don't have good, complete combustion."

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Tire-burning power plant goes dark in Ford Heights

By: Steve Daniels March 22, 2011, Chicago Business

(Crain's) — A Ford Heights facility that burns tires to produce electricity has closed after failing to win passage last year of a state law to get tire-burning officially deemed a renewable fuel source.

The plant, which has twice entered and emerged from bankruptcy since beginning operations 15 years ago, is facing yet more questions about its future.

After shuttering the plant last month, plant owner Geneva Energy LLC is working on improvements to make the facility more efficient and hopes to restart sometime in May, CEO Benjamin Rose said in an interview. In the meantime, he’s had to lay off about 10 workers, half the employees running the plant in the economically disadvantaged south suburb.

Once the plant restarts, “we’ll be expecting to do it on a one-month test, and then we’re not sure,” he said.

The $100-million tire burner was built under the state’s old Retail Rate Law, which promised higher-than-market power rates to developers of incinerators and other waste-to-energy facilities. But the law was repealed months after the tire burner began operating, and ever since, a succession of owners has struggled to make a profit selling the power the plant produces on the wholesale market, Mr. Rose said.

Last year, Geneva Energy attempted to boost its revenue by lobbying for a state law that would have categorized tire-burning as a renewable energy source, giving purchasers of the plant’s electricity the ability to count it toward meeting state mandates for renewable use.

Mr. Rose estimated the law would have increased the plant’s revenue 10% to 20% by allowing it to negotiate long-term sales contacts, rather than leaving it subject to today’s low market prices.

The bill passed the state House but fell short in the Senate after environmental groups lobbied for its defeat.

“We’re not here to stand in their way, but let’s have truth-in-energy labeling here,” said Howard Learner, executive director of the Chicago-based Environmental Law and Policy Center, which lobbied against the bill. Tire burning “shouldn’t be masquerading as clean energy.”

Mr. Rose said the plant uses state-of-the-art pollution controls that make it significantly “cleaner” than a coal-fired power plant.

The plant is designed to burn up to 6 million tires a year but never has topped 3.5 million, Mr. Rose said. It generates up to 18 megawatts of power.

Tire Incineration FP 98

'Up North Skies' Up for Grabs

State Takes Advantage of clean Air to Promote Dirty Electricity

Joyce Petrakovitz, an artist and mother from Cadillac, was at the lake relaxing when a friend told her that the northern Michigan air she was breathing might soon not be so clean.

"He said that the state Department of Environmental Quality was quietly getting ready to issue a permit to let a plant in town burn tires to make electricity," Mrs. Petrakovitz recalled. "I wanted to know what it really meant."

Mrs. Petrakovitz, a brown-eyed woman with curly dark locks and a steady gaze, is well known for defending Wexford County's clean air and water. Yet even an activist and researcher as skilled as Mrs. Petrakovitz was unprepared for the threat she found: A DEQ plan to solve the state's waste tire problem by using northern Michigan's clean air as a pollution dump.

DEQ Director Russell Harding has apparently decided that he can best reduce Michigan's waste tire stocks by providing northern Michigan energy companies with a new source of fuel. And he can do that by issuing tire burning permits to the plants without requiring them to install "scrubbers," the industry's basic pollution prevention equipment. Scrubbers prevent at least 80 percent of such tire-burning pollutants as sulfur dioxide, which causes acid rain, from entering the atmosphere.

State air quality officials agree they have the authority to require scrubbers, but insist they do not have to exercise that power. The $1 million to $2 million cost of scrubbers is a minor expense to the multi-billion dollar utilities that own the facilities. NRG Energy, Inc., which owns the Cadillac plant, earned $2 billion in total revenue in 2000.

Not Dirty Enough

Mary Ann Dolehanty, a unit supervisor in the DEQ's Air Quality Division, explained that northern Michigan's air can become much dirtier before it runs afoul of federal air quality standards. It could get as thick as Houston or Los Angeles' air before it exceeds allowable pollution levels.

The federal Clean Air Act gives Michigan considerable power to keep the air as pure as possible. But the agency invested with that authority is not inclined to use it, she said. "It looks as though that (Cadillac) proposal will not include scrubbers..." The decision will be based on the regulations, and where we can push and where we can't."

That's not good enough for Mrs. Petrakovitz and other northern Michigan residents now organizing to change the DEQ's position.

"We're turning our air, one of this region's most important resources, into a giant air sacrifice zone," she said. "All for the sake of saving the multi-billion dollar utility companies that own these plants a few dollars. I think if more people in northern Michigan knew what was going on, they wouldn't tolerate it."

The DEQ's policy of interpreting federal law to benefit companies, not people, is nothing new. The agency has been at war with the Clinton administration for nearly eight years over federal Environmental Protection Agency proposals to make air cleaner. The DEQ filed 10 lawsuits against EPA in recent years to stop new air quality standards that would require big companies to reduce nitrogen oxide emissions, which cause smog. It also joined many of those same companies in a case pending before the U.S. Supreme Court to argue that EPA and state officials should base all Clean Air Act efforts on potential new business costs instead of human health effects.

Just the Beginning

NRG's Cadillac Renewable Energy and a CMS Energy power plant in Grayling are the two latest wood chip-burning plants in northern Michigan to apply for permission to add tires to their fuel mix. The DEQ has since 1993 issued permits to three other wood chip plants in McBain (Wexford County), Hillman (Montmorency County), and Lincoln (Alpena County) to burn a total of 45,920 tons of tires. Add the Cadillac and Grayling plants, plus a requested increase at Hillman, and the total comes to 102,495 tons.

It has become clear, however, that both more tire burning and more tire pollution is on the way. Two of the already-permitted plants now plan to double the amount of tires they burn. That's troubling to residents and scientists because a doubling of tire volumes does not result in a mere doubling of tire pollution loads.

Burning tires along with wood causes a unique combustion chemistry that produces a sixfold increase in acid rain pollutants when a plant burns twice as many tires. That means that the level of acid rain pollutants the DEQ now plans to allow the five plants to produce — 1,000 tons of sulfur dioxide annually — could easily reach 6,000 tons or more every year as the DEQ permits the plants to increase the amount of tires they burn without pollution controls.

Total sulfur emissions from northern Michigan tire-burning plants amount to a small portion of the more than 400,000 tons Michigan allows power plants and other industries to emit annually. But critics like Mrs. Petrakovitz point out that tire burning is a new and unnecessary source of pollution in northern Michigan. In addition to sulfur dioxide and nitrogen oxide, tire burning produces many other toxic and hazardous pollutants. Scrubbers can stop most of that pollution from turning into public health and environmental problems, she said.

Toxic Shell Game

Mrs. Petrakovitz is not alone. Tom Rozich, a respected fisheries biologist with the state Department of Natural Resources, says new sulfur emissions could increase the acidity of northern Michigan's lakes and streams. That kills fish.

In a memorandum to the DEQ in September, 1999, Mr. Rozich wrote: "We in the fisheries division have grave concerns over this proposal." New, uncontrolled emissions could hurt area lakes and streams, he explained. An example is Berry Lake, which lies approximately 4.5 miles southeast of the Cadillac plant and is already slightly acidic. "Additional acid rain will be detrimental to the existing fish populations," he wrote.

Lynn Fiedler, a DEQ air quality regulator, also spelled out the environmental protection conflict for her colleagues in a 1999 memorandum. "The rules are designed not to trade a solid waste problem into an air problem," she wrote.

A decade ago, Michigan joined other states in approving legislation to clean up tire dumps and strengthen oversight of scrap tire disposal. The 1991 law also called on the state to flex its regulatory muscle to find and promote alternative uses for scrap tires, such as recycling.

Michigan is making progress with cleanup and oversight. But of the roughly eight million scrap tires it converts to alternative uses each year, it directs less than two million into production of retreads, landfill liners, playground equipment, and recycled rubber products.

Top Incineration State

The state's preferred "alternative use" for waste tires is incineration, which accounts for the remaining six million tires the state converts each year. Michigan is already the sixth largest user of so-called "tire derived fuel" in the country, according to the Scrap Tire Management Council, an industry trade group in Washington.

Michigan is becoming a top state for incinerating tires because it is sending the scrap rubber to northern Michigan wood chip plants, which the Clean Air Act does not automatically require to use scrubbers. Michigan's only downstate, tire-burning facility is a cement plant, which burns other materials as well. It has scrubbers and other protections in place only because public outcry in the mid-1990s over longstanding pollution forced the state to finally take action.

Northern Michigan residents want the same respect from state agencies. "We have clean air," Mrs. Petrakovitz says. "It's what makes northern Michigan, northern Michigan. As citizens we need to do everything we can to make sure our air stays clean. It's absurd that the state agency that's supposed to do that isn't, especially when the technology is available at a reasonable cost."

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Tell the Michigan Department of Environmental Quality to exercise its authority to require scrubbers at northern Michigan tire-burning plants. One opportunity is a 7 p.m. public hearing, February 21, at the Cadillac Junior High School cafeteria. For information on future opportunities, go to www.mlui.org or the Cadillac Area Citizens for Clean Air Web site at http://users.michweb.net/~fsyoungman/.

Tire Incineration FP 100

RUBBER BEAT

Pyrolysis breaks down for some firms

Companies to take more than 9 years to make money, according to study

By Miles Moore

Various companies have tried to commercialize pyrolysis — the process of heating and breaking down tires into their component oil, steel and carbon black — even after a damning report from Goodyear Tire & Rubber Co. in the early 1980s.

The Goodyear study, which covered the operations of a pilot pyrolysis plant, estimated a pyrolysis facility would take 9.3 years to pull itself out of the red.

ECO2 Inc., a Hawthorne, Fla., pyrolysis company, fell apart earlier this year in shareholder acrimony after about five years. Its story was peaceful, however, compared with that of Colinas Tire Recovery Inc. and Repco Waste Recovery, two Coolidge, Ariz., companies that had a contract to use all the scrap tires in the Phoenix area in a pyrolysis project.

ECO2 President Charles Ledford put up financial assurances late in 1992 to establish a pyrolysis facility. The company established a pilot plant in Hawthorne the next year.

"This unit was a development unit, put up as a selling tool," said Bill Parker, an engineer in the Solid Waste Section of the Florida Department of Environmental Protection. "It only operated when someone interested in the process was there to see it."

Ledford attracted a number of shareholders to invest in the company. These shareholders waited for ECO2's patented pyrolysis technology to be licensed, while Ledford, trying to keep the company afloat, branched out into other ventures — faucets, jet skis, financing for two movies.

"It was a very mixed-up situation," Parker said. "[Ledford] was paying himself a pretty good salary, but the shareholders were not happy. They had paid $5 per share, and toward the end, the value was about 50 cents per share."

> *[ECO2 Inc.'s] unit was a development unit, put up as a selling tool. It only operated when someone interested in the process was there to see it.*
>
> **Bill Parker**
> *Florida Department of Environmental Protection*

Finally, in February 1997, the stockholders revolted.

"They cut Ledford off and left him with the tire assets," Parker said.

ECO2 sold its nontire assets to Casinos International, a gambling organization. Ledford has started a new firm in Hawthorne, called Earth First Recycling. He did not return repeated calls to his new business, but Parker said Ledford isn't undertaking any current pyrolysis projects.

The story of Colinas Tire and Repco, by contrast, ended not with a whimper, or even a bang, but a blaze. Three million shredded tires caught fire Aug. 1 at the Gila River Indian Community near Sacaton, Ariz.

This was not the outcome the Maricopa County (Ariz.) government envisioned when, in September 1993, it awarded a waste tire removal contract to Colinas Tire. The firm proposed using Maricopa County's waste tires to supply a pyrolysis facility it planned to build behind its existing business in Coolidge.

Colinas Tire shredded Maricopa County's tires and stored them at the Coolidge site, as promised in the contract. But by July 1994, problems began to arise; Colinas Tire had trouble obtaining permanent financing for the pyrolysis project and quickly was running out of storage room at Coolidge.

"As a result, the facility time line was dramatically behind schedule, and Maricopa County was faced with exercising the termination clause of the existing contract," according to a fact sheet issued by the Maricopa County Solid Waste Management Department.

Colinas Tire began discussions with Repco late in 1994 and the following February turned over the contract to Repco, with the approval of the Maricopa County Board of Supervisors. Colinas Tire remained as a subcontractor for shredding the tires.

There were continued delays in building the pyrolysis plant, however, and in June 1995 the Arizona Legislature passed a tire removal and recycling measure that mandated the cutoff of Maricopa County's tire recycling funds if the contract wasn't completed.

In September 1995, the county ordered Colinas and Repco to show proof of recycling or be declared in default.

By then, the county estimated, there were more than 9,900 tons of shredded tires at Coolidge and more than 35,200 tons at the Gila River Indian Community.

Colinas and Repco filed a lawsuit in October 1995, seeking an injunction against the county terminating their contract. More than a year of negotiations followed, during which Maricopa County issued a new request for scrap tire removal proposals from recycling firms.

Maricopa County finally accepted a $330,000 settlement payment from Colinas and Repco's insurers in February 1997. The county offered the money to the Indian community for tire removal. But Tribal Gov. Mary Thomas rejected it as an insult and said it wouldn't even make a dent in the enormous pile.

Firefighters managed to control the fire by Aug. 15 by covering the burning tire shred with dirt, said Candice Bell, manager of the Indian community's solid waste program.

Officials removed about half the shred from the pile before the fire could reach it.

"Every now and then there's a flare-up when a crater opens up, so we have to re-cover," Bell said. There is no smoke now and no runoff, because water was not used to control the fire. Nevertheless, half the rubber is scorched, while the other half is scattered.

The Indian community and Maricopa County are in discussions about what to do with the remnants of the pile.

"From a legal standpoint, the tires are now the property of the Gila River Indian Community," said Christine Holloway, director of the Maricopa County Solid Waste Management Department. "Morally, everybody is trying to come up with the best solution."

Colinas and Repco are no longer involved, Holloway said. Attempts to reach officers of those companies were unsuccessful. ■

Moore is a reporter with Crain Communications' Rubber & Plastics News

mlive.com
Everything Michigan

Lincoln, Viking Energy battle over burning tires

Tuesday, June 25, 2002

By Eric English
TIMES WRITER

Alcona County's village of Lincoln has rejected a local power plant's bid to burn more old tires, setting the stage for a court battle to decide the issue.

Viking Energy of Lincoln had requested a zoning variance allowing it to burn up to 38 tons a day of shredded tires to create power, more than doubling the amount currently allowed by village ordinance.

The village's zoning board of appeals voted 4-3 on June 20 to deny the variance. Village President Phil Potter cast the deciding vote.

"I shouldn't have been put in that position in the first place, but I went with my conscience," Potter said.

The zoning board's decision rejects terms of a proposed legal settlement between Lincoln and Viking Energy. An ongoing lawsuit between the two sides is expected to resume in Alcona County Circuit Court.

"It's going to be a battle, and hopefully, we will prevail," Potter said.

Viking Plant Manager David James could not be reached for comment by The Times.

The Michigan Department of Environmental Quality issued a permit in 2000 for Viking to burn up to 44 tons of shredded tires a day, which equals about 1.6 million old tires a year. Village ordinance limits the plant to burning no more than 17 tons of tire material per day.

The plant was originally built in 1989 to burn wood chips purchased from local logging companies.

The DEQ concluded that the increased tire burning would not be a public health threat because the plant filters emissions from its smokestack. The DEQ has also approved tire burning at several other wood-fired power plants in the northern Lower Peninsula.

Local environmental activists have criticized the state's policy on tire burning and are applauding Lincoln's attempts to limit the activity through local ordinance enforcement.

"They have made a stand for the community and for the environment and public health of our community," said Steve Yokom, a member of the Alcona County Environmental Coalition.

The coalition has given the village $7,000 to defray legal costs in its court fight with Viking Energy. Potter said the village council will discuss how to pay the remaining $14,000 in legal bills accumulated so far when it meets in July.

The village's lawsuit was originally filed in December 2000 and alleges that the company is violating local zoning ordinance. The case seeks an injunction to stop Viking's operations until further court order.

If successful, the village's lawsuit could set a precedent for other communities where power plants have received state permits to burn "alternative fuels."

Viking Energy, also known as Tractebel Lincoln Power Station, sells the electricity it generates to a statewide energy pool.

- Eric English covers regional news for The Times. He can be reached at 1-800-727-7661.

Tire-burning plan scrapped at Marion site - Residents still want to stem all alternative uses

Appalachian Focus Environmental News
B1: Submit
Date: 8/4/01
Time: 9:40:47 AM

Discussion

This article appeared in the Dominion Post Newspaper, Morgantown, West Virginia on August 2, 2001.

Associated Press

FAIRMONT -- Plans to continue test-burning tires for fuel at the Grant Town Power Station have been dropped, but people who live nearby are still worried about the prospect of burning waste from a Superfund site.

Cathy Rodriguez, who organized a demonstration at the power plant Wednesday, said neighbors want nothing burned from the Sharon Steel site in Fairmont or a former ordnance factory in Morgantown.

Kipin Industries of Aliquippa, Pa., has been negotiating with ExxonMobil to convert waste from the Sharon Steel Superfund site into fuel, but power plant Manager Herb Thompson said he has yet to agree to burn waste from either site.

The tire-burning test died for lack of community support.

Several homeowners complained of black, oily soot on their homes, yards and cars during a 30-day test burn of tires in October 1998.

"As a company, we saw no benefit in going forward" with a second, 14-day test, Thompson said. "Maybe it's something we'll look at again down the road, but from our standpoint, it was a draw and we just decided to bow out."

Don Bonk, a Department of Energy project manager at the National Energy Technology Laboratory in Morgantown, said a meeting on the second round of tests had been planned for later this week.

As many as 72 commercial and industrial power plants were using tire chips as fuel in 1998, Bonk said.

The DOE wants to perfect the process of chipping old tires at pickup sites. It would chop them into 1-inch squares, then haul them to power plants where they can be blended with coal.

Thompson said the power station staff is proud of its role in reclaiming old gob piles of coal and helping to restore the land.

"We're not going to do anything or participate in anything that will take that feather from our cap," he said.

"CHEJ is the strongest environmental organization today – the one that is making the greatest impact on changing the way our society does business."

Ralph Nader

"CHEJ has been a pioneer nationally in alerting parents to the environmental hazards that can affect the health of their children."

New York, New York

"Again, thank you for all that you do for us out here. I would have given up a long time ago if I had not connected with CHEJ!"

Claremont, New Hampshire

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