Cancer, Leukemia, Asthma, Anemia, depression, Mood Swings, Dysimmunity

HEALTH EFFECTS OF CHEMICALS EXPECTED TO BE EMITTED FROM THE AQUILA POWER PLANT

I. The chemicals expected to be emitted by the Aquila power plant are Formaldehyde, Acrolein, Carbon Monoxide, Nitrogen Oxides, which include Nitrogen Dioxide and Nitric oxide or better known as acid rain, Polycyclic Aromatic Hydrocarbons, Benzene and possibly others we haven't identified.

By Aquila's statement all of these chemicals are expected to be emitted at low safe levels by the current safety standards. We have to ask what the safety levels are when all of these chemicals are combined and emitted into the environment chronically and for long term. What kind of health impacts can we expect?

Let's take each chemical individually:

- Formaldehyde at chronic, low level, long term, exposure can cause irritation to eyes, nose, throat, and lungs. It can cause depressed immune system. It is considered reproduction toxic, neurotoxin, liver toxic, and gastrointestinal toxic. Formaldehyde is ranked as one of the top 10% most hazardous compounds to human health and ecosystems. Formaldehyde is a recognized carcinogen leading to lung, nasopharyl, and brain cancers. The EPA assumes that there are no exposures to carcinogens that have zero risk; even very low exposures increase risk.

- Acrolein at chronic, low level, long term exposure can cause irritation of eyes, nose, throat, and lungs. Can cause decreased breathing rates which can lead to decreased oxygenation of blood.

- Benzene at chronic, low level, long term exposure can cause increased risk of Myelogenous leukemia, Lymphocytic leukemia, Hodgkins Disease, Hairy Cell leukemia, Aplastic Anemia, Mylodisplastic Syndrome, reproductive dysfunction, damage to the immune system, structural and numerical chromosome damage. Chronic effects can be seen long after exposure. Benzene is classified as a group A carcinogen. As stated previously, there is no safe level of exposure to a known carcinogen.

- Nitrogen oxides are broken down to Nitrogen dioxide and nitric oxide. Nitric oxide is a main ingredient in acid rain. Nitrogen dioxide reacts with sunlight to add to ozone and smog conditions. Researchers at the Yale School of Forestry and Environmental Studies has stated, "Reducing ozone pollution by about 35% on any given day could save about 4000 lives a year across the country." Low level, chronic, long-term exposure can irritate eyes, nose, throat, and lungs. Symptoms would include coughing, shortness of breath, tiredness, nausea, and fluid build up in lungs. Tests on animals indicate it can cause toxic effects to

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developing fetus and changes in genetic material to cells. There have been no tests on human subjects to prove these effects on humans.

- Polycyclic Aromatic Hydrocarbons are a group of over 100 different chemicals, also known as PAH's. PAH's can attach to dust and soil particles. Dust particles can be inhaled and soil particles can be ingested by animals and contaminate plants. PAH's can also migrate through the soil and gain access to underground water. PAH's settle through lakes and rivers to the bottom and then can be ingested by bottom feeding aquatic life. Chronic, low level, long term exposure can cause increases in lung and skin cancer, as well as non-cancer respiratory diseases.

- Carbon Monoxide at low level, long term, chronic exposure displaces oxygen in blood cells, which can cause a condition called Carbon Monoxide Poisoning Syndrome. Symptoms include headaches, attention deficits, visual and verbal defects, mood changes, depression, hearing loss, balance problems, and seizures. With chronic exposures the residual levels in the body stay increased. It takes weeks to months for levels to disappear when there is no exposure.

II. We would also like to address the possible health impacts of the high voltage power lines. An extensive study conducted by the California Department of Health Sciences has concluded EMF's (electromagnetic fields) can increase risk of childhood leukemia, adult brain cancer, Lou Gehrig's Disease, and miscarriage. It is also suspected that EMF' increase risk of asthma, headaches, &depression. These findings were supported by other studies in the UK, Canada, Switzerland, and by the International Commission on Non-Ionizing Radiation Protection. Connecticut law requires the Connecticut Siting Council to include health and fair market value issues when deciding on the application to expand and build 345-kilovolt lines. They recommend burying the lines. These same problems will effect our wildlife and plant life.

We can also expect health impacts on our livestock, wildlife, aquatic life, and domestic animals. Animals and birds will suffer the same risks as humans but possibly more so. All could experience decreased immune systems which could lead to increased susceptibility to diseases, allergies, asthma, cancer, and heart disease. All could experience decreased sperm and egg production and quality, low birth weights, birth defects, and low milk production. These health impacts will also have unfavorable economic effects on people who raise livestock as a livelihood.

In general this power plant could create an unhealthy place for humans and animals to live. We do not believe that Aquila is a very healthy neighbor.

References:

#1 Risk Assessments for Toxic Air Pollutants: A Citizen's Guide - US Environmental Protection Agency

#2 Carbon Monoxide Poisoning Syndrome - Carbon Monoxide Headguarters

#3 Tox FAQs for Polycyclic Aromatic Hydrocarbons (PAH's) - Agency for Toxic Substances & Disease Registry

#4 TOX FAQs for Acrolein - Agency for Toxic Substances & Disease Registry

#5 TOX FAQs for Nitrogen Oxides - Agency for Toxic Substances & Disease Registry

#6 Formaldehyde - US Environmental Protection Agency

#7 TOX FAQs for Formaldehyde - Agency for Toxic Substances & Disease Registry

#8 Hazardous Air Pollutants (HAPs) Section 112 - US Environmental Protection Agency

#9 Benzene Exposure Information & Health Effects - Benzene 411

#10 Benzene - US Environmental Protection Agency

#11 Benzene - Jan. 1988 - A Quire Database

#12 Benzene and Diseases of the Blood: Revisited - Nachman Brautbar, M.D.

#13 Formaldehyde - Scorecard - Environmental Defense

#14 Formaldehyde - AFSCME Health & Safety Fact Sheet

#15 Pollution Locator - Hazardous Air Pollutants & Chemicals Contributing to Estimated Cancer Risk Scorecard - Environmental Defense

#16 Study links smog increase, urban deaths. Reuters. Articles on CNN.COM

#17 New Information on EMF - Power line Health Facts

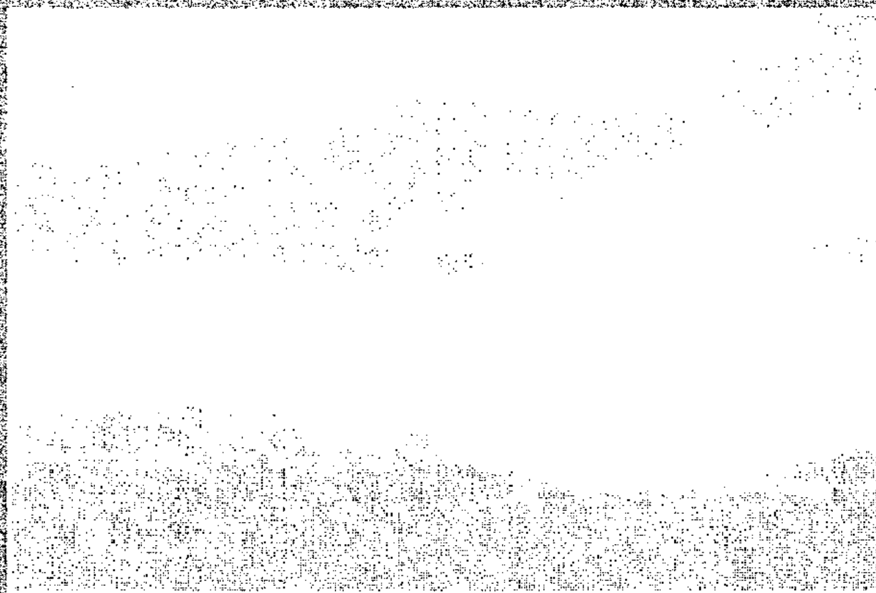
#18 Opinions of Leading government Authorities - Power Line Health Facts

NITROGEN

Nitrogen Oxide Emissions and Midwest Power Plants

CLEAN AIR TASK FORCE

January, 2003



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CREDITS

Written by: Ellen Baum, Clean Air Task Force

Technical Assistance: David Schoengold, MSB Energy Associates

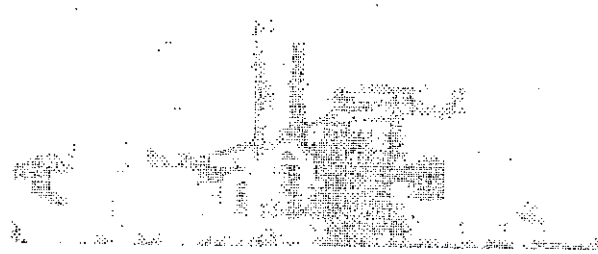
Reviewed by: Amy Hennen, Izaak Walton League of America
Kurt Waltzer, Ohio Environmental Council
Bruce Hill, Clean Air Task Force

Design: Jill Bock Design

Cover Photos: Jenny Hager

Nitrogen Oxide Emissions and Midwest Power Plants

The release of nitrogen into our environment has more than doubled over the past century, contributing to problems such as ground level ozone, acid rain and other environmental challenges. In the Midwest, coal-fired power plants are one of the largest sources of nitrogen oxide pollution, accounting for 30 percent of total annual emissions. Power plants have remained exempt from modern pollution controls for decades. Some in the Midwest will be facing seasonal pollution controls beginning in 2004, others will remain uncontrolled. To fully address the threats this pollutant poses for our public health and environment, more will have to be done to reduce nitrogen oxide emissions from power plants in the Midwest.



Nitrogen Released From Fossil Fuels Are Harmful To Our Environment

Nitrogen, one of the earth's most abundant elements, is essential for life on earth. It is an important plant nutrient and a key building block of proteins. However, over the past century human activities – fertilizers, waste water treatment, animal wastes and atmospheric sources – have more than doubled nitrogen releases into the environment. This doubling has placed a demanding burden on our air, land and water resources.

The burning of fossil fuels is one of the major atmospheric sources of nitrogen. Combustion of fuels at high temperatures converts the elemental nitrogen in the air and fuel to nitrogen oxides (NO_x). Emissions from power plants and mobile sources are the largest source of NO_x in the US. From 1950 to 1997, the amount emitted into the atmosphere from fossil fuel combustion has increased by a factor of almost 40.[1]

After combustion and release, nitrogen oxides and their byproducts enter the environment in four important paths, each of which can affect human health and the environment:

- Nitrogen oxides are dangerous to breathe. When released from power plants or cars into nearby neighborhoods, they are associated with respiratory side effects such as asthma attacks.
- Ozone pollution (ground level ozone or smog) – a very strong airborne oxidizing agent with properties like chlorine bleach – forms when NO_x reacts with hydrocarbons in the presence of heat and sunlight. Ozone at ground level is linked with asthma attacks and even birth defects and also retards growth of trees and crops.
- Nitrogen oxides form small nitrate particles that are associated with serious health impacts like heart attacks and result in hazy skylines in our cities and national parks.
- Nitrogen oxides lead to pollution of soils, groundwater and estuaries. Nitrate particles can form nitric acids in the atmosphere contributing to acid rain and overloading ecosystems with nitrogen, effectively over-fertilizing them.

This report focuses on the impacts of emissions of NO_X in the Midwest and demonstrates the need for steep reductions from power plants – beyond those reductions required by existing EPA regulations.

Power Plants Unnecessarily Release Millions Of Tons Of Nitrogen Oxides Into The Air

Due to a loophole in the Clean Air Act, millions of tons of NO_x are unnecessarily released into the atmosphere each year by "grandfathered" power plants. As a home to the some of the Nation's largest smokestack polluters, Midwest power plants release a disproportionately large share of NO_x into the air, despite the fact that pollution control technology is readily available that reduces over 90 percent of the emissions from the region's largest and dirtiest smokestacks. As Table 1 illustrates NO_x emissions from all sources in the six Midwest states discussed in this report (Minnesota, Wisconsin, Michigan, Illinois, Indiana and Ohio) totaled almost 5 million tons in 1999, representing nearly 20 percent of all U.S. NO_x emissions.[2] Electric utilities in this six-state region emitted 1.5 million tons of NO_x in 1999, representing over 25 percent of the U.S. NO_x emissions from power plants. In the Midwest, coal combustion accounts for 97 percent of the NO_x emissions from electric utilities.

Table 1:

Nitrogen Oxide Emissions in Six Midwest States in 1999, tons per year

NO_x Emissions	All Sources	Power Plants	Power Plant %	Coal Plants	Coal Plants as % of Power Plants
Illinois	1,111,896	278,931	25.1	268,412	96.2
Indiana	860,290	350,017	40.7	349,028	99.7
Michigan	859,897	207,039	24.1	183,594	88.7
Minnesota	487,651	87,211	17.9	83,838	96.1
Ohio	1,149,097	431,481	37.5	429,518	99.5
Wisconsin	506,773	109,612	21.6	106,498	97.2
Total	4,975,604	1,464,291	29.4	1,420,888	97.0

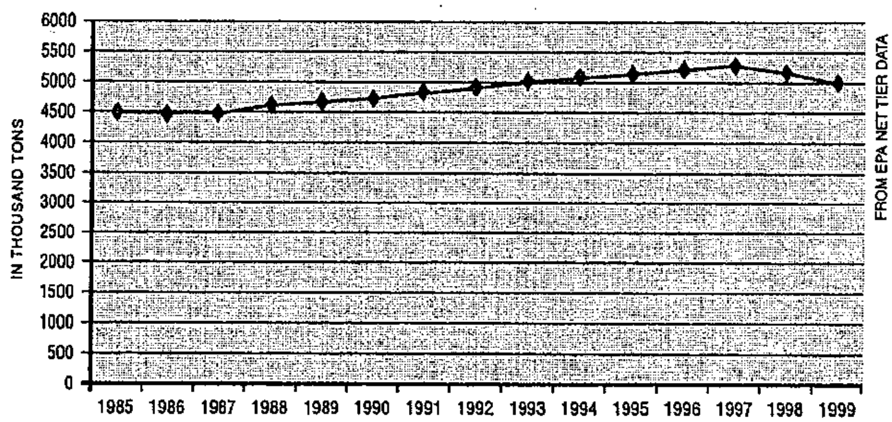
FROM EPA NET TIER AND CEMS DATA

Nitrogen Oxide Emissions Need To Be Significantly Reduced

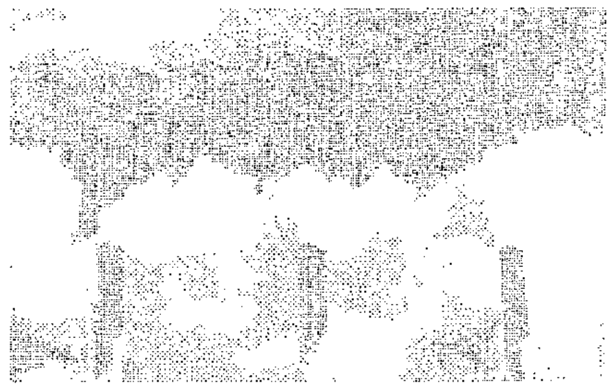
Figure 1 demonstrates that NO_x emissions from power plants have been steadily increasing for years. Recently, there has been a slight decrease in anticipation of a federal rule that will require some states to reduce the summertime NO_x emissions from power plants in order to reduce ozone pollution starting in 2004. However, if the technology solutions were applied year round, not just during the summer, and to all states, the Midwest would receive significantly greater relief from NO_x pollution.

Figure 1:

NO_x Emissions from 1985 to 1999 in Six Midwest States



An Incomplete Step



In 1998, the US EPA adopted a rule requiring 19 states, including Illinois, Indiana, Michigan, and Ohio to develop state implementation plans (SIPs) to clean up summertime NOx emissions from coal-fired power plants. Minnesota and Wisconsin do not have to comply with this requirement. The pollution controls are only required to be operated during the summer because the scope of the rule focused on smog-causing pollution and did not attempt to address haze, fine particles or acid rain. As a result, starting in 2004, summer time NO_x emissions from the four Midwestern states included in the rule will be cut by nearly 250,000 tons per season.

While this federal rule is an important step, requiring the pollution controls to operate year round and requiring similar cuts in all coal- and oil-fired power plants, including those in Wisconsin and Minnesota, would result in an additional 450,000 ton reduction in Midwestern NO_x pollution.

Figure 2:

Comparison of Annual Power Plant NO_x Emissions and Reductions in SIP Call States (IL, IN, MI, OH), Ozone Season vs Potential Year-Round Controls

(Based on 2001 emissions)

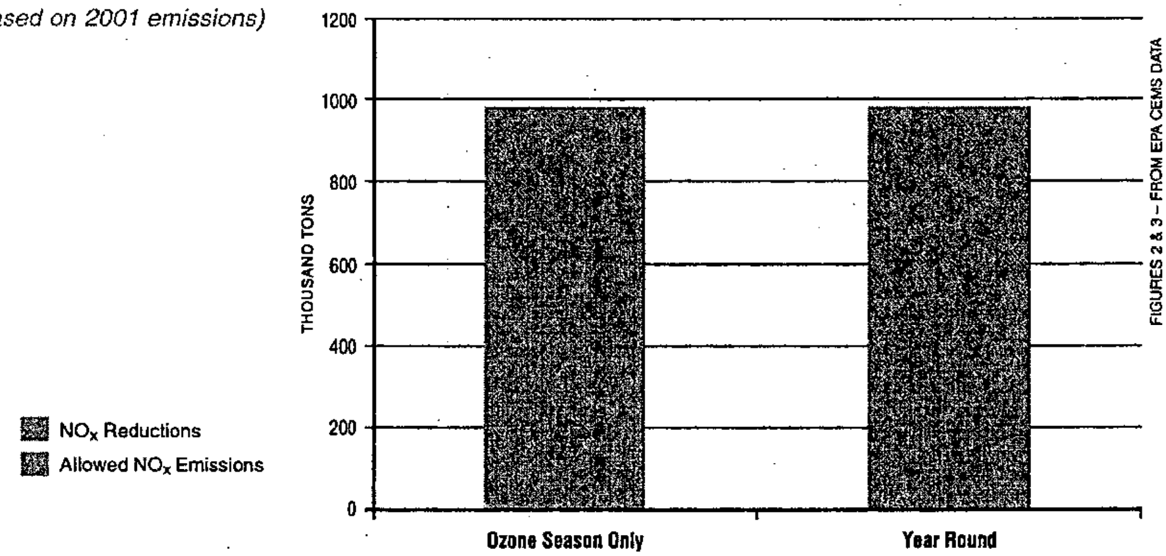
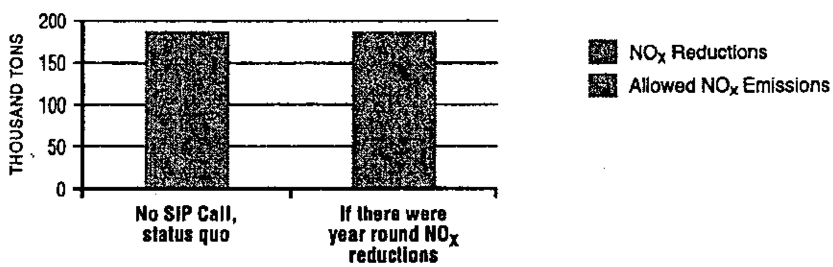


Figure 3:

Comparison Current Power Plant (no SIP requirement) NO_x Emissions from WI and MN vs Potential Year-Round NO_x Controls

(Based on 2001 emissions)



Nitrogen Oxides Pose A Serious Health Problem In The Midwest

Nitrogen dioxide causes respiratory ailments

Near emissions sources, short-term effects from nitrogen dioxide include coughs, exacerbation of existing respiratory problems, such as asthma and increases in respiratory illnesses in children.[3] Long-term exposure to local sources may alter lung tissues and lower resistance to lung infections.[4]

Nitrogen oxides contribute to unhealthy ozone levels in Midwestern urban centers

Ground level ozone can irritate lung airways, causing sunburn-like inflammations, and in some cases, in mortality.[5] Other reactions to breathing smoggy air include wheezing, coughing, pain when taking a deep breath, and breathing difficulties during exercise or outdoor activities.[6] The developing lungs of young children are particular susceptible to ozone, and exposure in utero can cause birth defects[7] and even infant death.[8] In the general population, people with respiratory problems are most vulnerable, but healthy people, who are active outdoors, can also be affected when ozone levels are high. And even at low concentrations, health problems can be triggered.[9] Table 2 provides state-specific information on health impacts from ozone.

Because production of tropospheric ozone is enhanced in the presence of heat and sunlight, formation of ground level ozone is largely a warm weather problem. From May through October, unhealthy ozone is a pervasive problem throughout the Midwest,[10] with bad air quality persisting for many hours throughout the summer.[11] This extended exposure has resulted in higher per capita respiratory hospital admissions from ozone in the Ohio River Valley than many other parts of the country.[12] Figure 4 is derived from a now-annual American Lung Association report that tracks ozone concentrations, nationwide over a three-year, rolling period. It shows that in the years 1998 to 2000, areas in the Midwest with at least one day of unhealthy ozone (as defined by EPA) were common. In most of these areas, unhealthy ozone occurred much more frequently than one day in a three-year period. Metropolitan-specific information can be found at the American Lung Association website.

Table 2:

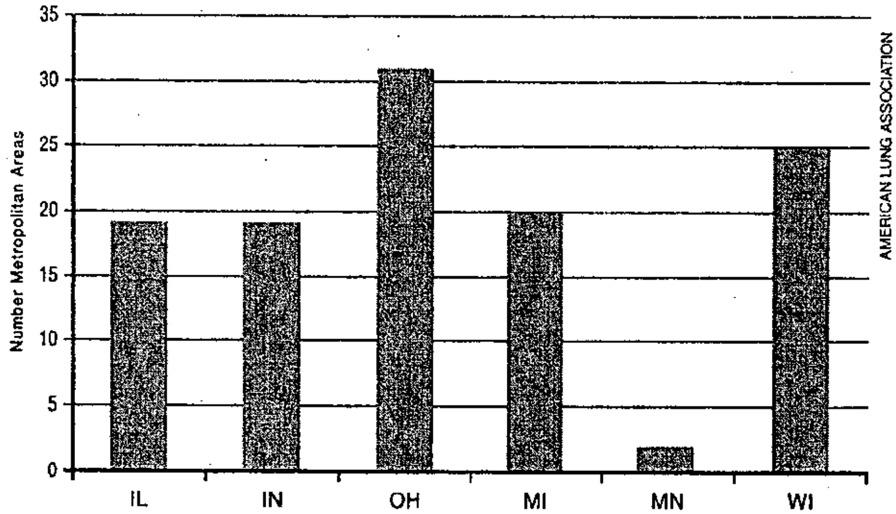
Modeled Ozone-Related Adverse Health Effects by State

State	Repiratory Hospital Admissions	Cardiovasc. Hospital Admissions	Total Repiratory ER visits	Asthma ER Visits	Minor Symptoms	Shortness of Breath	Asthma Attacks
Illinois	2,400	740	7,200	770	4,000,000	24,000	310,000
Indiana	1,500	480	4,500	470	2,500,000	8,000	190,000
Michigan	2,100	670	6,300	660	3,600,000	20,000	280,000
Minnesota	1,100	340	3,300	300	1,600,000	1,700	120,000
Ohio	2,800	830	8,400	870	4,700,000	19,000	350,000
Wisconsin	1,400	420	4,200	380	1,900,000	5,100	150,000

ABT ASSOCIATES, 1999

Figure 4:

Number of Metropolitan Areas, by State, with at Least One Day of Unhealthy Ozone During 1998-2000



Nitrogen oxides contribute to dangerous fine particulate matter pollution

When present in the atmosphere, nitrates[13] form fine particles (or aerosols), less than 1/100th of a human hair.[14] Nitrate particulate matter can form a significant fraction of measured $PM_{2.5}$, an EPA-required measurement of all fine particles. Nitrates are typically so tiny they can be inhaled deeply and become lodged in the lungs where they have adverse health consequences. Particulates reduce lung function in children[15] and a mother's exposure can stunt in utero growth.[16] For adults, short-term exposure to $PM_{2.5}$ results in lost work days and raises the likelihood of incurring respiratory (bronchitis, asthma) and heart illnesses.[17] In addition to the short-term effects, long-term exposure increases the risk of death[18] and shortens life spans by a few months to a few years.[19] There is no "safe" threshold for $PM_{2.5}$ below which no effect occurs.[20]

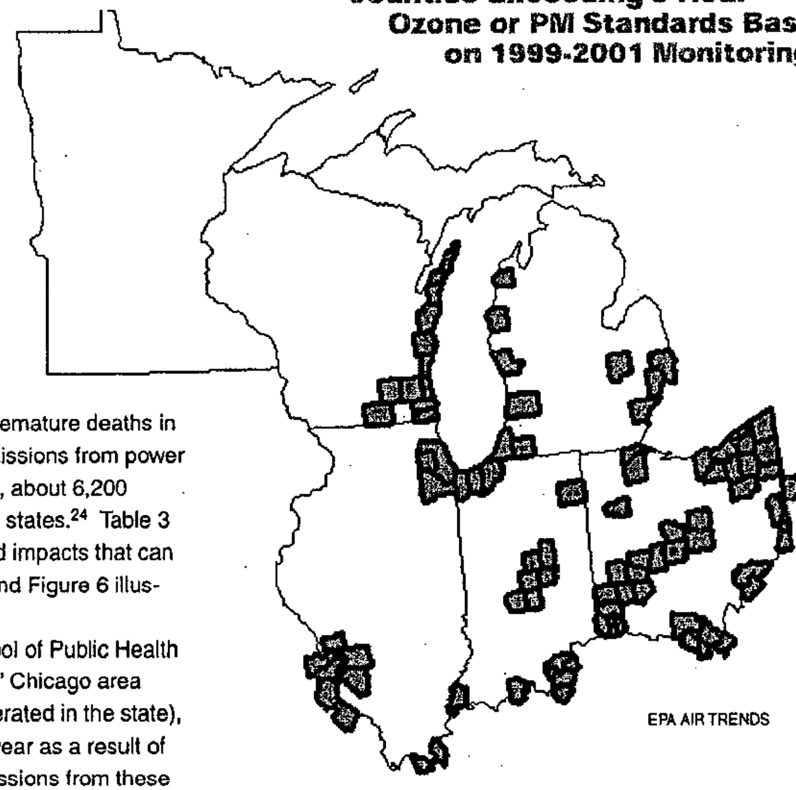
As the concentration of fine particles rises, healthy adult lung function can decline, and risk for heart attacks increases.[21] What this means is that fine particles may adversely impact human health at any concentration.

Populations most at risk of dying prematurely as a result of fine particles are the young, the old and persons who already suffer from lung and heart ailments. Studies have found communities with dirtier air to be associated with greater likelihood of premature death than areas with cleaner air.[22]

Fine particles are a serious problem in the Midwest, with millions of residents living in areas where particulate matter levels exceed the national standard of 15 micrograms per cubic meter of air (ug/m³). Figure 5 shows the combined $PM_{2.5}$ and ozone exceedances in the Midwest states. The high number of $PM_{2.5}$ exceedances makes it clear that people living in the Midwest are particularly at-risk to the impacts from fine particles. Nitrates, while a contributor to $PM_{2.5}$ year-round, have an even greater impact on $PM_{2.5}$ levels in winter months when they can make up over 50 percent of the particle mass.[23]

Figure 5:

Counties Exceeding 8 Hour Ozone or PM Standards Based on 1999-2001 Monitoring



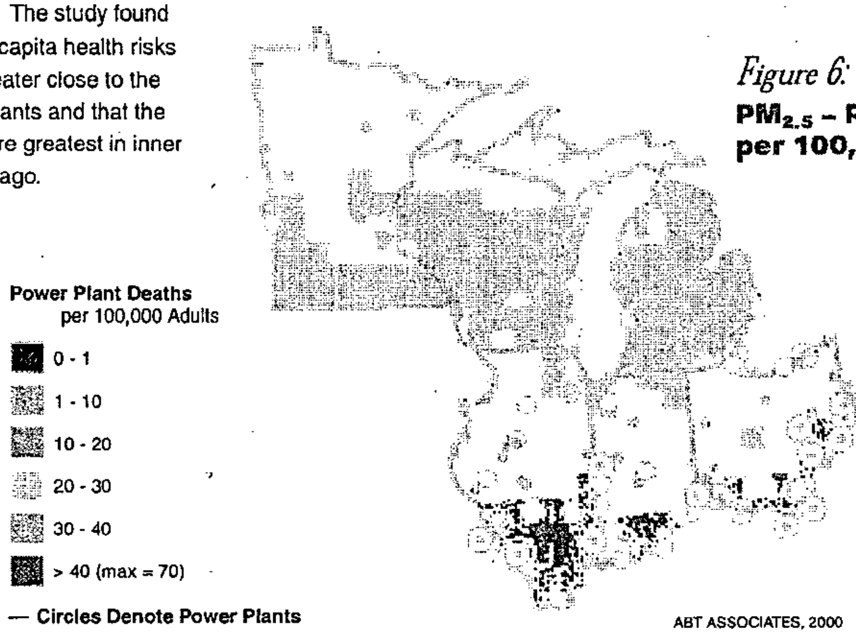
EPA AIR TRENDS

A recent report estimated 30,000 premature deaths in the U.S. each year are attributable to emissions from power plant-related particulate matter. Of these, about 6,200 deaths per year occur in the six Midwest states.[24] Table 3 summarizes state-by-state health-related impacts that can be attributed to fine particulate matter, and Figure 6 illustrates fine particle-related deaths.

According to a recent Harvard School of Public Health study of only nine power plants in Illinois' Chicago area (representing one fifth of the power generated in the state), there are about 320 excess deaths per year as a result of the fine particulate matter related to emissions from these plants.[25] The study found that per capita health risks were greater close to the power plants and that the risks were greatest in inner city Chicago.

Figure 6:

$PM_{2.5}$ – Related Deaths per 100,000 Population



ABT ASSOCIATES, 2000

Table 3:

Estimated Health Impacts from Fine Particulate Matter

ESTIMATE – Year 2007 / current emissions				Asthma Attacks	Deaths per 100,000	Chronic Bronchitis	Asthma ER Visits	Work Loss Days	Minor Restricted Activity Days
State	Pop 2007	Deaths	Hosp						
Illinois	12,434,632	1,695	1,113	33,126	24.6	1,021	385	282,705	1,454,490
Indiana	6,253,063	1,024	681	20,469	29.8	626	239	172,816	885,690
Michigan	9,813,453	870	578	18,527	16.3	564	215	158,856	817,280
Minnesota	5,070,807	246	182	5,821	9.0	175	60	49,836	258,057
Ohio	11,577,089	1,915	1,252	37,067	29.7	1,145	443	313,289	1,602,140
Wisconsin	5,570,223	447	318	9,348	14.6	283	100	79,303	408,749

ABT ASSOCIATES, 2000

Particulate matter equals hazy parks and city skylines especially in winter months

The spectacular scenic vistas in Midwest parks, wilderness areas and city skylines are blighted by the same fine particles that lodge deep into peoples' lungs. These particles degrade sharp, colorful scenes, leaving them shrouded in a milky white haze. Nitrates contribute to the hazy air, diminishing our ability to enjoy scenic views and urban landscapes and tarnish the image of our cities. As shown in Figure 7, on an annual basis, nitrates represent about one-fifth of the light-extinguishing particles in Minnesota's Boundary Waters National Park.

Haze Conditions from Navy Pier, Chicago, Illinois in 2001.

Note degradation in visibility under moderate particulate matter levels.

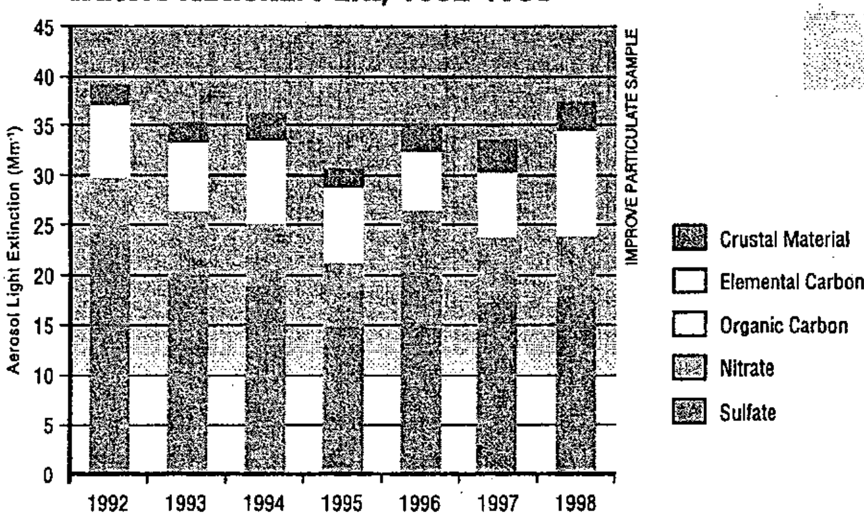
Left: August 26, 2000 – $PM_{2.5}$ = 35 µg/m³

Below: August 16, 2000 – $PM_{2.5}$ <10.0 ug/m³

PHOTOS: ILLINOIS EPA

Figure 7:

Contribution of NO_x and Other Species to Visibility Deterioration in Boundary Waters National Park, 1992-1998

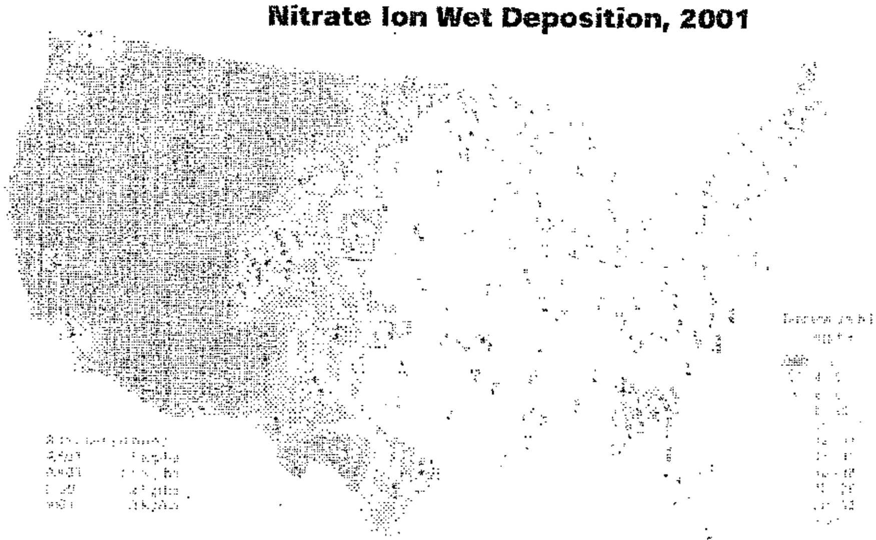


Ecosystems Are Damaged By Nitrogen And Ozone

Midwest has high exposure to nitric acid deposition

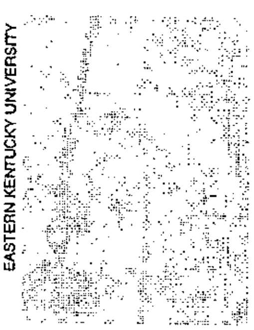
Nitrates fall to the earth's surface as acid deposition in rain, snow and fog as well through dry deposition. How a site handles this acidity depends on the level of deposition, soils and underlying geology. Figure 8 demonstrates that the Midwest states have among the highest deposition of nitrates the country. However, most of the soils in the Midwest are well buffered – that is they have ample supplies of bases such as calcium and magnesium to neutralize high acid inputs. A lower elevation, especially when compared to higher elevation sites to the east, also provides protection.

Figure 8:
Nitrate Ion Wet Deposition, 2001



NATIONAL ATMOSPHERIC DEPOSITION PROGRAM/ NATIONAL TRENDS NETWORK – http://nadp.sws.uiuc.edu

But not all sites in the region are well buffered. The sandstone-based soils of southern Illinois, Indiana and Ohio are vulnerable to acid inputs. In areas of highest deposition, these soils were found to have higher acidity, less calcium, and reduced populations and species diversity of earthworms and other invertebrates. In addition, growth declines of oaks were correlated to the acidity of the site, i.e. the more acidic, the less growth.[26]



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And being well buffered does not mean that there is no impact. Modeling work conducted in the early 90s showed that the buffering capacity of Ohio soils downwind of Akron and Cleveland were depleted much faster than soils in parts of the states that received less acidic deposition, suggesting that eventually these buffered soils, and the plants that rely on them, can be altered by acid rain.[27]

Finally, Minnesota and Wisconsin are home to many naturally acidic lakes. In these lakes, there is very little natural buffering capacity, and thus even small changes in acidic deposition can harm the aquatic life in those lakes.

There is also demonstrated damage occurring close to the borders of Midwest states. Sugar maple health across thousands of acres in western Pennsylvania is degraded,[28] and acid-sensitive fish have disappeared from Pennsylvania streams where they formerly occurred in large numbers.[29]

Figures 9 and 10 show nitrate deposition at National Atmospheric Deposition Program sites in two representative Midwestern states – Wisconsin and Ohio – for the years 1997 through 2001.[30] These charts reflect that at most sites nitrate deposition is either unchanged or on the rise. (Note that not all sites have data for all five years.) This raises a troubling point, that despite declining emissions, that there is not an equivalent change in the nitrate deposition burden.

Figure 9:
Nitrate Deposition, Wisconsin 1997-2001

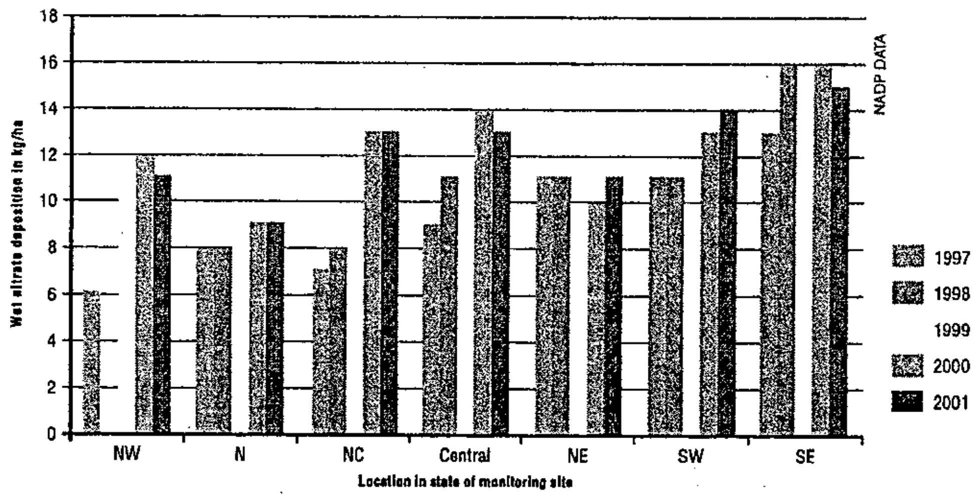
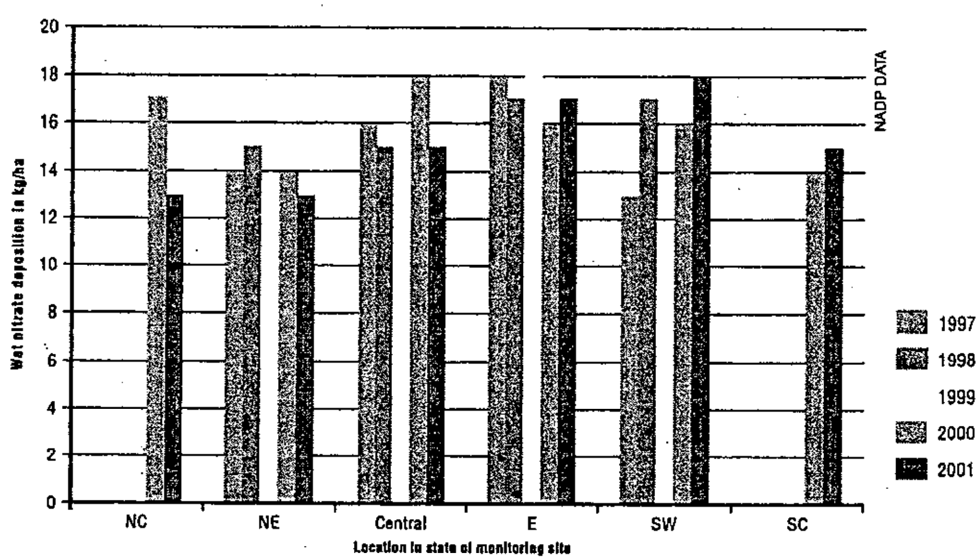


Figure 10:
Nitrate Deposition, Ohio 1997-2001



Loss of species diversity

Most ecosystems have developed with a limited supply of nitrogen. Increases of nitrogen, therefore, can cause a shift in the dominant species and reduce species diversity as the plants adapted to take advantage of high nitrogen are able to force out many native plants. Research at the University of Minnesota has shown that increased nitrogen in grasslands changes plant and insect species composition and species diversity.[31] Increasing the nitrogen available in the soil can offer an edge to some weeds that have evolved to take advantage of normally rare periods of abundant nitrogen. Rapidly growing weeds, which are often invaders from other ecosystems, can overwhelm native species.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In sugar maple forests across northern tier states – from northeastern Minnesota to southwestern Michigan – deposition of nitrogen has been found to alter nitrogen cycling and accelerate the loss of plant nutrients from forest soils.[32] The changes from these soil changes may be subtle, but if they persist they could affect long-term forest health.

[illegible]

Nitrogen from watersheds originating in Great Lake states is contributing to the "dead zone" in the Gulf of Mexico, which, in the summer of 2002, covered 8500 square miles, the size of Massachusetts.[33] When the nitrogen-rich waters of the Mississippi River flow into the poorly mixed, shallow Gulf waters, excessive algae is produced. This excess algae consumes oxygen during decomposition, leaving waters oxygen depleted.[34] Fish and other marine animals need oxygen for survival. When it is not available, some species die, and others swim into more oxygen-rich waters.

Atmospheric sources of nitrogen account for nearly 20 percent of the total amount of nitrogen reaching the Gulf. Over half of that 20 percent comes from Midwest sources.[35]

In the Ohio River watershed, nearly 25 percent of the region's nitrogen that reaches the Gulf of Mexico comes from the atmosphere. Smaller, but not insignificant, amounts come other Midwest states that feed into the Mississippi River. By percent, contribution from Ohio is followed closely by Indiana, then Illinois, Wisconsin and Minnesota.[36]

NOAA

Ozone suppresses crop yield and tree growth

Ozone affects plants through short-term, highly concentrated exposure as well as prolonged exposure at lower concentrations. There is no "safe" threshold ozone concentration or seasonal exposure level above which effects do not occur. Depending on the duration of exposure and sensitivity of plants, injury can even result from exposures that typically occur throughout the growing season. Once in the plant, ozone interferes with plant chemistry, reduces plant growth and yield and/or compromises the ability of a plant to withstand other stresses such as cold, insects and diseases.

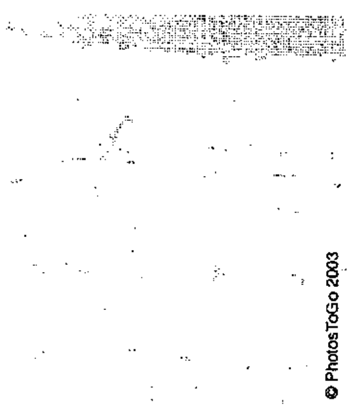

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Table 4 shows exposure to ozone for the three major commodity crops grown in Minnesota, Wisconsin, Michigan, Illinois, Indiana and Ohio (representing up to 80 percent of regional crop production) is costing Midwest farmers between $227,330,000 - 664,278,000 annually.[37]

These same levels of ozone affect forests as well. The US Forest Service has identified areas in Michigan and Wisconsin where forests show visible signs – mottled and discolored leaves – of ozone impacts.[38] Modeling results indicate that tree growth is slowed in all Midwest states for black cherry, red maple, white pine and aspen.[39]

Table 4:
Impact of Ozone in 1997 on Major Crops by State

State	Annual production value for corn, soybeans & wheat *(in thousand dollars)*	Estimated value in production without ozone loss *(in thousand dollars)*	Annual cost of crop loss of three major commodity crops due to ozone exposure *(in thousand dollars)*
Illinois	$6,872,106	$6,917,825 - 7,049,096	$45,719 - 176,990
Indiana	$3,621,561	$3,709,463 - 3,799,839	$87,902 - 178,278
Michigan	$1,204,150	$1,214,788 - 1,237,666	$10,638 - 33,516
Minnesota	$4,655,007	$4,655,007 - 4,743,453	$0 - 88,446
Ohio	$2,938,770	$3,021,841 - >3,093,193	$83,071 - >154,423
Wisconsin	$1,717,072	$1,717,072 - 1,749,697	$0 - 32,625
Total	**$21,008,666**	**$21,235,996 - >21,672,944**	**$227,330 - >664,278**

EPA AND USDA DATA

Current Planned Reductions Of Nitrogen Oxide Emissions Do Not Go Far Enough

Under the EPA's ozone transport rule that was finalized in 1998, most states east of the Mississippi River must significantly reduce their summertime emissions of NO_x to control ozone formation. This rule directly impacts power plant emissions from four Midwest states: Illinois, Indiana, Ohio and Michigan. These four states were required to develop state implementation plans (SIPs) to reduce ozone, and NO_x cutbacks are an important part of these reduction strategies. These cuts are required only during the summertime to control ozone concentrations when they are at their highest. However, making the cuts only in summer months does not help curb problems related to winter NO_x emissions – in particular the dominance of NO_x in winter fine particulates and the deposition of nitrates in non-summer months when ecosystems are particularly sensitive. And the ozone transport rule does not cover Minnesota or Wisconsin, and both of these states have areas on the verge of being in non-attainment with the new ozone standard being implemented now by EPA. Table 5 shows expected NO_x reductions under the SIP call as well as what the reductions would be were the cuts extended year round and geographically.

Reducing NO_x emissions year round and including Minnesota and Wisconsin gets NO_x emissions close to the target range of power plant pollutant reduction bills that have been introduced in the US Congress, illustrating that by many disparate measures, the Midwest has a ways to go to fully clean up its power plant NO_x emissions.

Table 5:

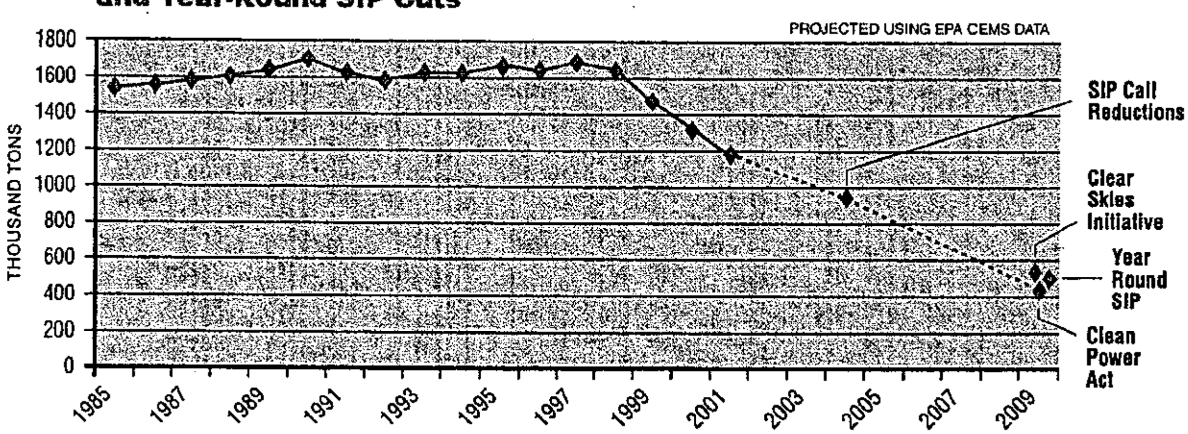
Current Power NO_x Emissions to SIP Call and Potential Year-Round Reductions, in tons

State	Power plant emissions during 2001	Year round NO_x emissions under summer-time SIP call	NO_x emissions allowed if included WI & MN and were year-round
Illinois	199,859	148,957	73,692
Indiana	306,531	226,541	114,555
Michigan	140,951	114,688	77,921
Minnesota	81,083	81,083	32,126
Ohio	332,957	243,491	118,239
Wisconsin	101,083	101,083	40,051
TOTAL	**1,162,464**	**915,843**	**456,584**

PROJECTED USING EPA CEMS DATA

Figure 11:

Emissions Midwest Power Plant NO_x 1985-2001, with Current SIP Call and Targets from Proposed Power Plant Legislation and Year-Round SIP Cuts



Technologies To Reduce Nitrogen Oxides From Power Plant Have Been In Use For Two Decades

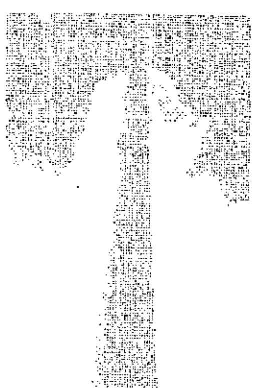
Emissions controls are in use today that minimize the formation of NO_x during the combustion process and reduce the amount of NO_x formed during combustion prior to exiting the stack into the atmosphere. Selective catalytic removal (SCR) systems typically reduce as much as 90 percent and on some occasions even a higher percentage of NO_x gas emissions from coal-fired power plant smokestacks.[40] SCR technologies, which add only a small fraction to the cost of electricity, have been used worldwide since the 1980s.

HUNTINGTON ENVIRONMENTAL SYSTEMS

Solutions

Call on state and federal lawmakers to:

- **Clean up power plants.** Electric power generation is responsible for approximately one-third of the NO_x emissions in the United States. For over thirty years, the oldest, dirtiest coal-burning power plants have circumvented the most protective air emissions standards required of modern plants. As a result, these grandfathered power plants are allowed to emit as much as four times more NO_x than modern power plants. And while some Midwest power plants are beginning to clean up under the summertime reduction rule, the rule does not cover all of the Midwest and does not address wintertime NO_x impacts. All polluting power plants must be made to comply with year-round modern emissions control standards. Proven NO_x emission controls, together with more efficient fuel-burning processes, mean that there are no technological barriers to cleaning up the oldest and dirtiest plants. Modernizing power plants will protect our health and environment.



Call on EPA to:

- **Aggressively implement the new ozone and $PM_{2.5}$ standard.** EPA will soon be designating areas as out of attainment with national air quality standards for ozone and fine particle pollution. All Midwestern states, except Minnesota, have areas that are certain to fail one or both standards. The agency must help the states meet these standards as soon as possible by adopting a rule to reduce interstate pollution from power plants.
- **Stop the effort to weaken the Clean Air Act.** The EPA has proposed revising a section of the Clean Air Act, known as New Source Review, in a way that will allow grandfathered power plants to increase pollution and undercut the ability of state and local officials to meet new air quality standards. The New Source Review program requires that any facility that makes a major modification and increases their air emissions must install the best available control technology. The changes to the program were first proposed by Vice-President Cheney as part of the Administration's energy policy. Some of the proposed changes would allow grandfathered power plants to invest as much as $150 million per year to rebuild old plants and perpetuate their grandfathered status under the law, while claiming the investments are "routine maintenance," thus allowing them to avoid having to install pollution controls.
- **Aggressively enforce lawsuits against power plants that illegally upgraded their facilities.** EPA has taken enforcement actions against numerous Midwest power plants for upgrading the capacities of their coal plants and evading the permitting process that would require new air pollution controls. The agency must ensure these actions, brought under the current New Source Review provision, are completed, and the plants are required to clean up.

You can:

- **Use less energy.** The United States uses more energy per capita than any other country. Using less energy and using energy more efficiency will reduce the amount of nitrogen in our air and water.

Endnotes

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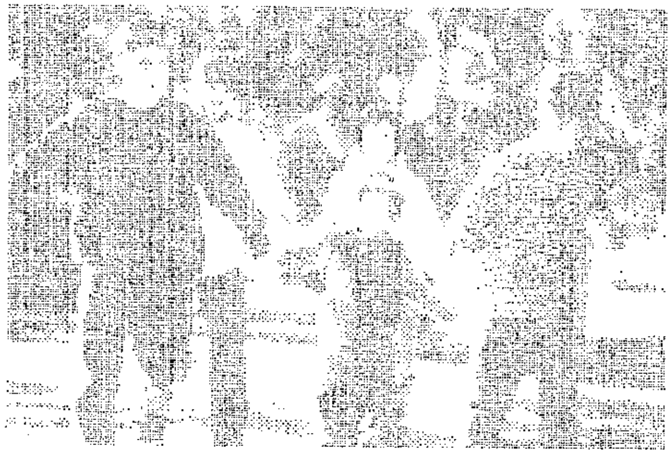
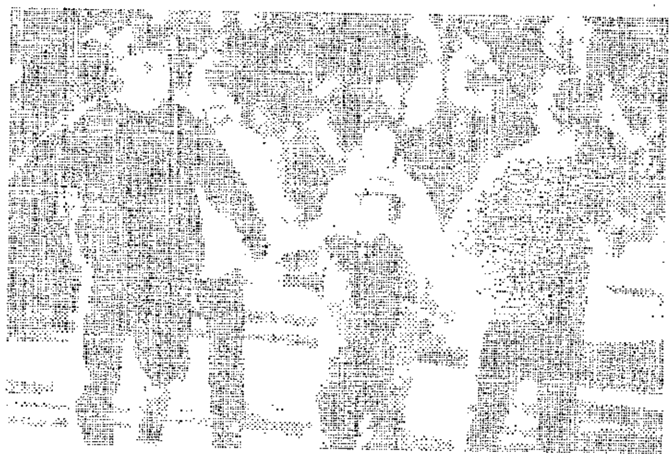


CLEAN AIR TASK FORCE

77 Summer Street, Boston, MA 02110
Tel: 617-292-0234 • Fax: 617-292-4933



CLEAN AIR TASK FORCE

77 Summer Street, Boston, MA 02110
Tel: 617-292-0234 • Fax: 617-292-4933

AFFIDAVIT

Before me, the undersigned authority personally appeared Ellen Baum who, being by me duly sworn, deposed as follows:

1. My name is Ellen Baum. I am of sound mind, capable of making this Affidavit, and personally acquainted with the facts herein stated.

2. I am a custodian of the records of the Clean Air Task Force, a not-for-profit organization.

3. Attached hereto are 13 pages of records from the Clean Air Task Force. These 13 pages of records are kept by me in the regular course of business of the Clean Air Task Force and it was the regular course of business of the Clean Air Task Force for an employee or representative of said organization with knowledge of the act, event, condition, opinion or diagnosis recorded to make the record or to transmit the information thereof to be included in such record; and the record was made at or near the time of the act, event, condition, opinion or diagnosis. The records attached hereto are the original or exact duplicates of the original.

Ellen Baum
Affiant.

STATE OF Maine)
) ss
COUNTY OF Cumberland)

IN WITNESS WHEREOF, I have hereunto subscribed my name and affixed my official seal this 21st day of December, 2004.

Conrad Schneider
Notary Public
007768

My Commission expires:

August 31, 2005

Stop
EXHIBIT
60
1-5-05

Bob Holden, Governor • Stephen M. Mahfood, Director
STATE OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
www.dnr.mo.gov

DEC 29 2004

Mr. Block Andrews
Director of Environmental Services
Aquila, Incorporated
20 West 9th Street
Kansas City, MO 64105

RE: New Source Review Permit - Project Number: 2004-03-143

Dear Mr. Andrews:

Enclosed with this letter is your permit to construct. Please study it carefully. Also, note the special conditions, if any, on the accompanying pages. The document entitled, "Review of Application for Authority to Construct," is part of the permit and should be kept with this permit in your files.

Operation in accordance with these conditions, your new source review permit application and with your Part 70 Operating Permit Application is necessary for continued compliance.

The reverse side of your permit certificate has important information concerning standard permit conditions and your rights and obligations under the laws and regulations of the State of Missouri.

If you have any questions regarding this permit, please do not hesitate to contact me at (573) 751-4817, or you may write to the Department of Natural Resources' Air Pollution Control Program, P.O. Box 176, Jefferson City, MO 65102.

Thank you,

AIR POLLUTION CONTROL PROGRAM

Kendall B. Hale

Kendall B. Hale
New Source Review Unit Chief

KLM:lkb

Enclosures

c: Kansas City Regional Office
PAMS File: 2004-03-143

Permit Number: 122004-017

DEFENDANT'S EXHIBIT NO. 142

STATE OF MISSOURI

DEPARTMENT OF NATURAL RESOURCES

MISSOURI AIR CONSERVATION COMMISSION

PERMIT TO CONSTRUCT

Under the authority of RSMo 643 and the Federal Clean Air Act the applicant is authorized to construct the air contaminant source(s) described below, in accordance with the laws, rules and conditions as set forth herein.

Permit Number: 122004-017 Project Number: 2004-03-143

Owner: Aquila, Incorporated

Owner's Address: 20 West 9th Street, Kansas City, Missouri 64105

Installation Name: South Harper Peaking Facility

Installation Address: 24110 S. Harper Road, Peculiar, Missouri 64078

Location Information: Cass County, S29/32, T45N, R32W

Application for Authority to Construct was made for:

Installation of three natural gas fired simple cycle combustion turbines, a 9.8 million Btu per hour natural gas fired heater, and a 0.47 million Btu per hour emergency diesel fire pump to generate a total nominal electrical power output of 341 megawatts during peak electricity demand periods. This review was conducted in accordance with Section (8), Missouri State Rule 10 CSR 10-6.060, *Construction Permits Required*.

☐ Standard Conditions (on reverse) are applicable to this permit.

☑ Standard Conditions (on reverse) and Special Conditions (listed as attachments starting on page 2) are applicable to this permit.

DEC 29 2004

EFFECTIVE DATE

DIRECTOR OR DESIGNEE
DEPARTMENT OF NATURAL RESOURCES

MO 780-1204 (1-03)

STANDARD CONDITIONS:

Permission to construct may be revoked if you fail to begin construction or modification within two years from the effective date of this permit. Permittee should notify the Air Pollution Control Program if construction or modification is not started within two years after the effective date of this permit, or if construction or modification is suspended for one year or more.

You will be in violation of 10 CSR 10-6.060 if you fail to adhere to the specifications and conditions listed in your application, this permit and the project review. Specifically, all air contaminant control devices shall be operated and maintained as specified in the application, associated plans and specifications.

You must notify the Air Pollution Control Program of the anticipated date of start up of this (these) air contaminant source(s). The information must be made available not more than 60 days but at least 30 days in advance of this date. Also, you must notify the Department of Natural Resources Regional Office responsible for the area within which you are located within 15 days after the actual start up of this (these) air contaminant source(s).

A copy of this permit and permit review shall be kept at the installation address and shall be made available to Department of Natural Resources' personnel upon request.

You may appeal this permit or any of the listed Special Conditions as provided in RSMo 643.075. If you choose to appeal, the Air Pollution Control Program must receive your written declaration within 30 days of receipt of this permit.

If you choose not to appeal, this certificate, the project review, your application and associated correspondence constitutes your permit to construct. The permit allows you to construct and operate your air contaminant source(s), but in no way relieves you of your obligation to comply with all applicable provisions of the Missouri Air Conservation Law, regulations of the Missouri Department of Natural Resources and other applicable federal, state and local laws and ordinances.

The Department of Natural Resources has established the Outreach and Assistance Center to help in completing future applications or fielding complaints about the permitting process. You are invited to contact them at 1-800-361-4827 or (573) 526-6627, or in writing addressed to Outreach and Assistance Center, P.O. Box 176, Jefferson City, MO 65102-0176.

The Air Pollution Control Program invites your questions regarding this air pollution permit. Please contact the Construction Permit Unit at (573) 751-4817. If you prefer to write, please address your correspondence to the Air Pollution Control Program, P.O. Box 176, Jefferson City, MO 65102-0176, attention Construction Permit Unit.

Page No.	2
Permit No.	122004-017
Project No.	2004-03-143

SPECIAL CONDITIONS:

The permittee is authorized to construct and operate subject to the following special conditions:

The special conditions listed in this permit were included based on the authority granted the Missouri Air Pollution Control Program by the Missouri Air Conservation Law (specifically 643.075) and by the Missouri Rules listed in Title 10, Division 10 of the Code of State Regulations (specifically 10 CSR 10-6.060). For specific details regarding conditions, see 10 CSR 10-6.060 paragraph (12)(A)10. "Conditions required by permitting authority."

South Harper Peaking Facility
Cass County, S29/32, T45N, R32W

1. Operational Limitation
   - A. South Harper Peaking Facility (Aquila) shall burn only natural gas from the three natural gas fired simple cycle combustion turbines. If Aquila wishes to use any other type of fuel in the future in any of the three turbines, the Best Available Control Technology (BACT) analysis and ambient air quality analysis will need to be re-evaluated.

   - B. Aquila shall limit the total hours of operation of the three Siemens-Westinghouse Model 501D5A turbines (Emissions Points EP-01, EP-02, and EP-03) to less than 5,000 hours in any consecutive 12-month period.

   - C. Aquila shall limit the total hours of operation of <u>each</u> of the three Siemens-Westinghouse Model 501D5A turbines (EP-01, EP-02, and EP-03) to less than 2,000 hours in any consecutive 12-month period, except in the case of a Force Majeure Event. In the case of a Force Majeure Event that renders one or two gas turbines inoperable, the total unused permitted hours of operation may be transferred to the remaining operable unit(s). In order for an event to be considered a Force Majeure Event, Aquila must receive approval from the Air Pollution Control Program's Enforcement Section.

   - D. Except during periods of startup and shutdown, Aquila shall limit the total hours of operation of the gas heater (EP-04) to less than 6,000 hours in any consecutive 12-month period.

   - E. Except during periods of startup and shutdown, Aquila shall run the three Siemens-Westinghouse Model 501D5A turbines (EP-01, EP-02, and EP-03) at a load level no less then 75 percent.

   - F. Aquila shall only operational test the emergency fire pump between the hours of 1:00 p.m. and 5:00 p.m. and shall limit the total hours of operation to less than 250 hours in any consecutive 12-month period.

SPECIAL CONDITIONS:

The permittee is authorized to construct and operate subject to the following special conditions:

2. Emission Limitation
   A. Except during periods of startup and shutdown, Aquila shall limit Nitrogen Oxide (NO_X) emissions from each of the Siemens-Westinghouse Model 501D5A turbines (EP-01, EP-02, and EP-03) to 15 parts per million by volume (ppmvd) corrected to 15 percent (%) oxygen on a dry basis for a three-hour rolling average.

   B. Except during periods of startup and shutdown, Aquila shall limit Carbon Monoxide (CO) emissions from each of the Siemens-Westinghouse Model 501D5A turbines (EP-01, EP-02, and EP-03) to 25 ppmvd corrected to 15 percent (%) oxygen on a dry basis for a one hour rolling average.

   C. Except during periods of startup and shutdown, Aquila shall limit emissions of Particulate Matter less than ten microns in aerodynamic diameter (PM_{10}) to less than 15.25 pounds per hour when utilizing wastewater injection for Turbine Number One (Siemens-Westinghouse Model 501D5A, EP-01) and 10.00 pounds per hour each from Turbine Numbers Two and Three (Siemens-Westinghouse Model 501D5A, EP-02 and EP-03) and Turbine One when not using wastewater injection.

3. Compliance Testing
   Stack tests shall be performed on one of the three identical gas turbines permitted herein at Aquila sufficient to demonstrate compliance with the Special Conditions contained in this permit. Specifically, the stack testing shall:
   A. Demonstrate compliance with the emission limitations specified in Special Conditions 2.A through 2.C.

   B. Develop a formaldehyde emission factor in order to verify the validity of the emission factor used for the modeling analysis. In the event that the stack testing results in an emission factor that exceeds that used in this review, a revised modeling analysis will need to be submitted by Aquila. The revised modeling must be submitted to the Director of the Air Pollution Control Program within 90 days of completion of the required testing.

   C. Demonstrate compliance with Subpart GG, *Standards of Performance for Stationary Gas Turbines,* of the New Source Performance Standards (NSPS).

   D. Be conducted across the full range of loads (i.e. 75%, 85%, and 100%) that the turbines are expected to operate.

SPECIAL CONDITIONS:

The permittee is authorized to construct and operate subject to the following special conditions:

E. The stack test shall be performed within 60 days of achieving the maximum production rate of the turbines but no later than 180 days after initial startup for commercial operation of the turbines and shall be conducted in accordance with the stack procedure outlined in Special Conditions 3.A through 3.D. The test shall be conducted every five (5) years from the date of the initial test.

F. The date on which performance tests are conducted must be pre-arranged with the Air Pollution Control Program a minimum of 30 days prior to the proposed test so that a pretest meeting may be arranged if necessary, and to assure that the test date is acceptable for an observer to be present. A completed Proposed Test Plan form (copy enclosed) may serve the purpose of notification and must be approved by the Air Pollution Control Program prior to conducting the required emission testing.

G. Two copies of a written report of the performance test results shall be submitted to the Director of the Air Pollution Control Program within 30 days of completion of any required testing. The report must include legible copies of the raw data sheets, analytical instrument laboratory data, and complete sample calculations from the required EPA method for at least one sample run.

H. The test report is to fully account for all operational and emission parameters addressed by these permit conditions as well as in Subpart GG of the NSPS.

I. Pursuant to 40 CFR §60.8(b)(3) and subject to the following conditions, Aquila may substitute the 40 CFR Part 75 NO_X and diluent continuous emission monitoring system (CEMS) certification procedures for the Reference Method 20 testing for the purpose of demonstrating initial compliance with Subpart GG of the NSPS. If the Part 75 NO_X and diluent CEMS certification procedures are chosen to demonstrate initial compliance, Aquila shall adhere to the following requirements:

1) Aquila shall successfully complete the Part 75 NO_X and diluent CEMS certification tests so that the data are, at a minimum, conditionally certified prior to the testing deadlines outlined in 40 CFR §60.8(a) or Part 75, whichever date is earlier.

2) Aquila shall perform a stratification test for NO_X and diluent pursuant to the procedures specified in 40 CFR Part 75, Appendix A, Section 6.5.6.1(a) through (e) or Section 6.5.6.2 (a) through (e).

SPECIAL CONDITIONS:

The permittee is authorized to construct and operate subject to the following special conditions:

Once the stratification sampling is completed, Aquila shall analyze the data using the procedures in Section 6.5.6.3(a) and (c) to determine if subsequent RATA testing will occur along a short or long reference method measurement line. The short or long reference method measurement line, as determined above, will serve in lieu of the sampling points usually required by Reference Method 20. In no case shall RATA be based on fewer than three sample points as specified in 40 CFR Part 60, Appendix B, Performance Specification 2, Section 3.2.

3) Since the PSD permit limits Aquila to only natural gas, the SO_2 measurement requirements under 40 CFR Part 60, Appendix A, Reference Method 20, Section 6.3 are waived pursuant to 40 CFR §60.8(b)(4).

4. Continuous Emission Monitoring System (CEMS)

A. Aquila shall install, calibrate, maintain, and operate CEMS, and record the output of the systems, for measuring NO_X emissions discharged into the atmosphere. The CEMS shall be installed and operated according to the guidelines in 40 CFR Part 75 for the NO_X and diluent CEMS requirements. These systems shall be placed in an appropriate location on each combustion turbine's flue gas exhaust such that accurate readings are possible.

B. Aquila shall install, calibrate, maintain, and operate a CEMS, and record the output of the systems, for measuring the oxygen (O_2) content of the flue gases at each location where NO_X emissions are monitored. The O_2 content of the flue gases may be determined by use of either an O_2 CEMS or a CO_2 CEMS. If Aquila elects to use a CO_2 CEMS, the conversion process in EPA Method 20 must be used to correct the NO_X concentrations to 15 percent O_2.

5. Record Keeping

A. Aquila shall keep monthly, and the sum of the most recent 12-months, records that are adequate to determine compliance with Special Condition Number 1.B (total installation hours of operation). Attachment A, *Operational Schedule of the Three Siemens-Westinghouse Model 501D5A Turbines*, or an equivalent form of the company's own design, is suitable for this purpose. The most recent 60 months of records shall be maintained on-site and shall be made immediately available to Missouri Department of Natural Resources' personnel upon request.

SPECIAL CONDITIONS:

The permittee is authorized to construct and operate subject to the following special conditions:

B. Aquila shall keep monthly, and the sum of the most recent 12-months, records that are adequate to determine compliance with Special Condition Number 1.C (individual turbine hours of operation). Attachment B, *Individual Turbine Operational Schedule*, or an equivalent form of the company's own design, is suitable for this purpose. The most recent 60 months of records shall be maintained on-site and shall be made immediately available to Missouri Department of Natural Resources' personnel upon request.

C. Aquila shall keep monthly, and the sum of the most recent 12-months, records that are adequate to determine compliance with Special Condition Number 1.D (gas heater hours of operation). Attachment C, *Gas Heater Operational Schedule*, or an equivalent form of the company's own design, is suitable for this purpose. The most recent 60 months of records shall be maintained on-site and shall be made immediately available to Missouri Department of Natural Resources' personnel upon request.

D. Aquila shall keep monthly, and the sum of the most recent 12-months, records that are adequate to determine compliance with Special Condition Number 1.F (fire pump hours of operation). Attachment D, *Fire Pump Operational Schedule*, or an equivalent form of the company's own design, is suitable for this purpose. The most recent 60 months of records shall be maintained on-site and shall be made immediately available to Missouri Department of Natural Resources' personnel upon request.

6. Reporting

A. Aquila shall report to the Air Pollution Control Program's Enforcement Section, P.O. Box 176, Jefferson City, Missouri 65102, no later than ten (10) days after the end of each month if the 12-month cumulative total (Special Condition 5.A) records show that the source exceeded the limitation of Special Condition 1.B (5,000 hours of operation).

B. Aquila shall report to the Air Pollution Control Program's Enforcement Section, P.O. Box 176, Jefferson City, Missouri 65102, no later than ten (10) days after the end of each month if the 12-month cumulative total (Special Condition 5.B) records show that the source exceeded the limitation of Special Condition 1.C (2,000 hours of operation per turbine).

C. Aquila shall report to the Air Pollution Control Program's Enforcement Section, P.O. Box 176, Jefferson City, Missouri 65102, no later than ten

SPECIAL CONDITIONS:

The permittee is authorized to construct and operate subject to the following special conditions:

(10) days after the end of each month if the 12-month cumulative total (Special Condition 5.C) records show that the source exceeded the limitation of Special Condition 1.D (6,000 hours of operation).

D. Aquila shall report to the Air Pollution Control Program's Enforcement Section, P.O. Box 176, Jefferson City, Missouri 65102, no later than ten (10) days after the end of each month if the 12-month cumulative total (Special Condition 5.D) records show that the source exceeded the limitation of Special Condition 1.F (250 hours of operation).

E. Pursuant to 40 CFR §60.13(i), Aquila may make use of 40 CFR Part 75, Appendix D as an alternative to the fuel monitoring and sulfur fuel sampling and analysis requirements of Subpart GG of the NSPS. If Aquila elects to use this alternative, Aquila is subject to the following requirements:

1) Aquila shall submit an excess emissions report to the Air Pollution Control Program's Enforcement Section consistent with the format and schedule described in 40 CFR §60.7(d); and

2) For the purpose of excess emission reporting, Aquila shall report each day during which the sulfur content of the fuel exceeds the 0.8 percent by weight limitation.

F. Aquila shall report to the Air Pollution Control Program's Enforcement Section, P.O. Box 176, Jefferson City, Missouri 65102, no later than ten (10) days after the end of the month, in which performance testing has been performed and indicates non-compliance with Special Condition 2.A, 2,B, or 2.C.

G. In the case of a Force Majeure Event, Aquila shall notify the Air Pollution Control Program's Enforcement Section, P.O. Box 176, Jefferson City, Missouri 65102, no later than ten (10) days after an event has occurred that Aquila feels meets the definition of a Force Majeure Event.

Note 1: The term "startup and shutdown" used herein is hereby defined as those periods of time that a gas turbine is operated at a load level less than 75%.

Note 2: The term "Force Majeure Event" used herein is hereby defined as any event, occurrence, or circumstance beyond the reasonable control of, and without the fault or negligence of, Aquila. "Force Majeure Event " shall include, but are not limited to, earthquakes, fires, floods, lightning strikes,

SPECIAL CONDITIONS:

The permittee is authorized to construct and operate subject to the following special conditions:

acts of the public enemy, war, or regulations or restrictions imposed by governmental, military, or lawfully established civilian authorities. A claim of Force Majeure Event is subject to the approval of the Air Pollution Control Program Enforcement Section.

REVIEW OF APPLICATION FOR AUTHORITY TO CONSTRUCT AND OPERATE
SECTION (8) REVIEW
Project Number: 2004-03-143
Installation ID Number: 037-0063
Permit Number: 122004-017

South Harper Peaking Facility
24110 S. Harper Road
Peculiar, Missouri 64708

Complete: March 29, 2004
Reviewed: April 7, 2004

Parent Company:
Aquila, Incorporated
20 West 9th Street
Kansas City, Missouri 64105

Cass County, S29/32, T45N, R32W

REVIEW SUMMARY

- South Harper Peaking Facility (Aquila) has applied for the authority to install three natural gas fired simple cycle combustion turbines to generate a total nominal electrical power output of 341 megawatts (MW) during peak electricity demand periods. The three gas turbines to be utilized are identical Siemens Westinghouse Model 501D5A units. The individual turbine units have a maximum hourly design rate (MHDR) heat input of 1,455 million British Thermal Units (MMBtu) per hour. The project will also consist of a 9.8 MMBtu per hour natural gas fired heater, used to pre-heat the natural gas fuel supplied to the turbines and a 0.47 MMBtu per hour emergency diesel fire pump.

- Hazardous Air Pollutant (HAP) emissions are expected from the heater and three turbines due to the combustion of natural gas and the fire pump due to the combustion of diesel fuel. The primary HAPs of concern from the proposed equipment are acrolein, formaldehyde, and polycyclic aromatic hydrocarbons (PAH). The potential emissions of formaldehyde (CAS Number 50-00-0) are above its respective threshold level, but less than major source levels.

- 40 CFR Part 60 Subpart GG, *Standards of Performance for Stationary Gas Turbines* is applicable to the three gas turbines permitted herein.

- None of the National Emission Standards for Hazardous Air Pollutants (NESHAP) in 40 CFR Part 61 are applicable to this project.

- Maximum Achievable Control Technology (MACT), Subpart YYYY, *Combustion Turbines* does not apply because potential emissions of individual and combined HAPs are indirectly limited to a de minimis level by the hours of operation conditions of this permit.

- This review was conducted in accordance with Section (8) of Missouri State Rule 10

CSR 10-6.060, *Construction Permit Required.* Potential emissions of PM_{10}, NO_X and CO are above major thresholds. Potential emissions of VOC are greater than de minimis levels. Potential emissions of individual and combined HAPs are indirectly limited to a de minimis level by the hours of operation conditions of this permit.

- Since potential emissions of total and individual HAPs are at de minimis levels, this installation is not considered a major source of HAPs as defined in 40 CFR Part 63, and 10 CSR 10-6.060(9).

- The Best Available Control Technology (BACT) requirements apply to the proposed equipment. The BACT analysis was based upon each turbine operating in simple cycle mode, burning exclusively natural gas, and operating only 2,000 hours per year. The gas heater will operate only 6,000 hours per year. NO_X emissions from the gas turbines will be controlled through the use of dry low-NO_X burners. Low NO_X burners will also be employed on the gas heater. Ignition Timing Retard will be used on the emergency fire pump for NO_X emission control. Good combustion practices will be utilized to control CO emissions. The exclusive use of low ash/low sulfur containing fuel, together with good combustion practices, will be utilized in controlling PM_{10} and SO_X emissions from all equipment. A re-evaluation of the BACT analysis and/or ambient air quality analysis will be required if South Harper Peaking Facility wishes to: retrofit the turbines with a heat recovery steam generator within a short period of time (e.g. 4-5 years) that would otherwise be accommodated within a phased Prevention of Significant Deterioration (PSD) permit, burn other forms of fuel in any of the equipment, or wishes to increase the hours of operation limitation for any piece of equipment.

- This installation is on the List of Named Installations [10 CSR 10-6.020(3)(B), Table 2] Number 27. A stationary source category which, as of August 7, 1980, is being regulated under Section 111 or 112 of the Act. This installation is subject to Subpart GG of the NSPS, which applies to gas turbines installed after October 3, 1977. Therefore, the major source threshold for all criteria pollutants is 100 tons per year.

- This installation is located in Cass County, which is not currently designated nonattainment for any criteria pollutant.

- Air quality modeling for this project was performed to determine the ambient impact of those pollutants that will be emitted in significant amounts (NO_X, CO, and PM_{10}). Air quality modeling was also performed to determine the ambient impact of formaldehyde. Based upon the model reviewed by the Air Pollution Control Program staff, the study submitted by Aquila is complete and demonstrates there will not be an exceedance of the National Ambient Air Quality Standards (NAAQS), Risk Assessment Levels (RALs), or available increment.

- Ambient air monitoring was not required for this project since the modeling analysis indicated that the ambient impacts of the modeled pollutants were below significance thresholds. Continuous Emission Monitoring Systems (CEMS) are required on each combustion turbine to demonstrate compliance with NO_X emissions limits.

- Emission testing for NO_X, CO, PM_{10}, and formaldehyde will be required as specified in the special conditions of this permit.

- A Part 70 Operating Permit application is required for this installation within 1 year of equipment startup.

- Approval of this permit is recommended with special conditions.

INSTALLATION/PROJECT DESCRIPTION

South Harper Peaking Facility (Aquila) has applied for the authority to construct three natural gas fired simple cycle combustion turbines to generate a total nominal electrical power output of 341 MW during peak electricity demand periods in Cass County near Peculiar, Missouri. The plant was to be located originally near Harrisonville, Missouri and public notice for the initial location took place earlier this year. On September 13, 2004, a revised PSD permit application was received changing the location of the plant to Peculiar, Missouri.

The three gas turbines to be utilized for this project are identical Siemens-Westinghouse Model 501D5A units that will be fired exclusively with natural gas. The individual turbine units have a heat input of 1,455 MMBtu per hour. This heat input is taken at a worst case ambient temperature of negative 1.8 degrees Fahrenheit (°F), an ambient relative humidity of 60%, a barometric pressure of 14.458 pounds per square inch absolute, and is based on a higher heating value of natural gas. Each 4-stage Siemens-Westinghouse Model 501D5A gas turbine utilizes 14 can-type dry low-NO_X combustors in a circular array. It incorporates a 19-stage axial flow compressor, and utilizes electric starting motors. Each turbine will power an air-cooled, 60 hertz (i.e. 3600 revolutions per minute) generator. The project will also consist of a 9.8 MMBtu per hour natural gas fired heater used to heat the natural gas fuel supplied to the turbines and a 0.47 MMBtu per hour emergency diesel fire pump.

Simple cycle turbines have high volume, high temperature exhaust streams. The maximum heat input and subsequent generating capacity of each turbine depends on ambient conditions. At higher temperatures, the heat consumption and output generally decreases. Potential emissions from the turbines are greatest during periods of low ambient temperature since more fuel can be burned during these times. However, the turbine is operating at its maximum efficiency during lower temperatures. The Siemens-Westinghouse Model 501D5A turbines are equipped with dry low-NO_X burners, which will achieve a maximum NO_X emission rate of 15 parts per million by volume on a dry basis (ppmvd) when corrected to 15% oxygen in the stack gas.

In order to distinguish between a peaking station and a baseload station, the Air Pollution Control Program has previously limited the hours of operation of power plants that are strictly designed as peaking stations. The limitation on hours of operation ensures an installation, that is permitted as a peaking station, does not operate continuously as a baseload station. The annual hours of operations that a power plant will operate impacts the conclusions arrived at in a project's Best Available Control Technology (BACT) analysis.

Recent permits issued by the Air Pollution Control Program have limited each turbine to 2,000 hours per year with a limitation of 5,000 hours per year for all the turbines combined. The same limitations apply to the Aquila installation. For record keeping purposes, operational time is considered to be the total number of hours that Aquila has any of the three or combination of the three turbines connected to the utility grid by closure of the generator breaker.

EMISSIONS/CONTROLS EVALUATION

All of the criteria pollutants will be emitted from the operation of these units, with PM_{10}, NO_X, and CO being emitted in amounts greater than significance levels (i.e. greater than de minimis levels). HAP emissions are also expected due to the operation of the turbines, with the main HAP of concern being formaldehyde. Potential emissions of both formaldehyde and VOCs are indirectly limited to their respective de minimis levels by the hours of operation conditions in this permit. The emission factor used to determine formaldehyde emissions will be verified through stack testing. Dry low-NO_X burners will be used to control NO_X emissions from the turbines. The Special Conditions of this permit limits the NO_X emissions to 15 ppmvd on a three-hour rolling average. Good combustion practices will be used to control CO emissions from the turbines. The CO emissions of the turbines are limited to 25 ppmvd on a one-hour rolling average by the Special Conditions of this permit.

The emission factors used to estimate emissions from the Siemens-Westinghouse Model 501D5A turbines for the criteria pollutants were provided by the equipment manufacturer.

Potential emissions of the application represent the potential of the proposed equipment, assuming continuous operation (8760 hours per year). Conditioned potential emissions are based on an annual limit of 2,000 hours for each the three turbines and 6,000 hours for the gas heater. The potential emissions in Table 1 represent the emission rate at 100% loading and ambient conditions of 0.0°F. Emissions from start-up and shutdown are not included in the emission estimates in the table.

Table 1: Emissions Summary (tons per year)

Pollutant	Regulatory *De Minimis* Levels	Existing Potential Emissions	Existing Actual Emissions	Potential Emissions of the Application	Conditioned Potential Based on Hours Limitation	New Installation Conditioned Potential
PM_{10}	15.0	N/A	N/A	154.72	35.47	N/A
SO_x	40.0	N/A	N/A	12.00	2.86	N/A
NO_x	40.0	N/A	N/A	1,075.16	247.42	N/A
VOC	40.0	N/A	N/A	75.13	17.26	N/A
CO	100.0	N/A	N/A	1,090.22	250.53	N/A
Acrolein	0.04*/10.0	N/A	N/A	0.12	0.03	N/A
Formaldehyde	2.0*/10.0	N/A	N/A	13.58	3.10	N/A
PAH	0.01*/10.0	N/A	N/A	0.04	0.01	N/A
Total HAPs	10.0/25.0	N/A	N/A	19.72	4.54	N/A

N/A = Not Applicable
* Threshold level for the HAP of concern.

PERMIT RULE APPLICABILITY

This review was conducted in accordance with Section (8) of Missouri State Rule 10 CSR 10-6.060, *Construction Permits Required.* Potential emissions of NO_X and CO are above major thresholds. Potential emissions of PM_{10} are above significant levels (i.e. de minimis levels). Potential emissions of all other pollutants are at de minimis levels.

APPLICABLE REQUIREMENTS

South Harper Peaking Facility shall comply with the following applicable requirements. The Missouri Air Conservation Laws and Regulations should be consulted for specific record keeping, monitoring, and reporting requirements. Compliance with these emission standards, based on information submitted in the application, has been verified at the time this application was approved. For a complete list of applicable requirements for your installation, please consult your operating permit application.

GENERAL REQUIREMENTS

- *Submission of Emission Data, Emission Fees and Process Information,* 10 CSR 10-6.110

  The emission fee is the amount established by the Missouri Air Conservation Commission annually under Missouri Air Law 643.079(1). Submission of an Emissions Inventory Questionnaire (EIQ) is required April 1 for the previous year's emissions.

- *Operating Permits*, 10 CSR 10-6.065

- *Restriction of Particulate Matter to the Ambient Air Beyond the Premises of Origin*, 10 CSR 10-6.170

- *Restriction of Emission of Visible Air Contaminants*, 10 CSR 10-6.220

- *Restriction of Emission of Odors*, 10 CSR 10-2.070

SPECIFIC REQUIREMENTS

- *Maximum Allowable Emissions of Particulate Matter From Fuel Burning Equipment Used for Indirect Heating*, 10 CSR 10-2.040

- *New Source Performance Regulations*, 10 CSR 10-6.070 – *New Source Performance Standards (NSPS) for Stationary Gas Turbines*, 40 CFR Part 60, Subpart GG.

- *Restriction of Emission of Sulfur Compounds*, 10 CSR 10-6.260

- *Acid Rain Source Permits Required*, 10 CSR 10-6.270

- *Emission Limitations and Emissions Trading of Oxides of Nitrogen*, 10 CSR 10-6.350

- *Restriction of Emission of Particulate Matter From Industrial Processes*, 10 CSR 10-6.400

BACT ANALYSIS

Introduction

Any source subject to Missouri State Rule 10 CSR 10-6.060, *Construction Permits Required*, Section (8) must conduct a Best Available Control Technology (BACT) analysis on any pollutant emitted in greater than de minimis levels. The BACT requirement is detailed in Section 165(a)(4) of the Clean Air Act, at 40 CFR 52.21 and 10 CSR 10-0.60(8)(B).

A BACT analysis is done on a case by case basis and is performed using a "top-down" method. The following steps detail the top-down approach:

1. Identify all potential control technologies – must be a comprehensive list, it may include technology employed outside the United States and must include the Lowest Achievable Emission Rate (LAER) determinations.
2. Eliminate technically infeasible options – must be well documented and must preclude the successful use of the control option.
3. Rank remaining control technologies – based on control effectiveness, expected emission rate, expected emission reduction, energy impacts, environmental impacts, and economic impacts.

4. Evaluate the most effective controls – based on case by case consideration of energy, environmental, and economic impacts.
5. Select BACT.

The three turbines, gas heater and emergency fire pump being permitted by Aquila are subject to BACT analysis for PM_{10}, NO_X, and CO emissions. Aquila prepared a BACT analysis based on the U.S. EPA RACT/BACT/LAER Clearinghouse (RBLC) database, vendor information, and previous permits for combustion turbines gas heaters and fire pumps issued in the State of Missouri and elsewhere. The BACT determination for the turbines must be at least as stringent as the NSPS for Combustion Turbines set forth in 40 CFR 60. The applicant has proposed emissions well below the NSPS limits. The BACT analysis is summarized, by pollutant, below.

NO_X Control Technologies

The conditioned potential emissions of NO_X resulting from the project permitted herein are significant (i.e. greater than 40.0 tons per year). Therefore, a BACT analysis is required for this pollutant. Table 2 lists the control technologies Aquila evaluated for this review (in order of control achieved) and the emission rates each control technology can attain.

Table 2: NO_X Control Technologies Considered

Control Technology	Equipment	Emission Rate/Control Efficiency Achieved
SCONOX™	Turbines	2 ppmvd
XONON ™	Turbines	3 ppmvd
Selective Catalytic Reduction (SCR)	Turbines	3-9 ppmvd
Selective Non-catalytic Reduction (SNCR)	Turbines	4-10 ppmvd
Dry Low-NO_X Burner	Turbines	9-25 ppmvd
Water/Steam Injection	Turbines	22-42 ppmvd
Low-NOx Burner	Gas Heater	N/D*
Selective Catalytic Reduction (SCR)	Gas Heater	90% C.E.
Ignition Timing Retard (ITR)	Emergency Diesel Fire Pump	N/D*
Selective Catalytic Reduction (SCR)	Emergency Diesel Fire Pump	90% C.E.

*N/D = Not Determined

SCONOX™

The SCONOX™ system is an add-on control device that uses an oxidation/absorption/regeneration cycle across a catalyst bed to achieve back-end reductions of NO_X, CO, and VOC. The system does not require ammonia as a reagent, and involves parallel catalyst beds that are alternately taken off line through means of mechanical dampers for regeneration.

According to Goal Line Technologies, LLC, the SCONOX™ catalyst works by simultaneously oxidizing CO to CO_2, NO to NO_2, and then absorbing NO_2. The NO_2 is absorbed into a potassium carbonate catalyst coating as potassium nitrite (KNO_2) and potassium nitrate (KNO_3). When a catalyst module begins to become loaded with KNO_2 and KNO_2, it is taken off line and isolated from the flue gas stream with mechanical dampers for regeneration.

Once the module has been isolated from the turbine exhaust [contains approximately five percent (5%) oxygen], four percent (4%) hydrogen in an inert carrier gas of nitrogen or steam is introduced. An absence of oxygen is necessary to retain the reducing properties necessary for regeneration. The lower flammability limit for hydrogen is 4%, so it is important that the air seals around the dampers do not leak. Hydrogen reacts with potassium nitrites and nitrates during regeneration to form water (H_2O) and nitrogen (N_2), which is emitted from the stack.

The SCONOX™ system can operate effectively at temperatures ranging from 300°F to 700°F. The gas turbines permitted herein will have an exhaust gas temperature of 950°F to 984°F. The exhaust gas from these turbines would have to be lowered to accommodate this air pollution control system. The SCONOX™ system manufacturer indicates that this technology can be applied to simple cycle turbines. Therefore, this control technology is considered technically feasible for this project.

SCONOX™ is a new technology and has been demonstrated on a 23 MW combined cycle turbine in the State of California. However, it has yet to be demonstrated for long term commercial operation on simple cycle turbines operated as peak power generation units. It is an inherent necessity for peak power generation units to be capable of rapid start-up and shutdown. The unknowns associated with any pollution control system which is the first of its kind, and which has no long term company or operation history, represents a level of risk that would alter the ability to reasonably finance the project. Therefore, SCONOX™ was eliminated as BACT for NO_X for this project.

XONON™

The XONON™ technology replaces traditional flame combustion with flameless catalytic combustion. The XONON™ system utilizes a chemical process versus a flame to combust fuel, thus limiting temperature and NO_X formation. Due to the subsequent low temperature of the process, thermal NO_X is virtually eliminated. This technology designed by Catalytica, Inc. has undergone testing on a 1.5 MW Kawasaki turbine in the State of California, which operates continually in a baseload capacity. NO_X emissions of three ppm or less have been demonstrated. Tests are currently underway to apply this technology to other types and sizes of turbines, but that data is currently unavailable. At this time it is unclear whether this technology, in its current state, could be applied to turbines used to generate peak power, which experiences repeated start-up, shutdowns, and changing load conditions. Therefore, for the purposes of this BACT analysis, the XONON™ system was not considered to be technically feasible.

Selective Catalytic Reduction (SCR)

SCR is a post-combustion control technology in which ammonia is added to the flue gas in the presence of a catalyst. The ammonia and NO_X react to form nitrogen and water. Since the exhaust stream for the turbines permitted herein is between 950°F and 984°F, a high temperature catalyst must be considered. High temperature zeolite catalysts do exist that allow the gases entering the SCR to reach temperatures of 1,050°F and greater. High excess air concentrations and high fuel combustion temperatures create NO_X. Lowering flame temperatures and controlling oxygen-fuel mix ratios at critical points in the combustion process can reduce NO_X formation. The catalyst accelerates the chemical reaction in which the ammonia and NO_X react to form nitrogen and water.

With SCR technology, the percent reduction of NO_X emissions can be increased by adding additional catalyst and ammonia. SCR is considered technically feasible for this application.

The feasibility of SCR was evaluated based upon economic, energy, and environmental impacts. The ammonia that does not react with NO_X passes through the system and is released into the atmosphere. In addition, SCR would cause a loss of energy due to an increase in back pressure on the combustion turbines as a result of the pressure drop across the catalyst bed. Also, the start-up and shutdown requirements of the additional SCR equipment would severely impair the "quick start" capability of the peaking turbine generators thereby eliminating the "spinning reserve" capacity of the peaking units. The use of SCR was estimated to cost $13,776 per ton of NO_X removed. This cost estimate was based upon each turbine operating 2,000 hours per year. Thus, SCR was eliminated as BACT due its cost for the limited number of operational hours being permitted (2,000 hours per turbine per year).

Selective Non-catalytic Reduction (SNCR)
SNCR is a post-combustion NO_X control technology in which a reagent (ammonia or urea) is injected into the exhaust gases in a temperature range between 1,700°F and 2,000°F. The reagent reacts chemically with NO_X forming nitrogen and water. Outside the upper end of this temperature range, the reagent is converted to NO_X. Outside the lower end of this temperature range, the reagent will not react and the reagent is discharged into the atmosphere. The Siemens-Westinghouse Model 501D5A turbines have exhaust temperatures up to approximately 984°F. Thus, in order to reach the temperature range in which SNCR is effective, the exhaust temperature of the turbines would need to be raised. To raise the exhaust temperature, additional fuel would need to be combusted and thereby increasing the NO_X and other criteria pollutant emissions. SNCR has not been applied to any combustion turbines according the RBLC database. Based upon this information, SNCR was eliminated as BACT for this project.

Dry Low-NO_X Combustors
Typically high fuel combustion temperature and high excess air concentrations create NO_X. Lowering the flame temperature and controlling the oxygen-fuel mix ratios at critical points in the combustion process can reduce NO_X formation. Because of their low cost-effectiveness per ton of NO_X reduced, dry low-NO_X technology has been rapidly incorporated into new equipment designs. Dry low-NO_X burners can achieve NO_X emissions at or below 15 ppm. For this project, dry low-NO_X technology is integrated into the design of the Siemens-Westinghouse Model 501D5A turbines and represents the baseline emission of 15 ppm for this turbine.

Water or Steam Injection
This is a combustion control technology that utilizes water or steam for flame quenching to reduce peak flame temperatures and thereby reduce NO_X formation. The injection of water or steam into a gas turbine can increase the power output by increasing the mass throughput, but at the same time reduces the efficiency of the turbine. Typically, water injection can achieve NO_X emission levels of 22 ppm while firing natural gas. Since dry low-NO_X burners are all ready being installed on the turbines and dry low-NO_X burners cannot be used with water or steam injection for additional NO_X control, water injection has been eliminated as BACT for this project.

Selection of NO_X Control Technology for Turbines
For this project, consisting of three stationary gas turbines operating in simple cycle mode for generation of electrical power during peak electricity demand periods and considering the 2,000 hours per year operational limitation, dry low NOx combustors with a NO_X emission limit of 15 ppmvd when corrected to 15% oxygen on a dry basis is considered BACT. This limitation is based on a three hour rolling average, and is not applicable during periods of startup and shut down.

Selection of NO_x Control Technology for Fuel Gas Heater
The RBLC web page does not list information regarding control equipment for gas heaters of this size. The only add-on NO_x control technique available for a unit the size that Aquila intends to install is SCR. The SCR process for removal of NO_x is discussed in the SCR section above. The vendor's removal efficiency for NO_x is 90%. The overall initial capital cost of installing an SCR system on the gas heater is approximately $119,000. On an annual basis, the SCR system would cost $102,900, which results in a cost per ton of NO_x removed of $58,000 while removing only 1.8 tons of NO_x per year. Based on environmental and economic impacts, low- NO_x burners are considered to be BACT.

Selection of NO_x Control Technology for Emergency Diesel Fire Pump
The use of add-on controls has not been documented in the RBLC for emergency fire pumps similar to this unit. However, SCR system vendors have indicated that these controls are available for the fire pump and for a unit of the size Aquila intends to install, 90% removal efficiency can be expected. The overall initial capital cost of installing an SCR system on a fire pump is approximately $131,300. On an annual basis, the SCR system would cost $43,960, which results in a cost per ton of NO_x removed of $189,690, while removing only 0.2 tons of NO_x per year. With such a low amount of NO_x removed at such a high cost per ton, SCR was not selected as BACT. Instead NO_x emissions on these diesel-fired units will be controlled by the use of ignition timing retard (ITR).

<u>CO Control Technology</u>

The conditioned potential emissions of CO resulting from the project permitted herein are significant (i.e., greater than 100.0 tons per year). Therefore, a BACT analysis is required for this pollutant. Table 3 lists the control technology Aquila evaluated for the BACT analysis for CO (in order of control achieved) and the emission rates each control technology can attain.

Table 3: CO Control Technology

Control Technology	Equipment	Controlled CO Emission Level
SCONOX™	Turbines	2 ppm
Oxidation Catalyst	Turbines	2 ppm
Combustion Control	Turbines	25 ppm
Good Combustion Practices	Gas Heater, Emergency Fire Pump	N/D*
Oxidation Catalyst	Gas Heater, Emergency Fire Pump	N/D*

*N/D = Not Determined

SCONOX™

SCONOX™

The SCONOX™ system was described in the BACT analysis for NO_X. In addition to controlling NO_X, the SCONOX™ system also controls VOC and CO. In analyzing the feasibility of the SCONOX™ system for this project, the review took into account the fact SCONOX™ controls all three pollutants. The reasons as to why SCONOX™ was eliminated as BACT for NO_X also result in the elimination of SCONOX™ as BACT for CO.

Oxidation Catalysts

Oxidation catalysts are a post-combustion technology used to oxidize CO to Carbon Dioxide (CO_2) without the introduction of additional chemicals. The activation energy for this reaction is lowered through the use of a catalyst and the oxidation then proceeds by utilizing excess air present in the turbine exhaust. An oxidation catalyst is usually platinum based, and operates in an optimal temperature range between 700°F and 1,100°F. Catalyst sintering can occur at higher temperatures resulting in permanent damage to the catalyst. Also, the addition of a catalyst bed onto the turbine exhaust will create a pressure drop, resulting in back pressure on the turbine. This reduces the turbine's efficiency and translates into energy costs. Conversion efficiencies for CO up to 95% are possible, and catalysts are available that will effectively handle the temperature range at which these turbines will operate.

Oxidation catalyst has not typically been required as BACT for natural gas combustion turbines operated in simple cycle mode and used exclusively for peaking service. The Missouri Department of Natural Resources acknowledges that oxidation catalyst has not been widely required as BACT in previous determinations. However, the use of oxidation catalyst is increasing and sources are voluntarily installing oxidation catalyst. The use of an Oxidation Catalyst was estimated to cost $8,618 per ton of CO removed. After evaluating the environmental, economical, and energy impacts for this permit application and considering the limited number of hours of operation to be permitted (2,000 hours per year per turbine), oxidation catalyst was eliminated as BACT for CO control.

Combustion Control

Good combustion practices include turbine design and operational elements to control the amount and distribution of excess air in the turbine combustion section and turbine exhaust gas. Good combustion practices applied to the Siemens Westinghouse Model 501D5A turbines can achieve CO emissions of 25 ppmv when corrected to 15% oxygen on a dry basis, during steady state operation.

Selection of CO Control Technology for Turbines

The control technologies were evaluated considering control effectiveness, expected emission rate, expected emission reduction, energy impacts, environmental impacts, economic impacts, and the limited number of hours of operation (2,000 hours per turbine). For this project, consisting of three stationary gas turbines operating in simple cycle mode for generation of electrical power during peak electricity demand periods and considering the 2,000 hours per year per turbine operational limitation, a CO emission limit of 25 ppmvd when corrected to 15% oxygen on a dry basis using combustion control is considered BACT. This limitation is based on a three-hour rolling average, and is not applicable during periods of start-up and shutdown.

Selection of CO Control Technology for Gas Heater
The RBLC does not list gas heater BACT determinations for control of CO emissions from gas heaters, however, one control vendor has indicated that a CO catalyst system may be used on a gas heater this size. The CO catalyst system is an add-on control that converts CO to CO_2 by use of a catalyst. The system is further described in the Oxidation Catalysts section above. On an annual basis, only 3.2 tons per year of CO would be removed at a cost of close to $12,700 per ton. This cost is considered to be economically unfeasible, therefore, add-on controls for CO emissions from the gas heater are not considered BACT. BACT for CO emissions from the gas heater is good combustion practices.

Selection of CO Control Technology for Emergency Diesel Fire Pump
The RBLC does not list CO add-on controls for emergency engines of this size. CO catalyst systems are available from vendors, however. A discussion of CO catalyst systems can be found in the Oxidation Catalysts section above. Because only 0.019 tons of CO would be removed, the cost per ton is over $756,000. These costs are considered economically infeasible, therefore, add-on controls for the emergency diesel fire pump are not considered for BACT. BACT for the fire pump is good combustion practices.

PM_{10} Control Technology

The conditioned potential emissions of PM_{10} resulting from the project permitted herein are significant (i.e. greater than 15.0 tons per year). Therefore, a BACT analysis is required for this pollutant.

PM_{10} emissions resulting from the combustion of natural gas are due to oxidation of sulfur contained in the fuel. Due to its low ash and sulfur content, natural gas combustion generates inherently low PM_{10} emissions. Available technologies used for controlling PM_{10} are centrifugal (cyclone) collectors, electrostatic precipitators, wet scrubbers, and fabric filters (baghouse).

While all of these post-process technologies would be technically feasible for controlling PM_{10} emissions from combustion turbines, none of the previously described control equipment has been applied to combustion turbines exclusively burning natural gas since exhaust gas PM concentrations are inherently low. Combustion turbines operate with a significant amount of excess air that generates large exhaust gas flow rates. Aquila's combustion turbines will generate low PM emissions in comparison to other fuels due to the low ash and sulfur content of natural gas. Exhaust stream PM_{10} concentrations of such low magnitude are not amenable to control using available technologies since removal efficiencies would be unreasonably low and cost excessive. Along the same vein, units as small as the gas heater and emergency fire pump are not designed. Because post-process stack controls for PM/PM_{10} are not economical for combustion turbines used exclusively in simple cycle peaking service, it was determined that BACT for PM_{10} is the use of good combustion practices for all equipment permitted in this project.

AMBIENT AIR QUALITY IMPACT ANALYSIS

Aquila submitted a refined modeling analysis that estimates the ambient impact of NO_X, CO, PM_{10}, and formaldehyde. This analysis was performed with the Industrial Source Complex Short Term (ISCST3) dispersion model. This is an EPA approved model that is appropriate for the refined modeling required for major source review.

Emissions are generated from three combustion turbines, the natural gas heater, and the emergency diesel fire pump. The emission rate from the turbine stack will depend on the mode of operation. The turbines were modeled for operation at the ambient temperature, which corresponds to the maximum emission rate at 75%, 85%, and 100% loads. The maximum emission rate for each load occurs at an ambient temperature of 0.0°F. The following tables contain the release parameters and the emissions rates for emission points from Aquila that were considered in the modeling.

Table 4: Aquila Modeled Stack Parameters

Unit	Source ID	Operating Loads	Stack Height (ft)	Stack Diameter (ft)	Stack Temperature (K)*	Stack Exit Velocity (ft/s)*
Turbine Number 1	EP-01	100% 85% 75%	55	24	786 (766) 745 (725) 727 (708)	58.1 (56.6) 51.8 (50.5) 47.7 (46.5)
Turbine Number 2	EP-02	100% 85% 75%	55	24	786 745 727	58.1 51.8 47.7
Turbine Number 3	EP-03	100% 85% 75%	55	24	786 745 727	58.1 51.8 47.7
Gas Heater	EP-04	100%	43	2.5	616	31.7
Fire Pump	EP-05	100%	17	0.5	804	0.33**

*Temperature and exit velocity of Turbine 1 are less when wastewater is injected.
**Rain cap on end of stack.

Table 5: Aquila Modeled Emission Rates

Unit	Operating Loads	CO (lb/hr)	NOx (Note 1) (lb/hr)	PM_{10} (lb/hr)	Formaldehyde (lb/hr)
Turbine Number 1	100% 85% 75%	82.70 71.00 63.00	18.61 15.96 14.16	All Loads 10.00 (15.25)	1.03 0.88 0.79
Turbine Number 2	100% 85% 75%	82.70 71.00 63.00	18.61 15.96 14.16	All Loads 10.00	1.03 0.88 0.79
Turbine Number 3	100% 85% 75%	82.70 71.00 63.00	18.61 15.96 14.16	All Loads 10.00	1.03 0.88 0.79
Gas Heater	100%	0.80	0.31	0.07	7.21×10^{-4}
Fire Pump	100%	0.17	2.06	0.04	3.67×10^{-5}

Note 1: Emission rate based on 2,000 hours of operation per year per turbine, 6,000 hours per year for the gas heater and 250 hours per year for the fire pump.
Note 2: Emission rate in parenthesis indicates use of wastewater injection.

In each case considered in the modeling, the significance levels were not exceeded for NO_X, CO, or PM_{10}. The modeling also demonstrated that the 24-hour and annual Risk Assessment Level (RAL) for formaldehyde would not be exceeded. For the criteria pollutants (NO_X, CO, PM_{10}), the significance level is the trigger point for an increment consumption analysis and an overall ambient impact analysis. The demonstration that the significance levels are not exceeded is the only modeling requirement for this review. The insignificant modeled impacts also eliminate the need for pre-construction monitoring for NO_X, CO, or PM_{10}.

Upon further internal review, the Special Conditions contained in this permit were revised as described below to more accurately represent the data used in the modeling analysis. Load-based limits for the turbines were found to be redundant, when coupled with a concentration-based limit and an hourly limit. The pound per hour emission limitations that were part of the draft permit have been removed to minimize record keeping while preserving a cap on emissions. The hourly limits, paired with the concentration limits, insures that the annual emissions shall not exceed the level that was used in the ambient air quality analysis. The emissions used in the modeling analysis assumed the 15 ppmvd for NO_x and 25 ppmvd for CO at base load, providing the worst-case scenario. Finally, the CO concentration limitation has been revised from a three hour to a one hour rolling average to insure that the hourly CO standards are not violated.

Additionally, a condition was added limiting the emergency fire pump to a maximum of 250 hours of operation in any consecutive 12-month period. No annual emission limits were placed on the fire pump or the gas heater, however, for NO_x, CO or PM_{10}. Both the hourly and annual potential emission rates are relatively insignificant in comparison to the turbines. Additional limits and record keeping would be burdensome and provide no additional benefit to the environment.

The following table lists the maximum modeled impact as well as the significance level or RAL for NO_X, CO, PM_{10} and formaldehyde in units of micrograms per cubic meter ($\mu g/m^3$). For a detailed description of the modeling analysis, along with a discussion of additional impact analyses conducted, please see the attached memorandum, *Revised Aquila – Cass County Air Dispersion Modeling*, dated October 19, 2004.

Table 6: Maximum Modeled Concentrations

Pollutant	Maximum Modeled Impact ($\mu g/m^3$)	Significance Level/RAL ($\mu g/m^3$)	Time Period
NO_X	0.39	1.0	Annual
CO	76.34	2,000	1-hour
	24.83	500	8-hour
PM_{10}	2.59	5.0	24-hour
	0.05	1.0	Annual
Formaldehyde (CAS Number: 50-00-0)	0.024	0.8	24-hour
	0.0005	0.08	Annual

STAFF RECOMMENDATION

On the basis of this review conducted in accordance with Section (8), Missouri State Rule 10 CSR 10-6.060, *Construction Permits Required*, I recommend this permit be granted with special conditions.

Lina Klein
Environmental Engineer

Date 12/28/04

PERMIT DOCUMENTS

The following documents are incorporated by reference into this permit:

- The Application for Authority to Construct form, dated March 26, 2004, received March 29, 2004, designating Aquila, Incorporated as the owner and operator of the installation.
- U.S. EPA document AP-42, *Compilation of Air Pollutant Emission Factors*, Fifth Edition.
- Kansas City Regional Office Site Survey, dated March 1, 2004.
- Stack tests submitted along with the application, dated March 26, 2004.
- Notification of facility name change, dated April 13, 2004.
- Revised permit application for new site, received September 13, 2004.

ATTACHMENT A: Operational Schedule of the Three Siemens-Westinghouse Model 501D5A Turbines

South Harper Peaking Facility
Cass County, S29/32, T45N, R32W
Installation ID Number: 037-0063
Project Number: 2004-03-143
Permit Number: ____________

This sheet covers the period from ____________ (month/year) to ____________ (month/year).

Copy this sheet as needed.

Hours that Aquila is Producing Electricity = Electricity Hours		
A. Total Electricity Hours for this Month	(Note 1)	
B. 12-Month Total Electricity Hours From Previous Month's Worksheet	(Note 2)	
C. Monthly Total Electricity Hours From Previous Year's Worksheet	(Note 3)	
D. Current 12-Month Total Electricity Hours	(Note 4)	

Note 1: Total number of hours that this installation had any of the three or combination of the three turbines (Emission Points EP-01, EP-02, EP-03) connected to the utility grid by closure of the generator breaker.
Note 2: Running 12-month total of electricity hours from previous month's worksheet.
Note 3: Electricity hours reported for this month in the last calendar year.
Note 4: Amount reported in Note 2 minus amount reported in Note 3 plus amount reported in Note 1 (D = B – C + A). Less than 5,000 hours indicates compliance.

ATTACHMENT B: Individual Turbine Operational Schedule

South Harper Peaking Facility
Cass County, S29/32, T45N, R32W
Installation ID Number: 037-0063
Project Number: 2004-03-143
Permit Number: ____________

This sheet covers the period from ____________ (month/year) to ____________ (month/year).

This sheet is for Turbine Emission Point EP-______

Copy this sheet as needed.

Hours that a Turbine is Burning Natural Gas = Unit Gas Hours		
A. Total Unit Gas Hours for this Month	(Note 1)	
B. 12-Month Total Unit Gas Hours From Previous Month's Worksheet	(Note 2)	
C. Monthly Total Unit Gas Hours From Previous Year's Worksheet	(Note 3)	
D. Current 12-Month Total Unit Gas Hours	(Note 4)	

Note 1: Total number of hours that this turbine was burning natural gas for this month (unit gas hours).
Note 2: Running 12-month total of unit gas hours from previous month's worksheet.
Note 3: Unit gas hours reported for this month in the last calendar year.
Note 4: Amount reported in Note 2 minus amount reported in Note 3 plus amount reported in Note 1. ($D = B - C + A$). Less than 2,000 hours indicates compliance.

ATTACHMENT C: Gas Heater Operational Schedule

South Harper Peaking Facility
Cass County, S29/32, T45N, R32W
Installation ID Number: 037-0063
Project Number: 2004-03-143
Permit Number: ____________

This sheet covers the period from ____________ (month/year) to ____________ (month/year).

This sheet is for Turbine Emission Point EP-______

Copy this sheet as needed.

A. Total Hours of Operation for this Month	(Note 1)	
B. 12-Month Total Hours of Operation From Previous Month's Worksheet	(Note 2)	
C. Monthly Total Hours of Operation From Previous Year's Worksheet	(Note 3)	
D. Current 12-Month Total Hours of Operation	(Note 4)	

Note 1: Total number of hours that the gas heater was operating for this month.
Note 2: Running 12-month total of operational hours from previous month's worksheet.
Note 3: Hours of operation reported for this month in the last calendar year.
Note 4: Amount reported in Note 2 minus amount reported in Note 3 plus amount reported in Note 1. ($D = B - C + A$) Less than 6,000 hours indicates compliance.

ATTACHMENT D: Fire Pump Operational Schedule

South Harper Peaking Facility
Cass County, S29/32, T45N, R32W
Installation ID Number: 037-0063
Project Number: 2004-03-143
Permit Number: ____________

This sheet covers the period from ____________ (month/year) to ____________ (month/year).

This sheet is for Emission Point EP-______

Copy this sheet as needed.

A. Total Hours of Operation for this Month	(Note 1)	
B. 12-Month Total Hours of Operation From Previous Month's Worksheet	(Note 2)	
C. Monthly Total Hours of Operation From Previous Year's Worksheet	(Note 3)	
D. Current 12-Month Total Hours of Operation	(Note 4)	

Note 1: Total number of hours that the fire pump was operating for this month.
Note 2: Running 12-month total of operational hours from previous month's worksheet.
Note 3: Hours of operation reported for this month in the last calendar year.
Note 4: Amount reported in Note 2 minus amount reported in Note 3 plus amount reported in Note 1. (D = B – C + A) Less than 250 hours indicates compliance.

Benzene

Common Name: Benzene
CAS Number: 71-43-2
DOT Number: UN 1114
Date: January, 1988

HAZARD SUMMARY

* Benzene can affect you when breathed in and by passing through your skin.
* Benzene is a CARCINOGEN HANDLE WITH EXTREME CAUTION.
* Exposure can cause you to become dizzy and lightheaded. Higher levels can cause convulsions and death.
* Exposure can irritate the nose and throat and may cause an upset stomach and vomiting.
* Benzene can cause an irregular heart beat that can lead to death.
* Prolonged exposure can cause fatal damage to the blood (aplastic anemia).
* Benzene is a FLAMMABLE LIQUID and a FIRE HAZARD.

IDENTIFICATION

Benzene is a colorless liquid with a pleasant odor. It is used mainly in making other chemicals, as a solvent, and is found in gasoline.

REASON FOR CITATION

* Benzene is on the Hazardous Substance List because it is regulated by OSHA and cited by ACGIH, DOT, NIOSH, IARC, NTP, CAG, DEP, NFPA and EPA.
* It is on the Special Health Hazard Substance List because it is a CARCINOGEN, a MUTAGEN and is FLAMMABLE.
* Definitions are attached.

HOW TO DETERMINE IF YOU ARE BEING EXPOSED

* Exposure to hazardous substances should be routinely evaluated. This may include collecting air samples. Under OSHA 1910.20, you have a legal right to obtain copies of sampling results from your employer. If you think you are experiencing any work related health problems, see a doctor trained to recognize occupational diseases. Take this Fact Sheet with you.
* ODOR THRESHOLD = 12.0 ppm.
* The odor threshold only serves as a warning of exposure. Not smelling it does not mean you are not being exposed.

WORKPLACE EXPOSURE LIMITS

OSHA: The legal airborne permissible exposure limit (PEL) is 1 ppm averaged over an 8 hour workshift, and 5 ppm which should not be exceeded in any 10 minute period.

ACGIH: The recommended airborne exposure limit is 10 ppm averaged over an 8 hour workshift.

NIOSH: The recommended airborne exposure limit is 1.0 ppm, which should not be exceeded during any 60 minute period.

Benzene is a CANCER CAUSING AGENT in humans. There may be no

safe level of exposure to a carcinogen, so all contact should be reduced to the lowest possible level.
* The above exposure limits are for air levels only. Skin contact may also cause overexposure.

WAYS OF REDUCING EXPOSURE
* A regulated, marked area should be established where Benzene is handled, used, or stored.
* Wear protective work clothing.
* Wash thoroughly immediately after exposure to Benzene and at the end of the workshift.
* Post hazard and warning information in the work area. In addition, as part of an ongoing education and training effort, communicate all information on the health and safety hazards of Benzene to potentially exposed workers.

This Fact Sheet is a summary source of information of all potential and most severe health hazards that may result from exposure. Duration of exposure, concentration of the substance and other factors will affect your susceptibility to any of the potential effects described below.

HEALTH HAZARD INFORMATION

Acute Health Effects
The following acute (short term) health effects may occur immediately or shortly after exposure to Benzene:

* Exposure can cause symptoms of dizziness, lightheadedness, headaches, and vomiting. Convulsions and coma, or sudden death from irregular heart beat, may follow high exposures.
* Exposure can also irritate the eyes, nose, and throat.

Chronic Health Effects
The following chronic (long term) health effects can occur at some time after exposure to Benzene and can last for months or years:

Cancer Hazard
* Benzene is a CARCINOGEN in humans. It has been shown to cause leukemia.
* Many scientists believe there is no safe level of exposure to a carcinogen.

Reproductive Hazard
* There is limited evidence that Benzene is a teratogen in animals. Until further testing has been done, it should be treated as a possible teratogen in humans.

Other Long Term Effects
Repeated exposure can damage the blood forming organs causing a condition called aplastic anemia. This can cause death. Long term exposure may cause drying and scaling of the skin.

EDICAL TESTING

efore beginning employment and at regular times after that, the ollowing are recommended:

Complete blood count.

* Urinary Phenol (a test to see if Benzene is in the body).

Any evaluation should include a careful history of past and present symptoms with an exam. Medical tests that look for damage already done are not a substitute for controlling exposure.

Request copies of your medical testing. You have a legal right to this information under OSHA 1910.20.

WORKPLACE CONTROLS AND PRACTICES

Unless a less toxic chemical can be substituted for a hazardous substance, ENGINEERING CONTROLS are the most effective way of reducing exposure. The best protection is to enclose operations and/or provide local exhaust ventilation at the site of chemical release. Isolating operations can also reduce exposure. Using respirators or protective equipment is less effective than the controls mentioned above, but is sometimes necessary.

In evaluating the controls present in your workplace, consider: (1) how hazardous the substance is, (2) how much of the substance is released into the workplace and (3) whether harmful skin or eye contact could occur. Special controls should be in place for highly toxic chemicals or when significant skin, eye, or breathing exposures are possible.

In addition, the following controls are recommended:

- Where possible, automatically pump liquid Benzene from drums or other storage containers to process containers.
- Specific engineering controls are recommended for this chemical by NIOSH. Refer to the NIOSH criteria documents on Benzene # 74 137 and "Refined Petroleum Solvents" # 77 192.

Good WORK PRACTICES can help to reduce hazardous exposures. The following work practices are recommended:

- Workers whose clothing has been contaminated by Benzene should change into clean clothing promptly.
- Do not take contaminated work clothes home. Family members could be exposed.
- Contaminated work clothes should be laundered by individuals who have been informed of the hazards of exposure to Benzene.
- If there is the possibility of skin exposure, emergency shower facilities should be provided.
- On skin contact with Benzene, immediately wash or shower to remove the chemical.
- Do not eat, smoke, or drink where Benzene is handled, processed, or stored, since the chemical can be swallowed. Wash hands carefully before eating or smoking.

PERSONAL PROTECTIVE EQUIPMENT

WORKPLACE CONTROLS ARE BETTER THAN PERSONAL PROTECTIVE EQUIPMENT. However, for some jobs (such as outside work, confined space entry, jobs done only once in a while, or jobs done while workplace controls are being installed), personal protective equipment may be appropriate.

The following recommendations are only guidelines and may not apply to every situation.

Clothing

* Avoid skin contact with Benzene. Wear solvent resistant gloves and clothing. Safety equipment suppliers/ manufacturers can provide recommendations on the most protective glove/clothing material for your operation.
* All protective clothing (suits, gloves, footwear, headgear) should be clean, available each day, and put on before work.
* ACGIH recommends VITON gloves for short periods of protection.

Eye Protection

* Eye protection is included in the recommended respiratory protection.

Respiratory Protection

IMPROPER USE OF RESPIRATORS IS DANGEROUS. Such equipment should only be used if the employer has a written program that takes into account workplace conditions, requirements for worker training, respirator fit testing and medical exams, as described in OSHA 1910.134.

* At any exposure level, use a MSHA/NIOSH approved supplied air respirator with a full facepiece operated in the positive pressure mode or with a full facepiece, hood, or helmet in the continuous flow mode, or use a MSHA/NIOSH approved self contained breathing apparatus with a full facepiece operated in pressure demand or other positive pressure mode.

HANDLING AND STORAGE

* Prior to working with Benzene you should be trained on its proper handling and storage.
* Benzene must be stored to avoid contact with OXIDIZERS (such as PERMANGANATES, NITRATES, PEROXIDES, CHLORATES, and PERCHLORATES), since violent reactions occur.
* Store in tightly closed containers in a cool well ventilated area away from HEAT.
* Sources of ignition such as smoking and open flames are prohibited where Benzene is handled, used, or stored.
* Metal containers involving the transfer of 5 gallons or more of Benzene should be grounded and bonded. Drums must be equipped with self closing valves, pressure vacuum bungs, and flame arresters.
* Wherever Benzene is used, handled, manufactured, or stored, use explosion proof electrical equipment and fittings.

Common Name: Benzene
DOT Number: UN 1114
DOT Emergency Guide code: 27
CAS Number: 71-43-2

NJ DOH Hazard rating	
FLAMMABILITY	3
REACTIVITY	0

CARCINOGEN
CONTAINERS MAY EXPLODE IN FIRE
POISONOUS GAS IS PRODUCED IN FIRE

Hazard Rating Key: 0=minimal; 1=slight; 2=moderate; 3=serious; 4=severe

FIRE HAZARDS

* Benzene is a FLAMMABLE LIQUID.
* Use dry chemical, CO2, or foam extinguishers. Water can be used to keep fire exposed containers cool.
* POISONOUS GAS IS PRODUCED IN FIRE.
* CONTAINERS MAY EXPLODE IN FIRE.
* The vapor is heavier than air and may travel a distance to cause a fire or explosion far from the source.
* If employees are expected to fight fires, they must be trained and equipped as stated in OSHA 1910.156.

SPILLS AND EMERGENCIES

If Benzene is spilled or leaked, take the following steps:

* Restrict persons not wearing protective equipment from area of spill or leak until cleanup is complete.
* Remove all ignition sources.
* Ventilate area of spill or leak.
* Absorb liquids in vermiculite, dry sand, earth, or a similar material and deposit in sealed containers.
* Keep Benzene out of a confined space, such as a sewer, because of the possibility of an explosion, unless the sewer is designed to prevent the buildup of explosive concentrations.
* It may be necessary to contain and dispose of Benzene as a HAZARDOUS WASTE. Contact the your state Environmental Program for specific recommendations.

==

FOR LARGE SPILLS AND FIRES immediately call your fire department.

==

FIRST AID

POISON INFORMATION

Eye Contact

Immediately flush with large amounts of water for at least 15 minutes, occasionally lifting upper and lower lids.

Skin Contact

Quickly remove contaminated clothing. Immediately wash area with large amounts of soap and water. Seek medical attention.

Breathing

Remove the person from exposure.
Begin rescue breathing if breathing has stopped and CPR if heart action has stopped.

PHYSICAL DATA

Vapor Pressure:	75 mmhg at 68oF (20oC)
Flash Point:	12oF (11oC)
Water Solubility:	Slightly soluble

OTHER COMMONLY USED NAMES

:hemical Name:
3enzene

)ther Names and Formulations:
3enzol; Coal Naphtha; Phenyl Hydride.

Not intended to be copied and sold for commercial purposes.

NEW JERSEY DEPARTMENT OF HEALTH
Right to Know Program
CN 368, Trenton, NJ 08625 0368

ECOLOGICAL INFORMATION

3enzene is produced from coal and is used to make medicinal chemicals, dyes, and many other organic compounds. It is also used to make artificial leather, linoleum, oil cloth, varnishes and lacquers. Benzene can enter the environment mostly from industrial effluents.

ACUTE (SHORT-TERM) ECOLOGICAL EFFECTS

Acute toxic effects may include the death of animals, birds, or fish, and death or low growth rate in plants. Acute effects are seen two to four days after animals or plants come in contact with a toxic chemical substance.

Benzene has high acute toxicity to aquatic life. It can cause death in plants and roots and membrane damage in leaves of various agricultural crops. No data are available on the short-term effects of benzene on birds or land animals.

HRONIC (LONG-TERM) ECOLOGICAL EFFECTS

hronic toxic effects may include shortened lifespan, reproductive roblems, lower fertility, and changes in appearance or behavior. hronic effects can be seen long after first exposure(s) to a toxic hemical.

enzene has high chronic toxicity to aquatic life. No data are vailable on the long-term effects of benzene on plants, birds, or and animals.

ATER SOLUBILITY

enzene is moderately soluble in water. Concentrations ofbetween to 1,000 milligrams will mix with a liter of water.

ISTRIBUTION AND PERSISTENCE IN THE ENVIRONMENT

enzene is slightly persistent in water, with a half-life of etween 2 to 20 days. The half-life of a pollutant is the amount f time it takes for one-half of the chemical to be degraded. bout 99.5% of benzen will eventually end up inair; the rest will nd up in the water.

IOACCUMULATION IN AQUATIC ORGANISMS

;ome substances increase in concentration, or bioaccumulate, in .iving oranisms as they breathe contaminated air, drink :ontaminated water, or eat contaminated food. These chemicals can)ecome concentrated in the tissues and internal organs of animals ınd humans.

:he concentration of benzene found in fish tissues is expected to)e somewhat higher than the average concentration of benzene in the ıater from which the fish was taken.

;UPPORT DOCUMENT: AQUIRE Database, ERL-Duluth, U.S. EPA, Phytotox.

Return to Polystyrene Production Problems Homepage

Last modified: 3 Mar 1996

ıttp://www.ejnet.org/plastics/polystyrene/benzene.html

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Benzene and Diseases of the Blood: Revisited

By Nachman Brautbar, M.D.

An etiologic association between benzene and diseases of the blood was shown more than 50 years ago, and has since been corroborated by epidemiologic studies, animal data and by carcinogenic bioassays. Benzene is now considered, by national and international scientific and health organizations, to be a human carcinogen. The purpose of this review is to summarize the available information on benzene and its effects on the hematologic (blood) system (revisited from 1992 CWCE).

Industrial Production and Usage

Benzene is produced in large quantities in the United States. A total of 4.4 million tons of industrial grades were projected in the United States in 1985. A very large portion of benzene is utilized as a component of gasoline, in an average concentration of less than one percent. Benzene is very important for unleaded fuels because of its anti-knock characteristics. In 1978, it is estimated that 1,650 million (1,650,000,000) gallons were used in gasoline. A much smaller amount, less than two percent, is used for solvent purposes in such products as industrial paints, rubber cement, adhesives, paint-remover, artificial leathers and laboratory solvents. Due to the volatility and high solubility of benzene it has the potential to migrate in the environment and contaminate water directly, and enter surfaces where water can penetrate.

Populations highly exposed to benzene are as follows: 1) workers engaged in its production, 2) workers engaged in chemical industries utilizing benzene, 3) workers in industries producing materials containing benzene, 4) workers utilizing or handling compounds containing benzene, 5) people living near factories producing or utilizing benzene. (Table 1 describes some of the industrial exposures to benzene).

Table 1. Potential Industrial Exposures to Benzene

1. Detergent Producers.
2. Pesticide Producers.
3. Gasoline Producers.
4. Solvent Producers.
5. Paint and Varnish Producers.
6. Adhesive Producers.

Benzene & Diseases of the Blood
Benzene is now considered, by international scientific and health organizations, to be a human carcinogen.
Read Article »

Drug Interactions
Estimates of drug-drug interactions have been reported as high as 20% of patients, who are on more than 5 medications at a time (polypharmacy).
Read Article »

Chemicals & Cancer
Chemical exposure and cancer date back several thousand years.

7. Rubber Industry Processors.
8. Petroleum Industry Processors.
9. Chemical Workers.
10. Waste Management.
11. Laboratory Technicians.
12. Auto Mechanics, Painters, Printers, Degreasing Operations.
13. Extraction & Sampling (Industrial Labs).
14. Hauling, Loading, Unloading & Tank Cleaning Operations.
15. Burning of Organically Originated Materials - Wood Burning, Garbage Burning, Insulation Materials, Hydraulic Fluids (Fire-Fighters, Law Enforcement, Technicians, Laborers).
16. Rubber & Rubber Coating, Adhesives, Sealants.

The level of benzene allowed in the workplace varies from country to country. Until 1978, in the USA the OSHA standard for benzene was 10 ppm (parts per million) with an acceptable ceiling concentration of 25 ppm. In 1978, OSHA stated that 1 ppm with a 5 ppm ceiling limit for 15 minutes during the eight-hour day is the level which most adequately assures, to the extent feasible, the protection of workers exposed to benzene.

Following reports of toxicity, the use of benzene has been reduced significantly. However, Ringen, et al,(1) and Holmberg, et al,(2) noted that benzene exposure may still occur in industry and is detectable in workroom air in many industrial activities. This is of great concern to those of us in occupational medicine, toxicology, and regulatory medicine.

Route of Human Exposure
Human exposure to benzene of significance is by the following:

1. Inhalation
2. Dermal exposure
3. Ingestion of water and other foods contaminated with benzene.

Although benzene is relatively soluble in water, commonly the magnitude of human exposure through water is probably negligible. Unless there is groundwater contamination from either industrial releases or underground storage tank deterioration causing leaks which in turn contaminates the drinking water. The respiratory route is commonly the primary source of human exposure to benzene. Much of this exposure to the general population is by way of gasoline vapors and automobile emissions. In industrialized areas and heavily congested areas, levels of 15 ppb (parts per billion) all the way to 57 ppb were described, while the average background levels have been reported to be 2.7 to 20 ppb.

Benzene is absorbed through the skin and skin contact is infrequent for the non-working general population. Therefore, the skin route is probably an insignificant source of exposure for the general population, but has been shown as a significant route of exposure in the working population.(3)

Smoking may be a significant benzene exposure source for a portion of the population. Studies have described that an individual who smokes one pack of cigarettes per day may be exposed to 10 mcg (micrograms) per cigarettes of benzene per day. In another report it was suggested that the average cigarette gives rise to about 31 mcg of benzene, so that the daily consumption of 10 cigarettes results in an uptake of about 310 mcg which is equivalent to the quantity of benzene inhaled over 24 hours when the air contains 7.5 mcg per cubic meter benzene at the respiratory minute value of 28.6 liters (for light work). In other words, under resting conditions the benzene concentration of the inhaled air would have to be at about 27 mcg per cubic meter in order for up to 310 mcg benzene to be inhaled in 24 hours.(4)

The literature as far as benzene and smoking-induced leukemia is not convincing. A recent study by Korte,(5) et al, combined epidemiological data on the health effects of smoking with risk assessment techniques for low-dose extrapolation and assessed the proportion of smoking-induced total leukemia and acute myeloid leukemia attributable to benzene and cigarette smoke. This study was based on linear potency models (the conservative oriented version of a suggested non-linear method is not accepted with the major regulatory and scientific bodies). According to this study, benzene is estimated to be responsible for approximately one-tenth to one-half of smoking-induced total leukemia mortality and up to three-fifths of smoking related acute myeloid leukemia mortality. The problem with this study is that the author admitted that cigarette smoke contains several suspected leukemogens such as 1,3-butadiene, n-nitrosodi-n-butylamine, styrene, and radioactive elements, and therefore benzene in cigarettes is unlikely to be independently responsible for most smoking-induced leukemia. The majority of the scientific literature has concluded that there is no support for cigarette smoke as a cause of hematolymphatic malignancies. However, the paper by Korte,(5) et al, lends support to the proposition that small amount of benzene exposure renders the cellular detoxification system more sensitive to the cumulative exposure from benzene.

Effects of Benzene on the Hematological System
To date, a long list of hematologic diseases has been scientifically linked directly to benzene exposure (Table 2).

Table 2. Benzene Exposure and Hematologic Disorders

1. Aplastic Anemia, Pancytopenia.
2. Acute Myelogenous Leukemia.
3. Erythroleukemia.
4. Myelomonocytic Leukemia.
5. Acute Promyelocytic Leukemia.
6. Chronic Myelogenous Leukemia.
7. Acute Lymphoblastic Leukemia.
8. Chronic Lymphocytic Leukemia.
9. Hodgkin's Disease and Non-Hodgkin=s Lymphoma.
10. Paroxysmal Nocturnal Hemoglobinuria.
11. Multiple Myeloma.
12. Lymphomas.
13. Thrombocythemia
14. Myelofibrosis.
15. Myelodysplastic Syndrome.

Benzene has been known as a hematologic poison since the nineteenth century when aplastic anemia in workers fabricating tires was described. Many other hematological diseases have since been reported to be the result of benzene exposure. Many of the hematological disorders related to benzene may not be dose-dependent as the mechanism of these diseases are yet not clearly understood.

A. Aplastic Anemia/Pancytopenia:
Aplastic anemia is a relatively rare, often fatal disorder in man. Its diagnosis is usually made on the basis of a significant reduction in the formed elements of the blood, including decreased white blood cells, anemia, and thrombocytopenia. A decrease in all three of these blood cells counts is defined as pancytopenia. A marked decrease in the number of cells in the bone marrow is called aplastic anemia. It is accepted that these two are not two separate diseases but rather a spectrum of bone marrow failure secondary to benzene toxicity. Indeed, a complete evaluation of a work force in a benzene-using plant revealed many affected individuals with effects ranging from a mild cytopenia to aplastic anemia of sufficient severity to warrant hospitalization; levels of exposure were 10-400 ppm of benzene.

The time of development of aplastic anemia or thrombocytopenia in relation to exposure is of great interest. The following studies have been described: (1) A follow-up study of 125 workers in a shoe factory who were exposed to levels of 400 ppm of benzene, 9 years later noted some persistent cytopenias. One individual had developed acute leukemia and died. (2) Four individuals were reported to have persistent decrease in blood counts and one patient had died of aplastic anemia 9 years after cessation of exposure. (3) An outbreak of hematological toxicity in leather workers in 1975 was directly temporally related to the use of an adhesive containing benzene beginning in about 1960. (4) Thirty-two cases of significant aplastic anemia in people exposed to benzene for 4 months to 15 years were reported in the literature. Exposure levels ranging from 150 to 650 ppm were reported. (5) In another study, 51 of 217 apparently healthy workers were found to have some hematological abnormalities including 6 cases of pancytopenia. These workers are described as having been exposed to 30 to 210 ppm benzene for as short as 3 months to 17 years.

This data indicates that aplastic anemia and thrombocytopenia in relation to benzene exposure may develop as early as several months.

B. Acute Myeloblastic Leukemia:
Acute myeloblastic leukemia is a cancer of the blood system in which there is an abnormal production of hematologic stem cells, granulocytic leukocytes, red blood cells and platelets. This disease is mostly observed in adults and has an increasing incidence with age, peaking in the 6th or 7th decade. There are a number of variants of acute myelogenous leukemia which can be considered to be part of the same disease. These include acute myelomonocytic leukemia, promyelocytic leukemia, and erythroleukemia.

The medical literature is replete with cases of acute myeloblastic leukemia in which benzene exposure has been shown as the causative agent. The relatively common description of aplastic anemia associated with benzene exposure followed through a pre-leukemic phase into acute leukemia further supports the concept that the bone marrow toxicity of benzene encompasses a wide spectrum of diseases presenting as anemia, thrombocytopenia, leukemia, or the other hematological diseases described in Table 2.

A published study in the New England Journal of Medicine, by Rinsky, et al,(6) quantitatively assessed the relation between benzene exposure and leukemia and examined the mortality rate of cohort with occupational exposure to benzene. Their findings are summarized in the following statements: (1) There is a strong positive exposure response relation between benzene and leukemia. (2) On the basis of their study, they conclude that exposure levels of less than 1 ppm annually, cumulative over a 40-year working lifetime increases the risk of leukemia by a factor of 1.7. (3) In the population studied, there was a statistically significant excess of death from multiple myeloma (multiple myeloma is another hematological abnormality, whereby not related to the leukemia lymphoma group, it is still a chronic hematological disease of the bone marrow). Of interest in this study is a description of a patient who died from leukemia 34 years after his exposure to benzene levels of 19.56 ppm over the years. Multiple myeloma, the cause of death in four members in this study, was described previously in relation to benzene, although in small numbers. Furthermore, it is of interest that these patients have a very long latency period from the time of exposure of over 20 years, and the lowest cumulative exposure of 40 ppm years.

C. Lymphoma and Lymphatic System:
Recently, studies aimed at evaluating the effects of benzene and leukemia have also shown an increase in the relative risk of lymphatic system malignancies in benzene workers. A recent study by NIOSH,(7) described increased mortality from lymphoma and lymphocytic leukemia. A similar increased risk for lymphatic cancer has been reported by other investigators. (8,9) Rubber chemical workers who were exposed to benzene had 4 to 5 fold higher risk of lymphoid malignancy than those unexposed.

D. Safety and Policy:
To reduce the risk of leukemia in industrial workers exposed to benzene, the United States Occupational Safety and Health Administration (OSHA) in 1978 reduced the permissible work place exposure of benzene from previous 10 ppm to 1 ppm. However, in 1980, the US Supreme court invalidated the OSHA benzene standard of 1 ppm. The court states that AOSHA had failed to provide substantial evidence of the need for regulation, and that it had not demonstrated a significant risk of material health impairment at the previous level of 10 ppm.@ Since then, three studies have been published, in each of which the amount of benzene exposure has been found to correlate strongly with the risk of death from leukemia. The study published in the New England Journal of Medicine on benzene and leukemia(6) further demonstrates that a cumulative benzene exposure of 400 ppm years is equivalent to a mean annual exposure of 10 ppm over a 40 year working lifetime. (Ten ppm was at that time the enforceable standard in the United States for occupational exposure to benzene.) They concluded that protection from benzene-induced leukemia would increase exponentially with

any reduction in the permissible exposure limit enforceable to date. Obviously, the crucial question of who will develop a hematological disease as a result of exposure at the workplace to benzene is impossible to answer scientifically. Although a dose relation has been demonstrated, the fact that some cases have been described where exposure to benzene was not at excessive levels suggests that even strict protective efforts may not completely prevent industrially-related benzene exposure and hematological cancers.

E. Levels of Exposure & Risk Assessment:
The issue of what is Aa safe level of exposure@ to benzene and what is Anot a safe level of exposure@, or as some would like to define it Asufficient exposure@ to cause a hematological cancer has been addressed by several studies and regulatory agencies. The study by the Environmental Protection Agency (EPA)(10) as well as the International Agency for Research on Cancer (11) clearly indicates that there is no safe level of exposure to carcinogenic agents in the absence of epidemiological data of safety in humans. In the absence of safety studies in humans, experimental animal data must be applied from a policy and public health prevention point of view. Indeed, the American Petroleum Institute (API) (12) stated that Ain as much as the body develops no tolerance to benzene and there is a wide variation in individual susceptibility, it is generally concluded that the only absolutely safe concentration for benzene is zero@. The most recent analysis of levels of exposure and risk assessment summarized by the 1998 position paper of the EPA clearly concludes that the dose-response relationship for benzene follows a linear line through the zero at low level (to be applied relevant to the Rinsky studies in the New England Journal of Medicine, 1987(6)). Specifically, that from an epidemiological point of view the cut-off point, is at 0.1 ppm cumulative exposure (40 years, 8 hours per day, workers) will equate to the background level of benzene risk for hematological cancers. Once the level of 0.1 ppm year cumulative exposure is established the risk will be that of background levels. Indeed, the studies by Infante(13) have shown that 35% of the workers exposed to benzene who died from leukemia or lymphoma were exposed to below 5 ppm average exposure levels. Picciano, et al(14) has shown chromosomal changes in workers exposed to levels of 1 ppm benzene. Increasing the level to 1 ppm year cumulative exposure, increases the risk exponentially to 1.7 as compared to the background level at 0.1 ppm year.(6)

The concept of cumulative benzene exposure for the working population must be well understood before one can address levels of exposure. The most recent studies by Hayes, et al, from the National Institute of Health,(15) provide the most extensive data on benzene exposure and hematological cancers. They clearly show that diverse hematopoietic malignancies can develop at benzene exposure levels of less than 10 ppm.

It is also important to remember that although many of the material safety data sheets of industrial solvents do not indicate the presence of benzene, the testimony in front of OSHA and the scientific papers published in that regards clearly indicate that industrial solvents contain benzene and cannot be produced without benzene contamination.(16,17) Therefore in the analysis of risk or causation one must take into account the knowledge that industrial solvents cannot be produced without contamination with benzene, and therefore they contain benzene.(16,17)

As far as levels of exposure, it is difficult for a physician to establish a level absent the data provided from the employer. These data are commonly not available, are not provided, or measurements are not done. The scientific medical literature allows the physician to extrapolate from the symptomatology of exposure, such as the threshold odor recognition for benzene, 61-91 ppm,(18) and symptomatology of dizziness, which is extrapolated to levels of 300 ppm.(19) This methodology has also been accepted by the U.S. Courts (20,21) Therefore it is imperative that the examining physician take a good history and look for odor recognition to extrapolate the levels of exposure and/or alternatively, symptoms of dizziness to extrapolate the levels of exposure.

F. Genetic Studies and Markers:
Several technologies developed in the last 10 years to evaluate chromosomal changes and DNA changes caused by environmental exposures, as well as a marker of environmental exposures. The use of chromosomal translocation as a biological marker of exposure in humans have become an important tool in the research, as well as in some instance a marker of exposure. Several methodologies have utilized and include structural chromosomal aberrations, sister chromatoid exchanges (SCEs) and micronuclear changes. These are markers of changes in the cellular genetic materials, and represent damage induced by chemicals. These methodologies are viewed as cytogenetic assays, and by themselves cannot provide a diagnosis, but they complement other methodologies which include gene mutation analysis, and DNA changes. Among the important uses of cytogenetics as a biomarker is the relationship between chromosomal aberrations secondary to chemicals and carcinogeneses.

A patient who developed aplastic anemia after exposure to benzene, was shown to have significant chromatoid fragments. (22) A cytogenic study which was carried out later,(23) on a patient who developed leukemia after 22 years of continuous exposure to a high concentration of benzene, showed that later in the process there were changes in 47 chromosomes in the bone marrow. Sellyei, et al,(24) studied patients who developed pancytopenia after having been exposed for 18 months to benzene. Significant chromosomal changes were detected even 7 years after remission from the anemia and the presentation of leukemia. In line with these changes, Forni, et al,(25) have studied 25 subjects with a history of hematopoietic abnormalities and benzene exposure, and compared these to 25 matched controls. They have shown that 18 years after clinical and hematological symptoms chromosomal aberrations were increased as compared to the control group. In 1965, Tough, et al,(26) have studied chromosomes of workers exposed to benzene for periods varying from 1 to 18 years. They have also shown a small but significant increase in chromosomal changes compared to a control group. These same investigators looked at workers exposed to benzene levels from 25 to 120 ppm, and found that they had significant chromosomal aberrations as compared to the normal population (which has a general background exposure to benzene levels). Hartwich, et al,(27) looked at 9 healthy refinery workers who were exposed to low levels of benzene, and also found significantly increased chromosomal changes compared to the control group. The National Research Council Advisory Center and Toxicology Study(28) concluded that close correlation between occupational exposure to benzene and persistence of chromosomal aberrations can be discussed only when there is an association between benzene induced hematopoietic disease and chromosomal aberrations, however, the absence of chromosomal changes, cannot be a determinant in the temporal relationship between exposure to benzene and hematopoietic diseases.

While it is true that these findings are in agreement with previous studies(29) they still could not explain the 43% of the patients who were not exposed, and still had abnormal chromosomal changes. This is a very important observation, since some investigators in the field claim that the Aabsence of chromosomal changes@ in benzene exposed individuals negates the clinical causative diagnosis of benzene induced hematopoietic disease. Essentially, all of the studies show that benzene can cause chromosomal changes, but does not cause it in all patients, and the absence of chromosomal changes cannot and does not rule out the exposure to benzene as a causative factor. Indeed, the courts have analyzed this issue and concluded that the genetic-chromosomal changes are not Afingerprints@ of benzene exposure.(30)

G. How to Make or Rule Out a Diagnosis of Benzene-Related Hematological Disease:

The examining physician who is faced with the question of causation in a patient with hematological malignancy and benzene exposure must utilize available epidemiologic and scientific data in the evaluation process. Ideally material safety data sheets as well as job analysis description, industrial hygiene report, and investigative report, specifying the frequency and amount of exposure of benzene levels in the air should be provided, and the examining physician should request information in relation to other exposures such as solvent, radiation and pesticides. Although the latency period may be important in the final analysis, one must remember that the scientific literature shows a range of anywhere from 6 months with an average of 15 years and up to 40 years in some cases. In some instances, it is probable that both the exposure to benzene on an industrial basis and exposure to other toxic chemical on a nonindustrial basis may be additive. In that scenario the reporting physician must determine whether the exposure to benzene, regardless of the other exposures, was a substantial factor in the development of the patient=s hematological cancer . The substantial factor is defined by the California Supreme Court in the Rutherford decision as Alevels which are not theoretical or infinitesimal@(31)

As an example, I will discuss a case of leukemia in a 58-year-old petroleum engineer. He describes exposure to benzene on a frequent weekly basis, and described the smell of benzene. (The odor recognition for benzene is 61-91 ppm, and therefore equates to levels of exposure of at least 61 ppm). His leukemia was diagnosed 5 years after his last exposure to benzene (he was exposed over a period of 5 years). An investigative report, job analysis and material safety data sheets clearly showed no other exposures to chemicals (such as nonindustrial) and very clearly indicated a daily exposure to benzene with its inhalation over a period of 5 years. Based on the levels of exposure, safety data sheets and absent any other chemical exposure (the latency period of 10 years was compatible with the diagnosis of benzene induced leukemia), and in the medical records it was concluded that this patient=s leukemia was the result of his benzene work exposure at levels of at least 61 ppm (latency period: from the date of first exposure to the date of diagnosis).

In summary, benzene is a hematological carcinogen based on both experimental animal studies(32) and human studies, as well as in vitro studies. While the precise mechanism of benzene carcinogenicity is not clear, it has been well-established that benzene affects the stem cell - meaning the immature cell of the hematopoietic system which can in turn develop into any of the hematological cells originating from the bone marrow and the lymphatic system. Table 3 summarizes the information required for evaluation of industrial causation in hematological diseases of benzene.

Table 3. Information Required in the Analysis of Benzene Exposure and Hematological Malignancies

1. Detailed history of exposure, including, frequency, duration and symptoms during exposure.
2. Job analysis description with detailed exposure history.
3. Air level measurements, if available from employer (commonly this information is unavailable).
4. Nonindustrial exposure to other hematological toxins.
5. Industrial and non-industrial exposure to solvents, pesticides & herbicides.
6. Latency period: time from initiation of exposure to diagnosis.

Disclosure
This paper represents the current state of the art of the benzene literature and the authors opinions.

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CHEMICAL PROFILES | Chemical Profile

Chemical: FORMALDEHYDE
CAS Number: 50-00-0

Chemical Profile for FORMALDEHYDE (CAS Number: 50-00-0)

- **Human Health Hazards**

Health Hazard		Reference(s)
Recognized:	Carcinogen	P65
Suspected:	Gastrointestinal or Liver Toxicant	ATSDR DIPA RTECS
	Immunotoxicant	EEC HAZMAP NAP SNCI
	Neurotoxicant	RTECS
	Reproductive Toxicant	EPA-SARA FRAZIER
	Respiratory Toxicant	ATSDR EPA-HEN HAZMAP OE! CREL RTECS
	Skin or Sense Organ Toxicant	EEC EPA-HEN HARV HAZMAP KLAA LADO OEHHA-AREL OE! CREL RTECS

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- **Hazard Rankings**

More hazardous than most chemicals in 7 out of 12 ranking systems.
Ranked as one of the most hazardous compounds (worst 10%) to ecosystems and human health.

[top]

- **Chemical Use Profile**

This is a high volume chemical with production exceeding 1 million pounds annually in the U.S.
Used in at least 10 industries.
Used in consumer products, building materials or furnishings that contribute to indoor air pollution.
Used in pesticide products.

[top]

- **Rank Chemicals by Reported Environmental Releases in the United States**

For a list of the geographic areas, facilities, or industrial sectors which report the largest releases or transfers of this chemical to the Toxics Release Inventory, select what you want:

- Rank States
- Rank Counties
- Rank Zip Codes
- Rank Facilities
- Rank Industrial Sectors

[top]

- **Regulatory Coverage**

On at least 8 federal regulatory lists.

[top]

- **Basic Testing to Identify Chemical Hazards**

Eight basic tests to identify chemical hazards have been conducted and are publicly available for this chemical.
Track whether this chemical is being voluntarily tested to provide basic hazard data. Copy its CAS number above and check the HPV Chemical Tracker.

[top]

- **Information Needed for Safety Assessment**

Lacks at least some of the data required for safety assessment.
See risk assessment data for this chemical from U.S. EPA or

Scorecard.

[top]

- **Links**

Additional information about this chemical may be available elsewhere in Scorecard.

Other web sites specific to this chemical:

- Agency for Toxic Substances and Disease Registry Public Health Statement
- Agency for Toxic Substances and Disease Registry ToxFAQ
- Agency for Toxic Substances and Disease Registry Toxicological Profile
- CalEPA Air Resources Board Toxic Air Contaminant Summary
- EPA Health Effects Notebook for Hazardous Air Pollutants
- EPA Integrated Risk Information System Report
- IPCS International Chemical Safety Card
- International Toxicity Estimates for Risk (ITER) from Toxicology Excellence for Risk Assessment
- National Institute for Occupational Safety and Health Pocket Guide to Chemical Hazards
- National Institute for Occupational Safety and Health Pocket Guide to Chemical Hazards
- National Safety Council Chemical Backgrounder
- New Jersey Fact Sheet

If none of these sources meet your needs, you can try searching some other chemical database Web sites.

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- **Notes**

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HEALTH AND SAFETY

FORMALDEHYDE

Formaldehyde (FAH) is a colorless, flammable gas with a strong, pungent odor. It is widely used in hospitals, in disinfectants, in carpet and furniture glues, and in a large number of other products. FAH is used in liquid form as a water and methanol solution called **Formalin**, which has a clear to milky appearance, and in solid form as a white powder called **Para-formaldehyde**. Formaldehyde gas may be given off by either liquid Formalin or Paraformaldehyde powder.

Formaldehyde's odor may be detected by some people. Many others, however, may not be able to smell it at all. Therefore, the sense of smell can not be relied upon to warn workers. Rather, irritation of the eyes, nose and bronchial tubes and watering eyes may indicate exposure to FAH or formaldehyde-containing substances more often than the sense of smell.

Uses

Formaldehyde products have a wide variety of uses in hospitals including:

- tissue preservatives and in embalming fluids in autopsy rooms and the pathology department;
- in kidney dialysis units and central supply as a sterilizing agent;
- in operating rooms as a disinfectant.

Many detergents, disinfectants and cleaning agents used by custodians may contain FAH. It is very important for custodial and housekeeping workers to become familiar with the products they use, how to work with those products safely and when safer substitutes may be available. Read the label. Ask questions. And be careful when handling any product containing formaldehyde.

Formaldehyde is also used in carpet and furniture glues and can contaminate office air, especially where there is already a building ventilation problem. (See the AFSCME Fact Sheet on *Indoor Air Pollution.)*

Formaldehyde is also a byproduct of engine exhaust, photochemical smog, and incinerator and cigarette smoke.

Acute (Short-term, Immediate) Effects

- **Low Exposure Levels (0.1-5 parts per million):** Burning, tearing of eyes; skin irritation.

- **Moderate Exposure Levels (10-20 ppm):** Burning of eyes, nose and trachea; severe coughing; severe difficulty in breathing; and intense tearing of the eyes.

- **High Exposure Levels (50-100 ppm):** Tightening in the chest; irregular heartbeat; severe headache; pulmonary edema (fluid in the lungs); inflammation of the lungs; possibly even death.

Chronic (Long-term, Delayed) Effects

- "Sensitization": Some workers may be especially sensitive to formaldehyde and may develop an "allergic" reaction to very low-level exposures. This is called "sensitization" and can occur suddenly, even after an employee has worked with FAH for years with no reaction.

  Sensitization to formaldehyde may occur in other environments outside the hospital setting. Many office products such as glues used in office furniture and rugs, carbonless copy paper, and the inks used by some copy machines contain formaldehyde. Where ventilation is poor, exposure to formaldehyde in offices can lead to "Tight Building Syndrome," or "Indoor Air Pollution," where workers develop allergies and flu-like symptoms. (See the AFSCME Fact Sheet on Indoor Air Pollution.)

  Where facilities have in-house print shops to publish newsletters, menus, and other materials, employees must also expect to find products which contain formaldehyde and may present a health risk.

- **Eczema**: Workers exposed to formaldehyde solutions or resins can develop eczema (flaking and itching skin), which may involve the eyelids, neck, hands, arms, armpits and scrotum. The condition may also be caused by contact with clothing contaminated with formaldehyde.

- **Dermatitis**: Contact with formaldehyde or contaminated clothing can also cause a severe form of skin disease called "dermatitis." Dermatitis may range from simple reddening of the skin to severe cracking and blistering. Prolonged exposure may cause the fingernails to turn soft and brown-colored.

- **Eye Damage**: Direct contact with the eye will cause severe burning and tearing, and may damage the cornea.

- **Cancer**: Formaldehyde is known to cause nasal cancer and may be associated with other respiratory cancers and cancer of the brain. The National Institute for Occupational Safety and Health (NIOSH) has recommended that FAH be treated as a potential human carcinogen. The American Conference of Governmental Industrial Hygienists (ACGIH) also calls formaldehyde a suspected human carcinogen.

- **Reproductive System**: There is also evidence that women workers exposed to formaldehyde experience menstrual disorders. Other studies have found that FAH can damage the genetic make-up of certain cells, which means it may cause birth defects.

Safe Work Procedures

1. **Training:** All employees working with formaldehyde or formaldehyde-containing products should be given comprehensive training which should include specific information about the product, how to use it safely, the hazards associated with it, personal protective equipment required, and procedures to follow in an emergency situation.

2. **Material Safety Data Sheets** (MSDS's) should be made available to each employee assigned to work with FAH or FAH-containing products. The MSDS should be provided to the employer by the manufacturer and should contain complete and detailed information on the chronic and acute health effects, fire and explosion hazards, and safety precautions. Training and MSDS's are usually required under Right-to-Know laws.

3. **Engineering Controls**

   - **Substitution:** One of the most effective methods of controlling exposure to formaldehyde is to substitute a safer, less toxic material where possible. For example, a dilute bleach may be used to disinfect the exterior of dialyzers and is much safer to use than cleaning agents containing formaldehyde.

     Extreme care must be used when selecting possible substitutes. The alternative should be thoroughly evaluated for possible health effects prior to selection. In many cases, **phenols, glutaraldehyde** and other cold sterilants may be used as safer alternatives for formaldehyde.

   - **Enclosure:** Enclosure of the process is another preferred method of controlling worker exposure. The employee is prevented from coming into direct contact with the formaldehyde. The enclosure should be designed with a slight vacuum so that any leaks will result in the flow of external air **into** the enclosure. The enclosure should be tested regularly to make sure that it is operating properly and that formaldehyde gas is not escaping into the general room air.

   - **Local Exhaust Ventilation:** Local exhaust ventilation -- where FAH is removed from the worker's breathing area -- should be used to control worker exposure if formaldehyde and associated products must be used. Laboratory work with formalin or specimens preserved in formalin should be done under a fume hood or in a biological safety cabinet. Alternatively, local ventilation with moveable ducting and adjustable air inlets may be used. However, these systems are often less effective because they depend upon being properly adjusted and are more easily tampered with.

     All local exhaust ventilation systems should be checked at installation to ensure that the system is working properly, at three month intervals, and whenever there is a change in process or operations.

     All ventilation systems provided to control contaminants should be exhausted separately from general room air to the outdoors to prevent exposure of other hospital workers to the contaminated air (see the AFSCME *Ventilation* Fact Sheet).

   - **General Dilution Ventilation** means providing an adequate number of air exchanges per hour to keep air moving in a work area. In a hospital setting, the use of floor fans and blowers in the ceiling will **not** protect workers from exposure to formaldehyde.

4. **Respiratory Protection:** Respirators should be available for emergency use but they should not be used to protect workers from exposure to formaldehyde on a day-to-day basis. In selecting the proper respirator, it is important to know **all** of the hazards to which workers may be exposed. The respiratory protection **must** be carefully selected with a complete understanding of the hazards present.

   IMPROPER USE OF RESPIRATORS IS DANGEROUS. Such equipment should only be used if the employer has a written program that takes into account work place conditions, requirements for worker training, and respirator fit testing. The program should also include medical exams, with emphasis on lung function, to determine an employee's ability to work under the additional strain of wearing a respirator (particularly a negative pressure respirator) as described in OSHA standard 29 CFR 1910.134 (see the AFSCME Respirators Fact Sheet).

5. **Protective Clothing:** Employees working with liquid formaldehyde should be provided with impervious clothing, heavy-duty waterproof gloves, face shields (8 inch minimum), aprons, boots and other protective clothing necessary to prevent skin contact with formaldehyde. Employees should wear splash-proof safety goggles where FAH may come into contact with the eyes.

6. **Personal Hygiene:** Workers should wash thoroughly, **any** areas of the body which may have come in contact with formaldehyde:

   - after exposure and at the end of each workday;

   - before lunch breaks and rest periods; and

- before eating, smoking or using toilet facilities.

Special Precautions

Formaldehyde is flammable and explosive but only in higher concentrations. Explosive concentrations may build up in improperly ventilated storage rooms and fume hoods. Formaldehyde should **NEVER** be stored near or used with hydrochloric acid because the two chemicals combine to form (bis) Chloromethyl Ether (BCME), a very powerful cancer-causing agent.

Medical Surveillance

Physical symptoms such as respiratory irritation or dermatitis should be an alarm that an employee is being overexposed to formaldehyde. A physician who knows the complete background of the nature of the worker's exposure should perform an examination. Monitoring of the employee's condition should continue as any treatment program is carried out. In addition, any other employees who may also be exposed to formaldehyde in the workplace or may show any symptoms of exposure to FAH should be examined. Medical examinations should be performed on an annual basis with special emphasis on the skin and the respiratory tract, and should include a medical history.

Workplace Exposure Limits

1. **OSHA** has issued a revised standard on formaldehyde. It reduces the Permissable Exposure Limit (PEL) from 1 part per million (ppm) to 0.75 as an 8-hour Time-Weighted Average (TWA) with a 2 ppm 15-minute Short Term Exposure Limit (STEL). Finally, the new standard establishes an "Action Level" at 0.5 ppm (8-hour TWA). At the action level, the employer is required to institute a monitoring and abatement program which must include the following:

    - **Monitoring.** Initial monitoring must be performed by every employer covered by the standard. If the initial monitoring indicates an exposure at or above the action level, the employer must continue monitoring periodically, but at least every 6 months. Monitoring must continue until the results of two consecutive sampling periods taken at least 7 days apart show the exposure level has been reduced to below the action level. Employees must be notified of the results of such monitoring and affected employees or their union representative may observe any monitoring.

    - **Regulated Areas.** The new standard requires the employer to establish regulated areas where monitoring indicates a level of formaldehyde which exceeds either the PEL (0.75 ppm) or the STEL (2 ppm). The areas must be signed and posted: **DANGER ... FORMALDEHYDE ... IRRITANT AND POTENTIAL CANCER HAZARD ... AUTHORIZED PERSONNEL ONLY.** Entry into the area must be restricted.

    - **Compliance Methods.** The employer is required to use engineering controls (described above) and work practice controls, excpt while such controls are being installed, during maintenance and repair activities for which such controls are impossible, and in work situations where engineering and work practice controls do not reduce exposure to below the PEL or STEL.

    - **Respiratory Protection.** Respirators are required to be worn while engineering controls are being installed, during maintenance and repair activities for which such controls are impossible, in work situations where engineering and work parctice controls do not reduce exposure to below the PEL or STEL, and in emergencies. The standard further specifies the types of respirators which are to be used for varying levels or contamination and requires that such use must be in compliance with 29 CFR 1910.134 (b)(d)(e) and (f), the OSHA Respiratory Protection Standard.

    - **Protective Clothing and Equipment.** The standard includes requirements for clothing which is impervious to formaldehyde, gloves, safety goggles, face shields, and other personal protective equipment which may be required under 1910.132 and 1910.133. The employer is also responsible for maintaining all personal protective equipment, including laundering of contaminated clothing.

    - **Hygiene Protection.** The standard requires change rooms for employees who must wear protective clothing, emergency quick drench showers, and emergency eyewash stations.

- o **Housekeeping.** The standard requires surveying for leaks or spills (including visual inspections), proper maintenance of equipment, spill clean-up procedures, and waste disposal methods.

- o **Medical Surveillance.** The standard requires medical surveillance for all employees exposed at levels above the action level or the STEL.

- o **Hazard Communication.** The requirement under the standard for the hazard communication program to be in compliance with the requirements of 29 CFR 1910.1200. This includes employee Right-to-Know training (repeated at least annually). Material Safety Data Sheets (MSDS), product labelling, and all other requirements under the Hazard Communication Standard (or, where applicable, state Right-to-Know laws.)

- o **Recordkeeping.** The standard requires the employer to establish and maintain accurate records of all monitoring of employee exposure to formaldehyde.

2. ACGIH (American Conference of Governmental Industrial Hygienists) is a standard-setting organization made up of industrial hygienists from governmental agencies and educational institutions. ACGIH has eliminated the old eight hour Time Weighted Average and the 2 ppm Short Term Exposure Limit and adopted a ceiling limit TLV 0.3 for FAH in June 1992. ACGIH has classified formaldehyde as a suspected carcinogen. That designation implies that there may be **NO SAFE LEVEL OF EXPOSURE** to formaldehyde.

3. NIOSH (National Institute for Occupational Safety and Health) recommends a ceiling limit of 0.1 ppm. NIOSH further recommends that formaldehyde be treated as a human carcinogen.

May 1993

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Particulate Matter ($PM_{\leq 10}$)

Airborne particulate matter, known as PM, is one of the major components of smog. PM include microscopic particles in the air. These particles, capable of being inhaled by humans, are divided into two size ranges: $PM_{2.5}$ and $PM_{\leq 10}$.

Between the two, "fine" particles less than 2.5 micrometers in size ($PM_{2.5}$) are responsible for causing the greatest harm to human health. 1/20th the width of a human hair, these fine particles can be inhaled deep into the lungs reaching areas where the cells replenish the blood with oxygen. They can cause breathing and respiratory symptoms, irritation, inflammation and damage to the lungs and premature deaths.

Some $PM_{2.5}$ are released directly to the atmosphere from industrial smokestacks and automobile tailpipes, but a large percentage is actually formed in the atmosphere from other pollutants such as sulphur dioxide (SO_2), nitrogen oxides (NO_x) and volatile organic compounds (VOC). Fossil fuel combustion in motor vehicles, power plants and large industries, as well as industrial process and solvent use are major sources of these other pollutants.

Although not as serious a threat to human health as $PM_{2.5}$, "coarse" particles covering the range from 2.5 to 10 micrometers in diameter ($PM_{\leq 10}$), are also known to cause adverse health effects. When inhaled, they tend to be deposited in the upper parts of the respiratory system from which they can be eventually expelled back into the throat. Coarse particles generally remain in the form in which they are released into the atmosphere without chemical transformation, eventually settling out under the influence of gravity. While some of these coarse particles are generated naturally by sea salt spray, wind and wave erosion, volcanic dust, windblown soil and pollen, they are also produced by human activities, such as construction, demolition, mining, road dust, tire wear and grinding processes of soil, rocks, or metals.

Health Effects of PM

Numerous studies have linked PM to aggravated cardiac and respiratory (heart and lung) diseases such as asthma, bronchitis and emphysema and to various forms of heart disease. Children and the elderly, as well as people with respiratory disorders such as asthma, are particularly susceptible to health effects caused by PM.

Scientists now believe that there is no "threshold," or safe level, for exposure to PM. Particulate matter is not limited to urban areas. Exposure to PM in Canada is widespread, and it remains a problem in every region of Canada all year round. A correlation has been established between high levels of airborne PM and increases in emergency room visits, hospital admissions and deaths.

PM is also an effective delivery mechanism for other toxic air pollutants, which attach themselves to particulate matter that floats in the air. These toxics are then delivered into the lungs, where they can be absorbed into the blood and tissue.

Environmental Impacts of PM≤10

The effects of PM on materials have been investigated for metals, wood, stone, painted surfaces, electronics and fabrics. The deposition of PM on these materials may cause soiling and discoloration, thus reducing their aesthetic appeal. Exposure to PM may also cause physical and chemical degradation of materials through the action of acidic particles.

Particulate matter is also associated with reduced visibility with poor air quality. The presence of particles in the air reduces the distance at which we can see the colour, clarity, and contrast of far away objects because the particles in the atmosphere scatter and absorb light.

The most obvious effect of particulate deposition on vegetation is the physical smothering of the leaf surface. This will reduce light transmission to the plant in turn causing a decrease in photosynthesis. Particle composition may cause both direct chemical effects on the plant and indirect effects through impacts on the soil environment. Particle accumulation on the leaf surface may increase the plant's susceptibility to disease.

Canada's Action

1. On May 27, 2000, based on scientific recommendations, Canada's Minister of Environment and Minister of Health announced their intention to declare particulate matter less than or equal to 10 microns ($PM_{\leq 10}$) toxic under the *Canadian Environmental Protection Act* (CEPA 1999). Under CEPA, key industrial sectors are required to set emission reduction targets and timetables to meet those targets.
2. The Government of Canada, provincial and territorial governments agreed in June 2000 to ratify the Canada-wide Standard for $PM_{2.5}$. All jurisdictions have committed to meet this new Standard by year 2010 or sooner. A wide range of actions to reduce emissions from vehicles, products and industry will have to be implemented to meet the Standard. Some of these, like vehicles and fuels will be carried out by the Government of Canada. Others, such as emission reductions from certain existing industrial sources, will be undertaken by provinces and territories. Emission reductions from a limited number of major industrial sectors that are of interest nationally will be achieved through joint efforts by the provinces/territories and the Government of Canada.

Improving Life, One Breath at a Time

Particulate Matter Air Pollution Tests

Comments of the American Lung Association® *of Washington* on the proposed revisions to the ozone and particulate matter air quality standards (Docket #A-95-58 and Docket #A-95-54) January 15, 1997

The new National Ambient Air Quality Standards (NAAQS) for ozone and particulate matter should be set at tighter levels than those proposed by the **Environmental Protection Agency (EPA)** to protect the health of Washington citizens. The Clean Air Act mandates that the NAAQS be set at a level to protect public health with a "margin of safety." Stricter standards than those proposed by the EPA are needed to provide this "margin of safety," and ensure that the health of sensitive individuals, such as people with asthma or emphysema, children, and the elderly is protected. According to the Clean Air Act the EPA must base the new standards on health and environmental effects, and other issues such as timing and cost should only be addressed during implementation.

In Washington state the main sources of particulate matter are motor vehicles, wood stoves, open burning, and industrial emissions. The health effects from these combustion sources are primarily from fine particles ($PM_{2.5}$) which are currently not federally regulated. These particles are hazardous because they are small enough to be inhaled deeply in human lungs. More than 50 epidemiological studies have been performed in different parts of the world, in different kinds of climatic conditions, and from different particulate sources, and the majority of the studies have found adverse health effects from particulate matter at levels lower than the current federal standard. Particulate air pollution has been associated with increased respiratory illness or chronic respiratory symptoms, asthma aggravation, increased hospital admissions, and premature death in many U.S. cities.

Scientific studies performed in Washington state have indicated that citizens are at risk for adverse health effects from particulate matter. A University of Washington study found that roughly one in eight emergency room visits for asthma in Seattle was linked to particulate air pollution. A study published in January 1996 by Joel Schwartz, Associate Professor at Harvard School of Public Health, found an association between particulate matter less than 10 microns in diameter (PM_{10}) and respiratory hospital

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admissions in Spokane. The Natural Resources Defense Council estimated that in the Washington state metropolitan area 1,400 people die prematurely each year from exposure to particulate matter, while a **American Lung Association®** report, *Dollars and Cents*, estimated that over $340 million in medical costs could be prevented each year in Washington state if the federal government adopted California's stricter PM_{10} Standard (50 $\mu g/m^3$, 24-h daily average, 30 $\mu g/m^3$ annual average).

In July 1996 ozone reached unhealthy levels in Washington state, levels that nearly exceeded the federal standard. Ozone air pollution contributes to lung disease and has been linked to increased hospital admissions and emergency room visits for asthma. Ozone exposure may lead to shortness of breath, chest pain on deep inspiration, and wheezing and coughing. Those most at risk to ozone pollution are the elderly, children, asthmatics, people with chronic respiratory diseases, and individuals who exercise outdoors. Children are especially at risk because they spend more time outdoors than adults and their airways are smaller and more susceptible to air pollutants. A recent study by the American Lung Association and the Harvard School of Public Health found cardio-pulmonary emergency room visits and hospitalizations doubled on days with high ozone levels in some areas of the United States. Another study published in October 1996 found that healthy outdoor workers experienced a decline in their lung function after being exposed to ozone concentrations below 0.085 ppm. This decline in lung function from ozone persisted to at least the following day. The EPA should adopt a 0.07 ppm, eight hour standard for ozone, which should be rounded down, and would thus provide the greatest protection.

The EPA should adopt a new standard for $PM_{2.5}$, no higher than 18 $\mu g/m^3$ (24 hour average) and 10 $\mu g/m^3$ (annual average), and set tighter standards for PM_{10}. The EPA should select the monitor in a given area with the highest annual average as the basis for determining attainment with the annual standard, instead of using spatial averaging as currently proposed. This approach would ensure that people living in areas with the highest levels ("hot spots") are adequately protected from $PM_{2.5}$. This is extremely important in Washington state where we have "hot spots," and do not sustain high levels of particulate pollution over long periods of time, as often occurs in the Eastern United States. Furthermore, the EPA should retain the current one-exceedance per year approach of measuring compliance with the 24-hour particulate matter standard, instead of selecting the 98th percentile reading from the monitors, as currently proposed by the EPA.

There may be no safe level of exposure to ozone or particulate matter, so in the interest of public health, we need to strive to achieve the lowest level possible. Even at the lowest levels, children, the elderly, people who work and exercise outside, and people with heart and lung disease still feel the effects of air pollution. The EPA should set the standard at a level which protects all citizens in all areas of the United States, as mandated in the Clean Air Act.

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For more information, email the American Lung Association® *of Washington* at **alaw@alaw.org** or call us at (206) 441-5100, or 1-800-LUNG-USA. No matter where you live in the United States, you can call **your local American Lung Association®** at 1-800-LUNG-USA.

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Health and Environmental Effects of Particulate Matter

United States
Environmental
Protection Agency
Office of Air &
Radiation
Office of Air Quality
Planning & Standards

FACT SHEET

July 17, 1997

HEALTH AND ENVIRONMENTAL EFFECTS OF PARTICULATE MATTER

Why are We Concerned About Particulate Matter?

- Particulate matter is the term used for a mixture of solid particles and liquid droplets found in the air. Coarse particles (larger than 2.5 micrometers) come from a variety of sources including windblown dust and grinding operations. Fine particles (less than 2.5 micrometers) often come from fuel combustion, power plants, and diesel buses and trucks.

- These fine particles are so small that several thousand of them could fit on the period at the end of this sentence.
  - They are of health concern because they easily reach the deepest recesses of the lungs.

- Batteries of scientific studies have linked particulate matter, especially fine particles (alone or in combination with other air pollutants), with a series of significant health problems, including:
  - Premature death;
  - Respiratory related hospital admissions and emergency room visits;
  - Aggravated asthma;
  - Acute respiratory symptoms, including aggravated coughing and difficult or painful breathing;
  - Chronic bronchitis;
  - Decreased lung function that can be experienced as shortness

  - of breath; and
  - Work and school absences.

Who is Most at Risk from Exposure to Fine Particles?

- The Elderly:
  - Studies estimate that tens of thousands of elderly people die prematurely each year from exposure to ambient levels of fine particles.
  - Studies also indicate that exposure to fine particles is associated with thousands of hospital admissions each year. Many of these hospital admissions are elderly people suffering from lung or heart disease.

- Individuals with Preexisting Heart or Lung Disease:
  - Breathing fine particles can also adversely affect individuals with heart disease, emphysema, and chronic bronchitis by causing additional medical treatment. Inhaling fine particulate matter has been attributed to increased hospital admissions, emergency room visits and premature death among sensitive populations.

- Children:
  - The average adult breathes 13,000 liters of air per day; children breathe 50 percent more air per pound of body weight than adults.
  - Because children's respiratory systems are still developing, they are more susceptible to environmental threats than healthy adults.
  - Exposure to fine particles is associated with increased frequency of childhood illnesses, which are of concern both in the short run, and for the future development of healthy lungs in the affected children.
  - Fine particles are also associated with increased respiratory symptoms and reduced lung function in children, including symptoms such as aggravated coughing and difficulty or pain in breathing. These can result in school absences and limitations in normal childhood activities.

- Asthmatics and Asthmatic Children:
  - More and more people are being diagnosed with asthma every year. Fourteen Americans die every day from asthma, a rate three times greater than just 20 years ago. Children make up 25 percent of the population, but comprise 40 percent of all asthma cases.
  - Breathing fine particles, alone or in combination with other pollutants, can aggravate asthma, causing greater use of medication and resulting in more medical treatment and hospital visits.

How do Particulate Matter and Fine Particles Affect the Environment?

- The same fine particles linked to serious health effects are also a major cause of visibility impairment in many parts of the U.S.

- In many parts of the U.S. the visual range has been reduced 70% from natural conditions. In the east, the current range is only 14-24 miles vs. a natural visibility of 90 miles. In the west, the current range is 33-90 miles vs. a natural visibility of 140 miles.

- Fine particles can remain suspended in the air and travel long distances. For example, a puff of exhaust from a diesel truck in Los Angeles can end up over the Grand Canyon, where one-third of the haze comes from Southern California. Emissions from a Los Angeles oil refinery can form particles that in a few days will affect visibility in the Rocky Mountain National Park. Twenty percent of the problem on dirtiest days in that Park is attributed to Los Angeles-generated smog.

- Airborne particles can also cause soiling and damage to materials.

What Improvements Would Result from EPA's New Standards?

- EPA's new standards will provide increased health protection from the following effects:

  - About 15,000 lives each year will be saved, especially among the elderly and those with existing heart and lung diseases.
  - Reduced risk of hospital admissions by thousands each year, and fewer emergency room visits, especially in the elderly and those with existing heart and lung diseases.
  - Reduced risk of symptoms associated with chronic bronchitis, tens of thousands fewer cases each year.
  - Reduced risk of respiratory symptoms in children, hundreds of thousands fewer incidences each year of symptoms such as aggravated coughing and difficult or painful breathing.
  - Reduced risk of aggravation of asthma, hundreds of thousands fewer incidences each year, in children and adults with asthma.
  - Reduced risks of susceptibility to childhood illnesses.

- Improved visibility over broad regions in the east and urban areas:

  - The Clean Air Act placed special emphasis on preserving visibility in certain national parks and wilderness areas. In response, EPA is developing a "regional haze" program intended to ensure all parts of the country make continued progress toward the national visibility goal of "no manmade impairment."
  - New standards that EPA has promulgated, together with the "regional haze" program under development, will protect against visibility impairment, soiling and material damage effects, and will further reduce acid rain.

Background: What Is Particulate Matter and What are "Fine" Particles?

- Particulate matter originates from a variety of sources, including diesel trucks, power plants, wood stoves and industrial processes. The chemical and physical composition of these various particles vary widely. While individual particles cannot be seen with the naked eye, collectively they can appear as black soot, dust clouds, or grey hazes.

- Those particles that are less than 2.5 micrometers in diameter are known as "fine" particles; those larger than 2.5 micrometers are known as "coarse" particles. Fine particles result from fuel combustion (from motor vehicles, power generation, industrial facilities), residential fireplaces and wood stoves. Fine particles can be formed in the atmosphere from gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds. Coarse particles are generally emitted from sources such as vehicles traveling on unpaved roads, materials handling, and crushing and grinding operations, and windblown dust.

- EPA is also maintaining a national air quality standard focused on small particles less than 10 micrometers in diameter (known as "PM_{10}") to protect against coarse particle effects. Ten micrometers are about one-seventh the diameter of a human hair.

- Before 1987, EPA's standards regulated larger particles (so called "total suspended particulates"), including those larger than 10 micrometers. By 1987, research had shown that the particles of greatest health concern were those equal to or less than 10 micrometers that can penetrate into sensitive regions of the respiratory tract. At that time EPA and states took action to monitor and regulate particulate matter 10 micrometers and smaller.

- In the years since the previous standard was enacted, hundreds of significant new scientific studies have been published on the health effects of particulate matter. Recent health effects studies suggest those adverse public health effects, such as premature deaths and increased morbidity in children and other sensitive populations, have been associated with exposure to particle levels well below those allowed by the current standard.

PM 2.5 Facts

What Is PM 2.5?
Microscopic particles that are easily inhaled and can lodge deep in the lungs. PM 2.5 is another way of saying fine particulate matter of a very small size, to be precise, particles less than 2.5 micrometers in diameter.

Where Does PM 2.5 Come From?
PM 2.5 comes mostly from fuel combustion in diesel engines, power plants, industrial facilities, and wood stoves. The burning of natural gas and diesel fuel produces significant amounts of PM 2.5. PM 2.5 can also be formed in the atmosphere (secondary formation) from gases such as sulfur dioxide, nitrogen oxides, and volatile organic compounds.

Is PM 2.5 Dangerous To Health?
Yes. Scientific studies have shown that PM 2.5 is related to significant health problems, including:

- Aggravated asthma;
- Chronic bronchitis;
- Acute respiratory symptoms and reduced lung function, including shortness of breath, difficult or painful breathing, and aggravated coughing;
- Cardiovascular disease;
- Premature death.

PM 2.5 emissions result in increased hospital admissions, emergency room visits, and work and school absences.

Who Is Most At Risk?
The elderly, children, asthmatics, and individuals with preexisting heart or lung disease.

Is PM 2.5 Regulated?
Yes. But, New York State agencies have ignored potential PM 2.5 impacts when reviewing and permitting new facilities. In 1997, the U.S. Environmental Protection Agency (EPA) set a new standard to regulate PM 2.5 as part of the National Ambient Air Quality Standards (NAAQS) under the Clean Air Act. Under the NAAQS, PM 2.5 levels should not be over 65 micrograms per cubic meter (mg/m3) measured over a 24-hour period and 15 mg/m3 averaged over a year. So, if an area is over 15 mg/m3, the PM 2.5 level is too high and poses a serious health risk.

Are There High Levels of PM 2.5 In New York City?
Yes, and many of these neighborhoods have the highest asthma rates in the world. The following locations have State air monitors that in 2000 showed PM 2.5 levels above the NAAQS 15 mg/m3 standard:

- Brooklyn— Greenpoint (16.2 mg/m3), Sunset Park (15.8 mg/m3)
- Bronx— Morrisania (16.6 mg/m3), Mott Haven/Port Morris (15.2 mg/m3)
- Manhattan— Canal Street (17.5 mg/m3), East Harlem (15.5 mg/m3), Midtown (18.4 mg/m3)

Monitoring data for 2001 indicate that PM 2.5 levels continue to rise.

What Should Be Done?

The potential impacts of PM 2.5 should be studied for any new polluting facility. Such a study must take into account the existing levels of PM 2.5, the health conditions of the nearby residents, the amount of emissions from the facility, the cumulative effect of multiple nearby polluting sources, and secondary formation of PM 2.5. If a new facility might harm people, the impacts must be minimized, and the emissions completely offset or the facility should not be built. Also, the City and State should immediately begin developing a control strategy for PM 2.5.

Information compiled by New York Lawyers for the Public Interest, 151 West 30th Street, New York, NY 10001

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EX. ORD. NO. 13045. PROTECTION OF CHILDREN FROM ENVIRONMENTAL HEALTH RISKS AND SAFETY RISKS

Ex. Ord. No. 13045, Apr. 21, 1997, 62 F.R. 19885, provided:

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1. Policy.

1-101. A growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because: children's neurological, immunological, digestive, and other bodily systems are still developing; children eat more food, drink more fluids, and breathe more air in proportion to their body weight than adults; children's size and weight may diminish their protection from standard safety features; and children's behavior patterns may make them more susceptible to accidents because they are less able to protect themselves. Therefore, to the extent permitted by law and appropriate, and consistent with the agency's mission, each Federal agency:

(a) shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and

(b) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

1-102. Each independent regulatory agency is encouraged to participate in the implementation of this order and comply with its provisions.

Sec. 2. Definitions. The following definitions shall apply to this order.

2-201. "Federal agency" means any authority of the United States that is an agency under **44 U.S.C. § 3502**(1) other than those considered to be independent regulatory agencies under **44 U.S.C. § 3502**(5). For purposes of this order, "military departments," as defined in **5 U.S.C. § 102**, are covered under the auspices of the Department of Defense.

2-202. "Covered regulatory action" means any substantive action in a rulemaking, initiated after the date of this order or for which a Notice of Proposed Rulemaking is published 1 year after the date of this order, that is likely to result in a rule that may:

(a) be "economically significant" under Executive Order 12866

(5 U.S.C. § 601 note) (a rulemaking that has an annual effect on the economy of $100 million or more or would adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities); and

(b) concern an environmental health risk or safety risk that an agency has reason to believe may disproportionately affect children.

2-203. "Environmental health risks and safety risks" mean risks to health or to safety that are attributable to products or substances that
the child is likely to come in contact with or ingest (such as the air we
breath, the food we eat, the water we drink or use for recreation, the soil we live on, and the products we use or are exposed to).

Sec. 3. Task Force on Environmental Health Risks and Safety Risks to Children.

3-301. There is hereby established the Task Force on Environmental Health Risks and Safety Risks to Children ("Task Force").

3-302. The Task Force will report to the President in consultation with
the Domestic Policy Council, the National Science and Technology Council, the Council on Environmental Quality, and the Office of Management and Budget (OMB).

3-303. Membership. The Task Force shall be composed of the:

(a) Secretary of Health and Human Services, who shall serve as a Co-Chair of the Council;

(b) Administrator of the Environmental Protection Agency, who shall serve as a Co-Chair of the Council;

(c) Secretary of Education;

(d) Secretary of Labor;

(e) Attorney General;

(f) Secretary of Energy;

(g) Secretary of Housing and Urban Development;

(h) Secretary of Agriculture;

(i) Secretary of Transportation;

(j) Director of the Office of Management and Budget;

(k) Chair of the Council on Environmental Quality;

(l) Chair of the Consumer Product Safety Commission;

(m) Assistant to the President for Economic Policy;

(n) Assistant to the President for Domestic Policy;

(o) Assistant to the President and Director of the Office of Science and Technology Policy;

(p) Chair of the Council of Economic Advisers; and

(q) Such other officials of executive departments and agencies as the President may, from time to time, designate.

Members of the Task Force may delegate their responsibilities under this order to subordinates.

3-304. Functions. The Task Force shall recommend to the President Federal strategies for children's environmental health and safety, within the limits of the Administration's budget, to include the following elements:

(a) statements of principles, general policy, and targeted annual priorities to guide the Federal approach to achieving the goals of this order;

(b) a coordinated research agenda for the Federal Government, including steps to implement the review of research databases described in section 4 of this order;

(c) recommendations for appropriate partnerships among Federal, State, local, and tribal governments and the private, academic, and nonprofit sectors;

(d) proposals to enhance public outreach and communication to assist families in evaluating risks to children and in making informed consumer choices;

(e) an identification of high-priority initiatives that the Federal Government has undertaken or will undertake in advancing protection of children's environmental health and safety; and

(f) a statement regarding the desirability of new legislation to fulfill or promote the purposes of this order.

3-305. The Task Force shall prepare a biennial report on research, data, or other information that would enhance our ability to understand, analyze, and respond to environmental health risks and safety risks to children. For purposes of this report, cabinet agencies and other agencies identified by the Task Force shall identify and specifically describe for the Task Force key data needs related to environmental health risks and safety risks to children that have arisen in the course of the agency's programs and activities. The Task Force shall incorporate agency submissions into its report and ensure that this report is publicly available and widely disseminated. The Office of Science and Technology Policy and the National Science and Technology Council shall ensure that this report is fully considered in establishing research priorities.

3-306. The Task Force shall exist for a period of 4 years from the first meeting. At least 6 months prior to the expiration of that period, the member agencies shall assess the need for continuation of the Task Force or its functions, and make appropriate recommendations to the President.

Sec. 4. Research Coordination and Integration.

4-401. Within 6 months of the date of this order, the Task Force shall develop or direct to be developed a review of existing and planned data resources and a proposed plan for ensuring that researchers and Federal research agencies have access to information on all research conducted or funded by the Federal Government that is related to adverse health risks in children resulting from exposure to environmental health risks or safety risks. The National Science and Technology Council shall review the plan.

4-402. The plan shall promote the sharing of information on academic and private research. It shall include recommendations to encourage that such data, to the extent permitted by law, is available to the public, the scientific and academic communities, and all Federal agencies.

Sec. 5. Agency Environmental Health Risk or Safety Risk Regulations.

5-501. For each covered regulatory action submitted to OMB's Office of Information and Regulatory Affairs (OIRA) for review pursuant to Executive Order 12866 (5 U.S.C. § 601 note), the issuing agency shall provide to OIRA the following information developed as part of the agency's decisionmaking process, unless prohibited by law:

(a) an evaluation of the environmental health or safety effects of the planned regulation on children; and

(b) an explanation of why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the agency.

5-502. In emergency situations, or when an agency is obligated by law to act more quickly than normal review procedures allow, the agency shall comply with the provisions of this section to the extent practicable. For those covered regulatory actions that are governed by a court-imposed or statutory deadline, the agency shall, to the extent practicable, schedule any rulemaking proceedings so as to permit sufficient time for completing the analysis required by this section.

5-503. The analysis required by this section may be included as part of any other required analysis, and shall be made part of the administrative record for the covered regulatory action or otherwise made available to the public, to the extent permitted by law.

Sec. 6. Interagency Forum on Child and Family Statistics.

6-601. The Director of the OMB ("Director") shall convene an Interagency Forum on Child and Family Statistics ("Forum"), which will include representatives from the appropriate Federal statistics and research agencies. The Forum shall produce an annual compendium ("Report") of the most important indicators of the well-being of the Nation's children.

6-602. The Forum shall determine the indicators to be included in each Report and identify the sources of data to be used for each indicator. The Forum shall provide an ongoing review of Federal collection and dissemination of data on children and families, and shall make recommendations to improve the coverage and coordination of data collection and to reduce duplication and overlap.

6-603. The Report shall be published by the Forum in collaboration with the National Institute of Child Health and Human Development. The Forum shall present the first annual Report to the President, through the Director, by July 31, 1997. The Report shall be submitted annually thereafter, using the most recently available data.

Sec. 7. General Provisions.

7-701. This order is intended only for internal management of the executive branch. This order is not intended, and should not be construed to create, any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies, its officers, or its employees. This order shall not be construed to create any right to judicial review involving the compliance or noncompliance with this order by the United States, its agencies, its officers, or any other person.

7-702. Executive Order 12606 of September 2, 1987 is revoked.

William J. Clinton.