

What can be seen below offers a substantially superior documentation of the pollutants in wood smoke, and listing of the resultant health effects from exposure to same, than you would have found in the March 30, 2016 report to CPSC on Outdoor Burning.

Sadly, the latter report massively "underplayed" and "under reported" the health and environmental risks or concerns about open air burning in London. The three major contributors (LFD, MLHU, Air Quality manager) apparently made their conclusions oblivious not only to the information contained below, but also the additional troves of available science that paints a very different picture of what we are really dealing with when we refer to "outdoor burning" ie. wood smoke pollutants.

The preamble informs that a "new" paper (Fine, 2001) lists several hundred more chemicals, not listed here.

I can't help but wonder if the built in cultural bias that gives outdoor wood burning (and indeed perhaps even more so indoor) a virtual free pass here in London (and sadly elsewhere in too many other jurisdictions, though by no means all jurisdictions thankfully) might be based on the continuing absurd level of blissful ignorance generally permeating our society at all levels about the writ large damage this exposure to wood smoke is doing to all of us, and to the environment we are all supposedly stewards of. Rather than I suppose, than believing some of us just don't actually care.

We are a product of our environment (inextricably intertwined) and we need to begin treating the air we breathe with a lot more respect, both for our own sake and for the greater good of the planet!

Medical Effects:

Health Effects Table

Health Effects of Wood Smoke Pollutants

Wood Smoke Pollutant Health Effects looks at current known health effects of each known toxic pollutant in wood smoke. Keep in mind that "the dose is the poison". What may be unnoticed by an adult in the short term may be a dose that is very damaging to a new or unborn baby. What is unnoticed in one individual may damage many other people. The following table [as a PDF](#) (size 16 KB).

For [References for Wood Smoke Tables 1-4 \(as PDF\)](#)

(**Wood Smoke Emissions** lists some of the known wood smoke chemicals, with a key for the physical state they are in. The major first portion of the list is from one published study (Larson, 1993), the weight of each of these pollutants per kilogram of wood burned is given. Other species found in other studies are listed as "Additional Wood Smoke Emissions" at the end of Table 1, and are included here for the big picture. Scientists know that there are hundreds, perhaps thousands of compounds, and the compounds are rapidly mixing and changing in the smoke itself. A new paper "Chemical Characterization of Fine Particle Emissions from Fireplace Combustion of Wood Grown in the Northeastern United States" (Fine, 2001) lists several hundred more chemicals. We are not including them in our list but provide the reference and abstract for those interested in further research.)

Table 3: Wood Smoke Pollutant Health Effects

Wood Smoke Pollutant	Health effect
Carbon Monoxide ¹	Poison: resulting change of oxyhemoglobin carboxyhemoglobin. Tissue hypoxia, cellular death, damages to the central nervous system, death. ¹⁴ Causes reproductive toxicity. ¹⁵ Reduces ability of blood to bring oxygen to body cells and tissues; cells and tissues need oxygen to work. May be particularly hazardous to people who have heart or circulatory (blood vessel) problems and people who have damaged lungs or breathing passages. ¹¹
Methane ¹	
VOCs (C2-C7) ¹	Volatile Organic Compounds cause serious

	<p>health problems such as cancer and other effects. All VOCs contain carbon. They can cause serious human illness. Hazardous. Causes ozone. Ozone causes breathing problems, reduced lung function, asthma, irritates eyes, stuffy nose, reduced resistance to colds and other infections, may speed up aging of lung tissues. Causes fatigue, generalized depression, increased lethargy or sleep, headaches, substernal pressure, generalized aches and accelerated cardiac action.¹⁷ Environmental Effects - ozone can damage plants and trees; smog can cause reduced visibility</p>
Aldehydes ¹	
Formaldehyde ¹	<p>The gas is toxic if inhaled or absorbed through the skin and is carcinogenic. ¹⁴ Can Harm Plants.¹¹</p>
Acrolein ¹	<p>Toxic, Bronchopneumonia, aveolitis, swelling and hemorrhaging of tiny vessels.¹⁶</p>
Propionaldehyde ¹	<p>Toxic ¹¹</p>
Butryaldehyde ¹	

Acetaldehyde ¹	Toxic ¹¹ , degeneration of olfactory epithelium, liver lesions, nasal cancer, growth retardation. ¹⁶
Furfural ¹	Irritates mucous membranes, causes headaches and photo-sensitivity and affects sugar metabolism. ¹⁴
Substituted Furans ¹	
Benzene ¹	Colorless volatile liquid. Harmful by transdermal absorption and acutely toxic by ingestion or inhalation, causing mucous membrane irritation, neurological symptoms, and death due to respiratory failure; chronic exposure may result in bone marrow depression and anemia. ¹⁴ Causes reproductive toxicity. ¹⁵
Alkyl Benzenes ¹	
Toluene ¹	Toulene is a well known addictive substance. (Glue sniffing) It gives feelings of intoxication. Causes sleepiness, dizziness, headache, muscular weakness, confusion, impaired co-ordination, and visual impairment. It is neurotoxic causing neurobehavivoral changes. Causes changes in Liver and kidneys, erosion of the nose, degeneration of

	<p>respiratory tract skin. Chronic abuse causes damage to the brain in the cerebral area and causes brain stem atrophy.¹⁶ Causes reproductive toxicity.¹⁵ Accumulates in blood and subcutaneous fat if insufficient clearance time between exposures. Irritates eyes and upper respiratory tract. Toulene interacts with other human exposures such as alcohol ingestion. Pattern recognition is disturbed, by both Alcohol and Toulene. Toulene effects accuracy more than Alcohol. Toulene combined with Alcohol caused performance and mood to decline more than for either one separately.</p>
Acetic Acid ¹	Irritant
Formic Acid ¹	More irritating than acetic acid. Dangerously caustic to the skin. ¹⁴
Nitrogen Oxides (NO,NO2) ¹	Lung damage. Illnesses of breathing passages and lungs (respiratory system). Acid aerosol which damages trees and lakes. ¹¹
Sulfur Dioxide ¹	Insecticide. Breathing problems, may cause permanent damage to

	lungs. Environmental effects - SO ₂ is an ingredient in acid rain (acid aerosols), which can damage trees and lakes. Acid aerosols can also reduce visibility.
Methyl chloride ¹	Toxic ¹¹
Napthalene ¹	Toxic ¹¹ , Carcinogenic. Acts like alcohol. ¹⁴
Substituted Napthalenes ¹	Toxic ¹¹
Oxygenated Monoaromatics ¹	
Guaiacol (and derivatives) ¹	
Phenol (and derivatives) ¹	Poison: colic, seizures, cardiac arrhythmias, shock, respiratory arrest. ¹⁴ Toxic ¹¹ , tremors, lower fetal body weight, possible skin carcinogen, EPA Inhalation data insufficient. ¹⁶ .
Syringol (and derivatives) ¹	
Catechol (and derivatives) ¹	Toxic ¹¹
Total Particle Mass ¹	
Particulate Organic Carbon ¹	Toxic ¹¹
Oxygenated PAHs ¹	
PAHs ¹	Toxic ¹²
Fluorene ¹	

Phenanthrene ¹	Also in coal. It is toxic and carcinogenic.
Anthracene ¹	Toxic ¹²
Methylanthracenes ¹	
Fluoranthene ¹	Toxic ¹²
Pyrene ¹	Toxic ¹²
Benzo(a)anthracene ¹	Toxic ¹² , probable human carcinogen. DNA damage and Gene mutation in mammalian cell cultures. ¹⁶
Chrysene ¹	Toxic ¹²
Benzofluoranthenes ¹	Toxic ¹²
Benzo(e)pyrene ¹	Toxic ¹²
Benzo(a)pyrene ¹	Toxic ¹² , Highly carcinogenic.
Perylene ¹	
Ideno(1,2,3-cd)pyrene ¹	Toxic ¹²
Benz(ghi)perylene ¹	
Coronene ¹	
Dibenzo(a,h)pyrene ¹	Toxic ¹⁵
Retene ¹	
Dibenzo(a,h)Anthracene ¹	
Trace Elements ¹	
Strontium ¹	Bone loss, calcification of cartilage. No EPA inhalation data exist.
Magnesium ¹	

Aluminum ¹	Excessive amounts in bloodstream may lead to neurological symptoms that can be fatal. Fumes may cause pulmonary fibrosis. ¹⁴
Silicon ¹	
Sulphur ¹	
Chlorine ¹	
Potassium ¹	
Calcium ¹	
Titanium ¹	
Vanadium ¹	Absorption via lungs; symptoms include irritation of the respiratory tract, pneumonitis, conjunctivitis, and anemia.
Chromium ¹	Toxic ^{11, 12}
Manganese ¹	Concentrates in mitochondria. Activates enzymes. ¹⁴ Acts on the Central Nervous System. Impairment of neurobehavior function: slowed visual reaction time, erratic fine hand, and forearm movement, finger tremor, affects audio verbal short term memory. Causes fatigue, tinnitus, irritability, and more coughs and acute bronchitis. ¹⁶ Central nervous system is the

	<p>primary target. Lodges in lung, providing a pool of slowly released manganese that eventually penetrated the brain. Half-life in the brain of about one year, concentrating in the basal ganglia, which are the brain structures critical for movement. Even modest levels are cumulative.¹⁷</p>
Iron ¹	
Nickle ¹	Toxic ^{11, 12,15}
Copper ¹	Toxic ¹²
Zinc ¹	Toxic ¹² Poison. Fever, vomiting, chills, myalgia, headache and pneumonitis. Looks like lead poisoning. ¹⁴
Bromine ¹	
Lead ¹	<p>Poisoning = Loss of appetite, weight loss, colic, constipation, insomnia, headache, dizziness, irritability, moderate hypertension, albuminuria, anemia, a blue line at the edge of the gums, encephalopathy especially in children) and peripheral neuropath leading to paralysis.¹⁴ Causes reproductive toxicity.¹⁵ Toxic ^{11, 12}. Health Effects - brain and other nervous system damage;</p>

	<p>children are at special risk. Some lead-containing chemicals cause cancer in animals. Lead causes digestive and other health problems. Environmental Effects - Lead can harm wildlife.¹¹</p>
Particulate Elemental Carbon ¹	
Normal alkanes ¹	
Cyclic di-and triterpenoids ¹	
Dehydroabietic acid ¹	
Lupenone ¹	
Friedelin ¹	
Chlorinated Dioxins ¹	<p>Toxic^{12,15} Wasting syndrome, fetal abnormalities or death, and problems with the immune and endocrine systems in humans, Mammals, in fish and in birds.</p>
Particulate Acidity ¹	
Additional wood smoke emissions found in other studies	
Cresol ³	Toxic & corrosive ^{14,11,15}
Isopimaric acid	-
Ethylbenzene ³	Toxic ¹¹ Causes changes in human blood. ¹⁶

Arsenic ⁴	Toxic ^{11,12} Causes skin eruptions, vomiting, diarrhea, abdominal pain, muscular cramps, and swelling of eyelids, feet, and hands. Chronic arsenic poisoning pigmentation of the skin accompanied by scaling, hyperkeratosis of the palms and soles, transverse white lines on the fingernails, headache, peripheral neuropathy and confusion. ¹⁴ Causes reproductive toxicity. ¹⁵
Cesium	Metallic ¹⁴
Cadmium ⁴	Poison Pneumoniosis ¹⁴ . Causes reproductive toxicity. ¹⁵ Toxic ^{11,12} Affects memory, attention concentration and joint pain. ¹⁶
Molybdenum ⁵	Poison, electron redox transport in the body. ¹⁴
Selenium ⁵	Cirrhosis, anemia, loss of hair, erosions of long bones. ¹⁴
Carbazole	Toxic ¹⁵
Acridine	
Barium	Poison, acid soluble salt ¹⁴
Phosphorus	Poison toothache, mandibular necrosis, anorexia, anemia. ¹⁴ Toxic ¹¹
Sodium	

Phenathrol	
Phenathrene	A PAH, Toxic and carcinogenic. Also in coal tar.
d10-phenanthrene	
acenaphthylene	Toxic, probable human carcinogen. Possible liver changes, vascular disorder, and Central Nervous System effects. More toxic than Napthylene. ¹⁶
nitronaphthalene	Vapor may cause blistering and opacity of the cornea ¹⁴ .
d12-chrysene	
3-methylcholanthrene	A PAH, pro carcinogen , highly carcinogenic, requires metabolic acceleration. Widely used in studies of carcinogenesis. ¹⁴
acenaphthene	Toxic ¹¹ probable human carcinogen. Possible liver changes, vascular disorder, and Central Nervous System effects. More toxic than Napthylene. ¹⁶
Indeno (1,2,3,c,d) pyrene	Probable human carcinogen. ¹⁶
Molds	
Thermoactinomyces vulgaris ¹³	P 962. Farmers lung" = Breathlessness with dry cough, loss of appetite, weight loss. ¹⁴

Aspergillus fumigatus ¹³	"Malt workers lung" = allergic aveolitis ¹⁴
Cladosporium herbarium ¹³	Possible central nervous system - abscesses & meningitis ¹⁴
Penicillium sp mixture ¹³	"Cheese handlers lung" ¹⁴
Micropolyspora faeni ¹³	Grows best at high temperatures. Bacteria occurring in branching filaments and forming a spore-producing mycelium. Principle cause of farmers lung. ¹⁴
Alternaria tenuis ¹³	Plant disease. Diseases of the lungs and in skin infection in man also a common allergen in human bronchial asthma. ¹⁴

Table 3: Wood Smoke Pollutant Health Effects

Wood Smoke Pollutant

Health effect

Carbon Monoxide¹

Poison: resulting change of oxyhemoglobin carboxyhemoglobin. Tissue hypoxia, cellular death, damages to the central nervous system, death. ¹⁴ Causes reproductive toxicity.¹⁵

Reduces ability of blood to bring oxygen to body cells and tissues; cells and tissues need oxygen to work. May be particularly hazardous to people who have heart or

circulatory (blood vessel) problems and people who have damaged lungs or breathing passages.¹¹

Methane¹

VOCs (C2-C7)¹

Volatile Organic Compounds cause serious health problems such as cancer and other effects. All VOCs contain carbon. They can cause serious human illness. Hazardous. Causes ozone. Ozone causes breathing problems, reduced lung function, asthma, irritates eyes, stuffy nose, reduced resistance to colds and other infections, may speed up aging of lung tissues. Causes fatigue, generalized depression, increased lethargy or sleep, headaches, substernal pressure, generalized aches and accelerated cardiac action.¹⁷ Environmental Effects - ozone can damage plants and trees; smog can cause reduced visibility

Aldehydes ¹

Formaldehyde¹

The gas is toxic if inhaled or absorbed through the skin and is carcinogenic. ¹⁴ Can Harm Plants.¹¹

Acrolein ¹

Toxic, Bronchopneumonia, aveolitis, swelling and hemorrhaging of tiny vessels.¹⁶

Propionaldehyde¹

Toxic ¹¹

Butryaldehyde¹

Acetaldehyde¹

Toxic ¹¹ , degeneration of olfactory epithelium, liver lesions, nasal cancer, growth retardation.¹⁶

Furfural¹

Irritates mucous membranes, causes headaches and photosensitivity and affects sugar metabolism. ¹⁴

Substituted Furans¹

Benzene¹

Colorless volatile liquid. Harmful by transdermal absorption and acutely toxic by ingestion or inhalation, causing mucous membrane irritation, neurological symptoms, and death due to respiratory failure; chronic exposure may result in bone marrow depression and anemia. ¹⁴ Causes reproductive toxicity.¹⁵

Alkyl Benzenes ¹

Toluene¹

Toulene is a well known addictive substance. (Glue

Burning Issues/Clean Air Revival, Inc. 1 Draft Sunday, June 3, 2001 **Table 3: Wood Smoke Pollutant Health Effects**

Wood Smoke Pollutant

Health effect

sniffing) It gives feelings of intoxication. Causes sleepiness, dizziness, headache, muscular weakness, confusion, impaired co-ordination, and visual impairment. It is neurotoxic causing neurobehavioral changes. Causes changes in Liver and kidneys, erosion of the nose, degeneration of respiratory tract skin. Chronic abuse causes damage to the brain in the cerebral area and causes brain stem atrophy.¹⁶ Causes reproductive toxicity.¹⁵ Accumulates in blood and subcutaneous fat if insufficient clearance time between exposures. Irritates eyes and upper respiratory tract. Toulene intereacts with other human exposures such as alcohol ingestion. Pattern recognition is disturbed, by both Alcohol and Toulene. Toulene effects accuracy more than Alcohol. Toulene combined with Alcohol caused performance and mood to decline more than for either one separately.

Acetic Acid¹

Irritant

Formic Acid¹

More irritating than acetic acid. Dangerously caustic to the skin. ¹⁴

Nitrogen Oxides (NO,NO₂)¹

Lung damage. Illnesses of breathing passages and lungs (respiratory system). Acid aerosol which damages trees and lakes. 11

Sulfur Dioxide¹

Insecticide. Breathing problems, may cause permanent damage to lungs. Environmental effects - SO₂ is an ingredient in acid rain (acid aerosols), which can damage trees and lakes. Acid aerosols can also reduce visibility.

Methyl chloride¹

Toxic 11

Napthalene¹

Toxic 11, Carcinogenic. Acts like alcohol. 14

Substituted Napthalenes 1

Toxic 11

Oxygenated Monoaromatics 1

Guaiacol (and derivatives)¹

Phenol (and derivatives)¹

Poison: colic, seizures, cardiac arrhythmias, shock, respiratory arrest. 14 Toxic 11, tremors, lower fetal body weight, possible skin carcinogen, EPA Inhalation data insufficient.¹⁶

Syringol (and derivatives)¹

Burning Issues/Clean Air Revival, Inc. 2 Draft Sunday, June 3, 2001

Table 3: Wood Smoke Pollutant Health Effects

Wood Smoke Pollutant

Health effect

Catechol (and derivatives)¹

Toxic 11

Total Particle Mass 1

Particulate Organic Carbon1

Toxic 11

Oxygenated PAHs 1

PAHs1

Toxic 12

Fluorene1

Phenanthrene1

Also in coal. It is toxic and carcinogenic.

Anthracene1

Toxic 12

Methylanthracenes 1

Fluoranthene1

Toxic 12

Pyrene 1

Toxic 12

Benzo(a)anthracene1

Toxic 12, probable human carcinogen. DNA damage and Gene mutation in mammalian cell cultures.¹⁶

Chrysene1

Toxic 12

Benzofluoranthenes1

Toxic 12

Benzo(e)pyrene1

Toxic 12

Benzo(a)pyrene1

Toxic 12, Highly carcinogenic.

Perylene 1

Ideno(1,2,3- cd)pyrene1

Toxic 12

Benz(ghi)perylene1

Coronene1

Dibenzo(a,h)pyrene1

Toxic 15

Retene1

Dibenzo(a,h) Anthracene1

Trace Elements1

Strontium 1

Bone loss, calcification of cartilage. No EPA inhalation data exist.

Magnesium1

Aluminum 1

Excessive amounts in bloodstream may lead to neurological symptoms that can be fatal.

Fumes may cause pulmonary fibrosis. 14

Silicon1

Sulphur1

Chlorine1

Potassium¹

Calcium¹

Titanium¹

Vanadium¹

Absorption via lungs; symptoms include irritation of

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Table 3: Wood Smoke Pollutant Health Effects

Wood Smoke Pollutant

Health effect

the respiratory tract, pneumonitis, conjunctivitis, and anemia.

Chromium¹

Toxic 11, 12

Manganese¹

Concentrates in mitochondria. Activates enzymes.¹⁴ Acts on the Central Nervous System. Impairment of neurobehavior function: slowed visual reaction time, erratic fine hand, and forearm movement, finger tremor, affects audio verbal short term memory.

Causes fatigue, tinnitus, irritability, and more coughs and acute bronchitis.¹⁶ Central nervous system is the primary target. Lodges in lung, providing a pool of slowly released manganese that eventually penetrated the brain. Half-life in the brain of about one year, concentrating in the basal ganglia, which are the brain structures critical for movement. Even modest levels are cumulative.¹⁷

Iron¹

Nickle¹

Toxic 11, 12,15

Copper¹

Toxic 12

Zinc¹

Toxic¹² Poison. Fever, vomiting, chills, myalgia, headache and pneumonitis. Looks like lead poisoning. ¹⁴

Bromine¹

Lead¹

Poisoning = Loss of appetite, weight loss, colic, constipation, insomnia, headache, dizziness, irritability, moderate hypertension, albuminuria, anemia, a blue line at the edge of the gums, encephalopathy especially in children) and peripheral neuropath leading to paralysis.¹⁴ Causes reproductive toxicity.¹⁵ Toxic 11, 12. Health Effects - brain and other nervous system damage; children are at special risk. Some lead-containing chemicals cause cancer in animals. Lead causes digestive and other health problems. Environmental Effects - Lead can harm wildlife.¹¹

Particulate Elemental Carbon¹

Normal alkanes¹

Cyclic di-and triterpenoids ¹

Dehydroabietic acid¹

Lupenone¹

Friedelin¹

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Table 3: Wood Smoke Pollutant Health Effects

Wood Smoke Pollutant

Health effect

Chlorinated Dioxins ¹

Toxic^{12,15} Wasting syndrome, fetal abnormalities or death, and problems with the immune and endocrine systems in humans, Mammals, in fish and in birds.

Particulate Acidity¹

Additional wood smoke emissions found in other studies

Cresol³

Toxic & corrosive ^{14,11,15}

Isopimaric acid

-

Ethylbenzene³

Toxic¹¹ Causes changes in human blood.¹⁶

Arsenic⁴

Toxic^{11,12} Causes skin eruptions, vomiting, diarrhea, abdominal pain, muscular cramps, and swelling of eyelids, feet, and hands. Chronic arsenic poisoning pigmentation of the skin accompanied by scaling, hyperkeratosis of the palms and soles, transverse white lines on the fingernails, headache, peripheral neuropathy and confusion. ¹⁴ Causes reproductive toxicity.¹⁵

Cesium

Metallic¹⁴

Cadmium⁴

Poison Pneumoniosis¹⁴. Causes reproductive toxicity.¹⁵ Toxic^{11,12} Affects memory, attention concentration and joint pain.¹⁶

Molybdenum⁵

Poison, electron redox transport in the body.¹⁴

Selenium⁵

Cirrhosis, anemia, loss of hair, erosions of long bones. ¹⁴

Carbazole

Toxic¹⁵

Acridine

Barium

Poison, acid soluble salt¹⁴

Phosphorus

Poison toothache, mandibular necrosis, anorexia, anemia.¹⁴ Toxic¹¹

Sodium

Phenathrol

Phenathrene

A PAH, Toxic and carcinogenic. Also in coal tar.

d10-phenanthrene

acenaphthylene

Toxic, probable human carcinogen. Possible liver changes, vascular disorder, and Central Nervous System effects. More toxic than Naphthylene.¹⁶

nitronaphthalene

Vapor may cause blistering and opacity of the cornea¹⁴.

d12-chrysene

3-methylcholanthrene

A PAH, pro carcinogen , highly carcinogenic, requires metabolic acceleration. Widely used in

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Table 3: Wood Smoke Pollutant Health Effects

Wood Smoke Pollutant

Health effect

studies of carcinogenesis. ¹⁴

acenaphthene

Toxic¹¹ probable human carcinogen. Possible liver changes, vascular disorder, and Central Nervous System effects. More toxic than Naphthene.¹⁶

Indeno (1,2,3,c,d,) pyrene

Probable human carcinogen.¹⁶

Molds

*Thermoactinomyces vulgaris*¹³

P 962. Farmers lung" = Breathlessness with dry cough, loss of appetite, weight loss. 14

*Aspergillus fumigatus*¹³

"Malt workers lung" = allergic aveolitis¹⁴

*Cladosporium herbarium*¹³

Possible central nervous system - abscesses & meningitis 14

Penicillium sp mixture¹³

"Cheese handlers lung" 14

*Micropolyspora faeni*¹³

Grows best at high temperatures. Bacteria occurring in branching filaments and forming a spore- producing mycelium. Principle cause of farmers lung.¹⁴

*Alternaria tenuis*¹³

Plant disease. Diseases of the lungs and in skin infection in man also a common allergen in human bronchial asthma.¹⁴

References for Wood Smoke Tables 1-4

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Burning Issues/Clean Air Revival, Inc.2 Wednesday, June 6, 2001