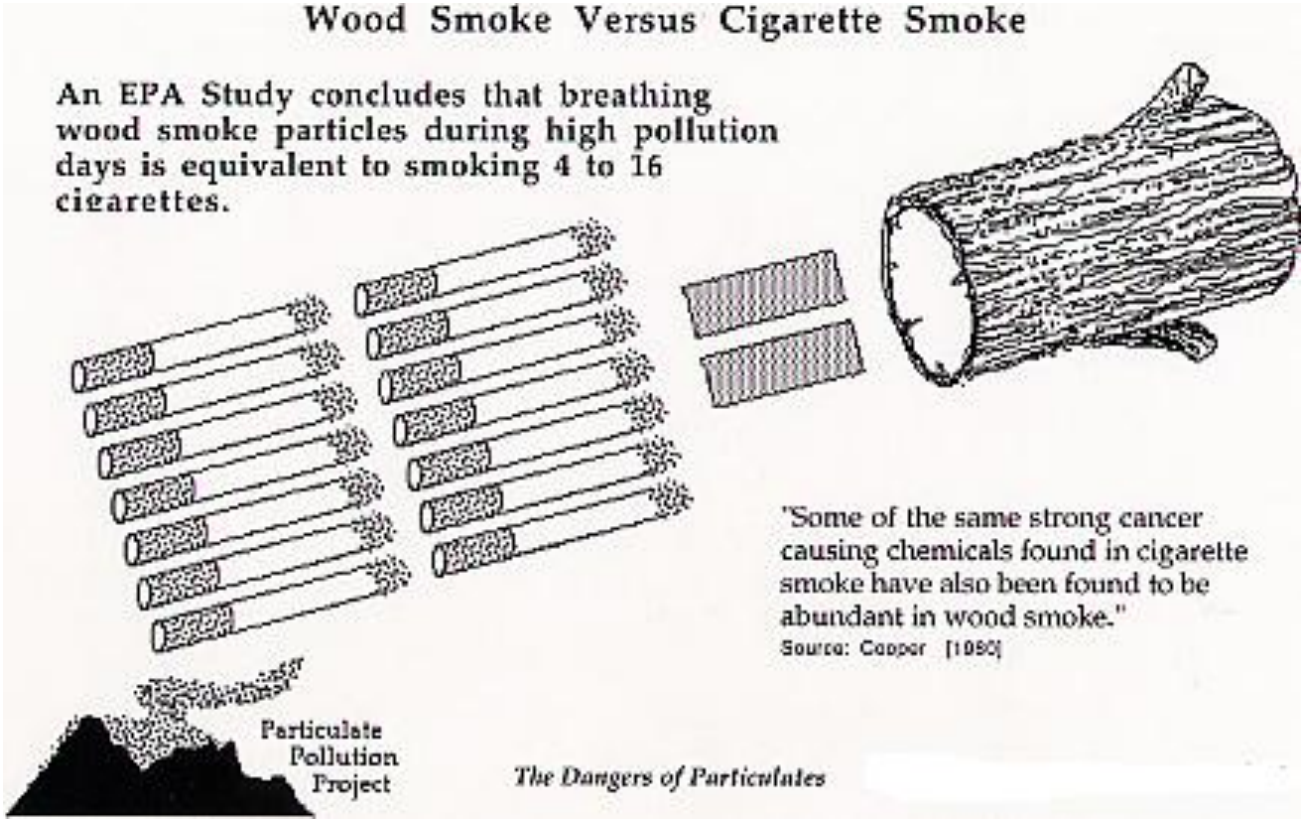
1. Slide presentation by, Harriet M. Ammann Ph.D., DABT, Senior Toxicologist, Air Quality Program, Washington State Department of Ecology:downloaded from www.ecy.wa.gov/programs/air/aop_permits/boiler/SMOKE1.PPT

Smoke is carcinogenic



WOOD SMOKE AND CANCER

The cancer threat from air pollution is a serious public health concern. Most of the wood smoke cancer research before 1985 focused on identifying the components of soot or the particulate portion of wood smoke, including carcinogens such as benzo(a)pyrene, best known from tobacco smoke research. The first known human carcinogens were from coal tars and chimney soot. The particle or soot component of air pollution has been clearly implicated as a human carcinogen from studies of human cancer victims.[22]

Many substances on the U.S. Environmental Protection Agency's (EPA) priority pollutant list, many suspected human carcinogens, co-carcinogens (cancer initiators or promoters), and cilia-toxic agents (poisonous to the hair-equipped cells which filter most particles out of the respiratory tract) have been identified from wood smoke particles.[14] However, many of the compounds in wood smoke particles have not been identified and even less is known about the toxic organic gases which are also released by wood burning.

Burning of fossil fuels, wood, tobacco, or garbage produces hundreds of different compounds associated with the soot, or particle phase of air pollution. Also produced are many gaseous compounds which are carcinogenic, such as benzene, aldehydes, alkenes, and numerous semi-volatile organic compounds.[21] Recent research has focused on the health effects from wood smoke as a whole, rather than further studies of its component parts.

In 1985 the EPA started a major long-term research program to clarify the sources of air pollution and population exposure, and to estimate future cancer risk (the Integrated Air Cancer Project.[11] Studies include human cancer victims, as well as laboratory mice, and bacteria and mammal cells exposed to the total mixture of particulate matter from urban air samples.

This research found motor vehicles and wood stoves to be the major sources of cancer risk from particulate air pollution in all the urban airsheds studied.[8,34]

Human cancer risks have now been estimated for lifetime exposure to diesel vehicle, leaded and catalyst-equipped gas vehicle, wood stove, cigarette smoke, coke oven (coal), and roofing tar emissions.[25] EPA researchers suggest that the lifetime cancer risk from wood stove emissions may be 12 times greater than the lifetime cancer risk from exposure to an equal amount of cigarette smoke. We must keep in mind that this is not actual cancer risk, but rather an estimate based on bacteria and animal studies comparing the potency of wood smoke to cigarette smoke and other better documented carcinogens. The lifetime human cancer risk estimates from exposure to wood smoke and motor vehicle emissions are theoretical based on such comparative potency tests.

The lifetime cancer risk estimate from exposure to motor vehicle emissions is more than three times that from equal exposure to wood stove emissions, based on recent EPA research in Boise, Idaho.[25] However, we also know that wood stoves produce much more particulate air pollution in the winter than motor vehicles in all Pacific Northwest cities studied by the EPA.[20,31,33,34]

With all of these cancer risk estimates we must also keep in mind that we do not yet have much information on actual yearly levels of human exposure to various types of particulate air pollution.

MUTAGENS IN WOOD SMOKE

Mutagens cause biological mutations or changes in cells such as chromosome defects or genetic damage. Mutagenicity is often used as a screening test for human cancer risk from compounds in air pollution. However, mutagens and carcinogens are not the same thing and not all mutagenic substances cause cancer. Motor vehicles and wood heating emissions cause mutations. These two sources are also major contributors to the human cancer risk from air pollution. [8]

A 1988 EPA study found that wood heat and motor vehicle emissions account for nearly all of the mutagenicity in winter air samples from Albuquerque, NM, Raleigh, NC, and Juneau, AK, over a wide range of climate and wood species. [34] This study found that biological mutations in bacteria exposed to winter air samples increased with higher concentrations of fine particulate matter and were most numerous at times of coldest temperatures, weekends and holidays -- when many wood stoves were in use. One would expect this to be true in Washington State as well.

In the United States more than 30% of mutagenic material emitted to the atmosphere each year comes from wood combustion, according to 1981 calculations. [15,24] In Washington State the contribution from wood smoke is greater than this national average since Washington has the third highest percentage of households burning wood in the United States, behind Oregon and Maine, according to a 1983 U.S. Forest Service survey. [30]

Australia's National Pollutant Inventory, accessed from www.npi.gov.au on 10 May 09

Emission report

You are here: NPI Home > Database Search

10 May 2009 13:28

Particulate Matter 10.0 um Summary - All sources: Canberra, ACT Airshed

The National Pollutant Inventory (NPI) has pollutant emissions from larger industrial facilities, and diffuse data for pollutant emissions from small facilities, transport (e.g. motor vehicles) and non-industrial sources (e.g. barbeques).

This report includes data for industrial facilities and diffuse sources (if available for this region) for the 2007 - 2008 NPI reporting year.

Emissions of Particulate Matter 10.0 um by Source

The table shows all the sources which emit Particulate Matter 10.0 um in Canberra, ACT Airshed. The total is the sum of the emissions to Air, Land, and Water. All emission amounts have been rounded to two significant figures. Note that totals may differ from the sum of the individual amounts, as these are also rounded after calculation.

Source (Diffuse Source * or ANZSIC Group)	Emission (kg/year) Total Sort	Air Sort	Land Sort	Wate Sort
Solid fuel burning (domestic) *	640,000	640,000		
Motor Vehicles *	92,000	92,000		
Barbeques *	69,000	69,000		
Burning(fuel red., regen., agric.)/ Wildfires *	46,000	46,000		
Construction Material Mining [091]	46,000	46,000		
Lawn Mowing (public open spaces) *	12,000	12,000		
Gaseous fuel burning (domestic) *	11,000	11,000		
Fuel Combustion - sub reporting threshold facilities *	8,100	8,100		
Water Supply, Sewerage and Drainage Services [281]	7,900	7,900		
Liquid fuel burning (domestic) *	7,500	7,500		
Lawn Mowing *	5,600	5,600		
Electricity Generation [261]	930	930		
Other Non-Metallic Mineral Mining and Quarrying [099]	730	730		
Tertiary Education [810]	660	660		
Concrete Batching *	410	410		
Hospitals [840]	390	390		
Defence [760]	260	260		
Other Personal Services [953]	170	170		
Central Government Administration [751]	150	150		
Scientific Research Services [691]	150	150		
Bakery Product Manufacturing [117]	72	72		
Electroplating *	0.0027	0.0027		
Total Emissions (kg/year)	950,000	950,000		

Wood Smoke
Chemical Composition

⊗Indicates a chemical present in both wood smoke and tobacco smoke
☠Indicates a hazardous chemical for which ATSDR has prepared a toxicological profile
Indicates a chemical classified as a carcinogen by the US government
●Indicates a chemical that is one of the Top 20 CERCLA priority hazardous substances
[1-275] Indicates position on the CERCLA priority hazardous substances list

ALL CHEMICALS LISTED BELOW ARE REPORTED PRESENT IN WOOD SMOKE

⊗☠[198]carbon monoxide, [66]methane, volatile organic compounds (C_2-C_7), *aldehydes*: ⊗☠[245]formaldehyde, ⊗☠[72]acrolein, propionaldehyde, butyraldehyde, ⊗acetaldehyde, furfural; substituted furans, ⊗☠●[6]benzene, *alkyl benzenes*: ⊗☠[68]toluene, ⊗acetic acid, ⊗formic acid; ⊗☠nitrogen oxides (NO, NO_2), ☠sulfur dioxide, ☠methyl chloride, ⊗☠[77]naphthalene, ⊗substituted naphthalenes, *oxygenated monoaromatics*: guaiacol (and derivatives), ⊗☠[162]phenol (and derivatives), syringol (and derivatives), ⊗catechol (and derivatives); particulate organic carbon, oxygenated polycyclic aromatic hydrocarbons, ☠●[9]*polycyclic aromatic hydrocarbons*: ⊗☠[270]fluorene, ⊗☠[219]phenanthrene, ⊗☠anthracene, methylanthracenes, ⊗☠[106]fluoranthene, ⊗☠[249]pyrene, ⊗☠[34]benzo(a)anthracene, ⊗☠[117]chrysene, ⊗☠●[10 60 70]benzofluoranthenes, ☠benzo(e)pyrene, ⊗☠●[8]benzo(a)pyrene, ☠perylene, ⊗☠[180]indeno(1,2,3-cd) pyrene, ☠benzo(ghi)perylene, coronene, ⊗dibenzo(a,h)pyrene, retene, ⊗☠●[16]dibenz(a,h)anthracene; *trace elements*: Sodium, Magnesium, ☠[186]Aluminum, Silicon, Sulfur, [96]Chlorine, Potassium, Calcium, Titanium, ☠[197]Vanadium, ⊗☠Chromium, ☠[138]Manganese, Iron, ⊗☠[53]Nickel, ☠Copper, ☠[73]Zinc, Bromine, ⊗☠●[2]Lead; particulate elemental carbon, normal alkanes (C_{24}-C_{30}), cyclic di-and triterpenoids, dehydroabietic acid, isopimaric acid, lupenone, friedelin, ☠chlorinated dioxins

Sources:

Larson TV and Koenig JQ. 1994. *Wood Smoke: Emissions and Noncancer Respiratory Effects*. Table 1, Chemical composition of wood smoke. *Annual Review of Public Health*, v.15, p.136-137.

US Surgeon General. 1989. *Reducing the Health Consequences of Smoking*. Tables 5-8, p.81-89.

US Department of Health and Human Services. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profiles.

US Department of Health and Human Services. National Toxicology Program. *Report on Carcinogens*. Tenth. 2002.

US Department of Health and Human Services. Agency for Toxic Substances and Disease Registry (ATSDR). Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). List of Priority Hazardous Substances, 2001

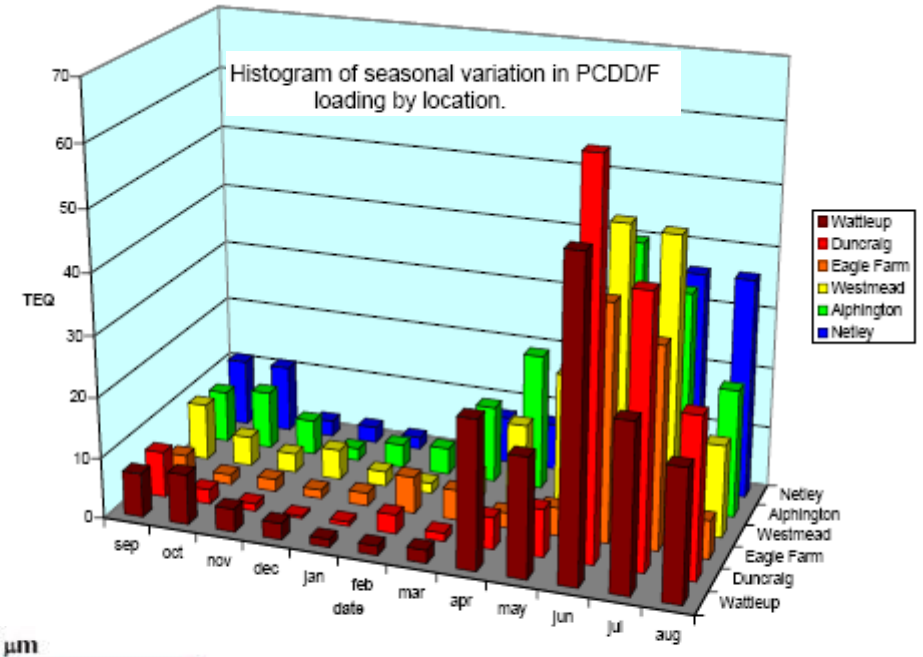
Chemicals Found in Both Wood Smoke and Tobacco Smoke

☠Indicates a hazardous chemical for which ATSDR has prepared a toxicological profile
Indicates a chemical classified as a carcinogen by the US government
●Indicates a chemical that is one of the Top 20 CERCLA priority hazardous substances
[1-275] Indicates position on the CERCLA priority hazardous substances list

[198] ☠	carbon monoxide
[245] ☠	formaldehyde
[72] ☠	acrolein
☠	acetaldehyde
[6] ☠ ●	benzene
[68] ☠	toluene
	acetic acid
	formic acid
☠	nitrogen oxides (NO, NO_2)
[77] ☠	naphthalene
	substituted naphthalenes
[162] ☠	phenol
☠	catechol
[270] ☠	fluorene
[219] ☠	phenanthrene
☠	anthracene
[106] ☠	fluoranthene
[249] ☠	pyrene
[34] ☠	benzo(a)anthracene
[117] ☠	chrysene
[10 60 70] ☠ ●	benzofluoranthenes
[8] ☠ ●	benzo(a)pyrene
[180] ☠	indeno(1,2,3-cd)pyrene
	dibenzo(a,h)pyrene
[16] ☠ ●	dibenz(a,h)anthracene
☠	chromium
[53] ☠	nickel
[2] ☠ ●	lead

Air toxics: PCDDs, PCDFs and polychlorinated biphenyls (PCBs)

Polychlorinated dibenzo dioxins (PCDDs) and furans (PCDFs) and dioxin-like polychlorinated biphenyls (PCBs), are amongst the most toxic pollutants known. A 12-month study of 6 locations in Australia covering industrial and residential sites, showed that levels of these harmful pollutants were close to zero, except when wood heaters were in use, when concentrations were up to 10 times higher than the non-heating season (see graph, right from Gras et al. http://www.cmar.csiro.au/e-print/open/gras_2005a.pdf).



NSWDECC (New South Wales Department of Environment and Climate Change), Air Emissions Inventory for the Greater Metropolitan Region in NSW http://www.epa.nsw.gov.au/air/airinventory.htm. 2007.

Table ES10 for PM2.5 emissions in Sydney is shown below.

Table ES10 Ten largest anthropogenic sources of particulate matter < 2.5 µm

Source Group	Source Type	Particulate Matter < 2.5 µm		
		Annual Emissions (tonnes/year)	Proportion of Annual Anthropogenic Emissions (%)	Cumulative (%)
Sydney				
Domestic-Commercial	Solid Fuel Combustion	4,503	34.3	34.3
Off-Road Mobile	Industrial Off-Road Vehicles and Equipment	1,152	8.78	43.1
On-Road Mobile	Exhaust Emissions Light Duty - Diesel	840	6.40	49.5
Industrial	Crushing, grinding or separating works	807	6.15	55.6
On-Road Mobile	Exhaust Emissions Passenger Cars - Petrol	797	6.08	61.7
On-Road Mobile	Exhaust Emissions Heavy Duty Commercial - Diesel	681	5.19	66.9
Industrial	Ceramics production (excluding glass)	606	4.62	71.5
Industrial	Other land-based extraction	418	3.18	74.7
Commercial	Poultry Farming (Meat)	237	1.81	76.5
Industrial	Petroleum refining	237	1.80	78.3
All	Other	2,848	21.7	100.0