

Smoke Gets in Your Lungs: Outdoor Wood Boilers in New York State



Eliot Spitzer
Attorney General of New York State
Environmental Protection Bureau
August 2005

Smoke Gets in Your Lungs: Outdoor Wood Boilers in New York State

Report Prepared by:

Judith Schreiber, Ph.D.
Chief Scientist

Robert Chinery, P.E.
Environmental Scientist

Jared Snyder
Assistant Attorney General

Eugene Kelly
Assistant Attorney General

Emily Valerio
Science Policy Intern

Ernesto Acosta
Science Intern

Office of the Attorney General
Environmental Protection Bureau
Peter Lehner, Chief
The Capitol
Albany, NY 12224
800-771-7755

www.oag.state.ny.us

Acknowledgments:

Special thanks to Peter Skinner, P.E., and Elizabeth Lenig for contributing to earlier drafts of this report, and to the various reviewers at the Albany Environmental Bureau for thoughtful comments and suggestions.

CONTENTS

Executive Summary	1
I. Introduction: The Increasing Use of Outdoor Wood Boilers (OWBs)	1
II. OWB Pollution	5
A. OWB Operation and Smoke	6
B. Human Health Impacts of OWB Smoke	9
C. Neighborhood Problems Created by OWB Smoke	12
III. OWB Efficiency, Costs, and Performance	13
A. Heating Efficiency	13
B. Costs	13
C. Environmental Performance	16
IV. Current Regulation of OWBs	17
A. Federal and State Regulations	17
B. Local Requirements	18
V. Recommendations	20
A. Develop Federal and New York State Regulations	20
B. Adopt Local Requirements	21
C. Improve Performance of and Information About OWBs	21
D. Increase Consumer Awareness	22
Appendix A Emissions from Outdoor Wood Boilers as Determined by EPA or Laboratory Tests	23
Appendix B Heating Efficiency of Outdoor Wood Boilers	24
Appendix C New York State Contacts for OWB Problems	25
Appendix D Town of Queensbury Ordinance	27
Appendix E References and Additional Information	30

TABLES AND FIGURES

Table 1: Number of OWBs Sold in New York State and Nationwide, 1999 to 2004	4
Table 2: Comparison of Emissions from Various Wood Combustion Units	8
Table 3: Initial Cost of Various Heating Systems	14
Table 4: Fuel Costs for Various Heating Systems	15
Table 5: Municipalities with Requirements Pertaining to OWBs	19
Figure 1: Schematic of OWB and Home	2
Figure 2: Schematic of Inside OWB	3
Figure 3: Comparison of Chimney Heights	4
Figure 4: Relative Emissions of Fine Particulate Matter from Home Heating Devices	9

ACRONYMS USED IN THIS REPORT

ASTM	-	Association for Standards and Testing Materials
BTU	-	British Thermal Unit
CDDs	-	Chlorinated dibenzo-p-dioxins
DEC	-	New York State Department of Environmental Conservation
DOH	-	New York State Department of Health
ECL	-	Environmental Conservation Law
EPA	-	United States Environmental Protection Agency
HPBA	-	Hearth, Patio, and Barbecue Association
NYCRR	-	New York Code of Rules and Regulations
OAG	-	New York State Office of the Attorney General
OWB	-	Outdoor Wood Boiler
PAH	-	Polycyclic Aromatic Hydrocarbon
PCBs	-	Polychlorinated biphenyls
PM	-	Particulate Matter

Executive Summary

Homeowners, especially in rural communities, are increasingly turning to wood burning units installed outside the home, known as outdoor wood boilers (OWBs), to heat their homes. OWB sales have tripled in New York since 1999, with over 7,000 OWBs sold from 1999 to 2004.

The New York State Office of the Attorney General (OAG) Environmental Protection Bureau reviewed information on OWBs and analyzed the manufacture, distribution, testing, and sales of OWBs in New York State. We found that while OWBs are advertised as a clean and economical way to heat one's house and water, OWBs may be among the dirtiest and least economical modes of heating, especially when improperly used. Even when used properly, OWBs emit, on an average per hour basis, about four times as much fine particulate matter pollution as conventional wood stoves, about 12 times as much fine particle pollution as EPA-certified wood stoves, 1000 times more than oil furnaces, and 1800 times more than gas furnaces. Such emissions are significant because fine particulate matter pollution has both short-term and long-term health effects.

Currently, neither federal nor New York State regulations address the proper use of, or limit the pollution from, OWBs. Unlike indoor woodstoves and other heating devices, OWBs do not have to meet safety or performance standards. In the absence of such regulations, some local governments have imposed sensible limits on OWBs, which are described in this report.

We recommend that comprehensive testing protocols and emission limitations be enacted. We also suggest practical steps that owners and neighbors can take to mitigate environmental and health problems associated with OWBs.

I. Introduction: The Increasing Use of OWBs

In the 1980s, as the cost of oil and natural gas rose and as Americans attempted to reduce their heating expenses, the prevalence of residential wood burning stoves and furnaces increased. As of 1998, nine percent of the homes in the United States used residential wood combustion units (including wood stoves, fireplaces, pellet stoves, masonry heaters and wood-fired furnaces) for at least a portion of their heating needs.¹ The United States Environmental Protection Agency (EPA) established emissions standards in 1988 for indoor residential wood stoves in an effort to decrease people's exposure to particulate matter, carbon monoxide, and other pollutants.² Consequently, all new residential wood stoves sold in the United States since 1992 require EPA certification and pollution controls.³ OWBs, however, which were rare in 1988, are not covered by the EPA residential wood stove regulations.

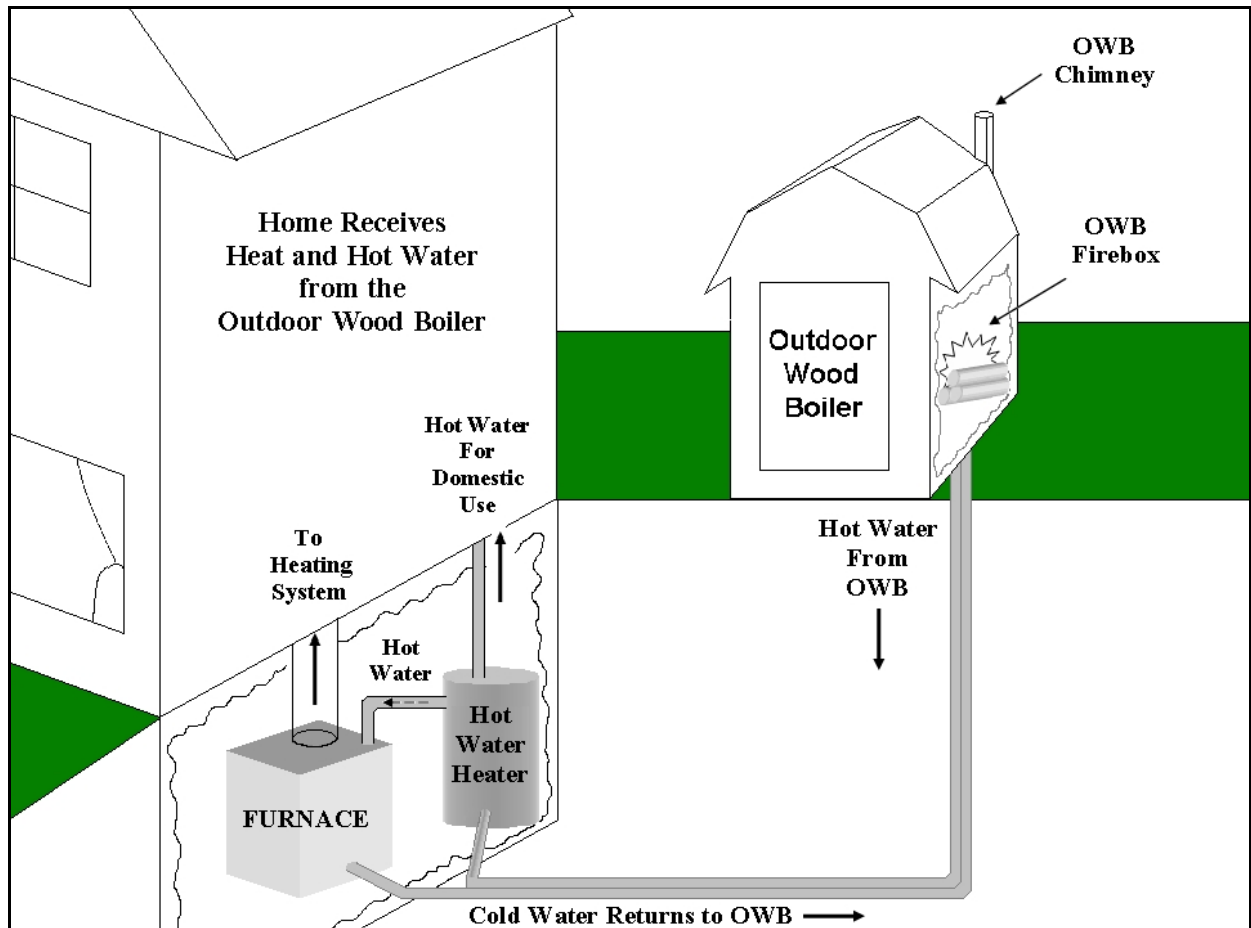
¹ Houck, J., et al., *Air Emissions from Residential Heating: The Wood Heating Option Put into Environmental Perspective*, Proceedings of a U.S. EPA and Air Waste Management Association Conference. Emission Inventory: Living in a Global Environment, V.1, pp. 373-384 (1998).

² Standards of Performance for New Residential Wood Heaters, 40 CFR §§ 60.530-60.539b.

³ A list of EPA approved wood stoves can be found on the EPA website, *available at* www.epa.gov/compliance/resources/publications/monitoring/programs/woodstoves/certifiedwood.pdf (last accessed May 31, 2005).

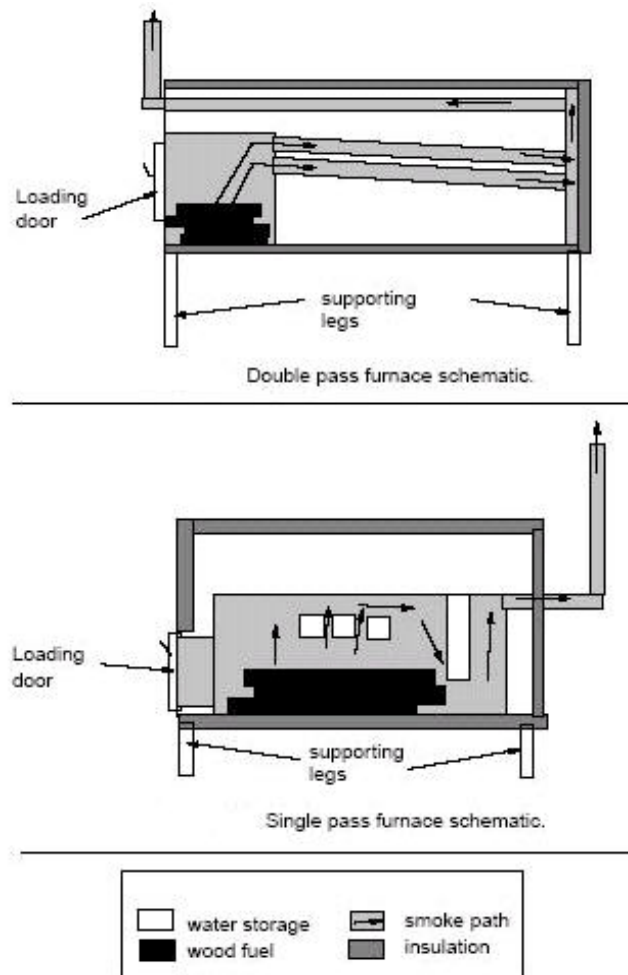
An OWB is a freestanding combustion unit located outside the home or structure to be heated (see Figure 1) that consists of a firebox surrounded by a water reservoir (see Figure 2). While designs vary by manufacturer, a typical OWB resembles a small shed with a short chimney to release combustion gases and an oversized firebox, built to accommodate unsplit logs up to five feet in length. OWBs vary in size, but are typically three to five feet wide, six to nine feet deep, and six to ten feet tall, including the height of the chimney.

Figure 1: Schematic of OWB and Home



OWBs are designed to accommodate large wood loads which can burn for many hours without tending. Wood is placed in the firebox (combustion chamber) by the OWB operator and is ignited. The water in the reservoir surrounding the firebox is heated when hot combustion gases from the firebox pass, via pipes, through the reservoir to the exhaust stack (see Figure 2). The heated water is pumped through insulated underground pipes from the OWB to the home or building where it is circulated through the home's heating system. Wood in the firebox continues to burn until the temperature in the home reaches the desired level. A thermostat in the home controls the burn rate of the fuel by varying the amount of air that is supplied to the firebox for wood combustion. When the thermostat temperature is reached, the firebox is deprived of oxygen, leaving the wood smoldering, until more heat is needed.

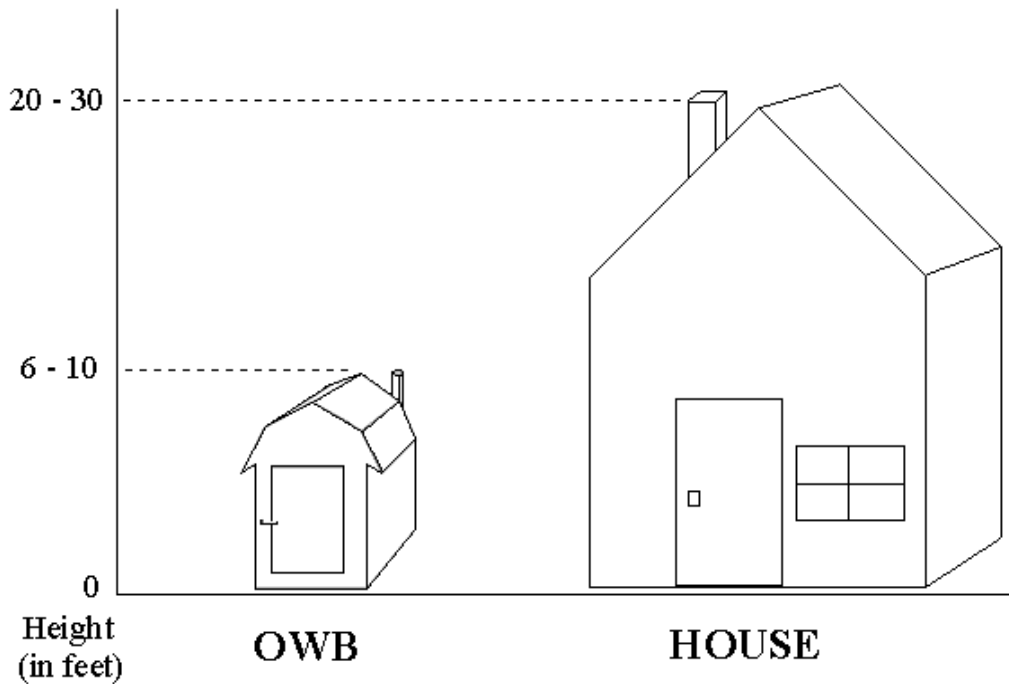
Figure 2: Schematic of Inside OWB⁴



In contrast to indoor wood stoves, which feature chimneys located above the building's roof line, smoke is released from the OWB via a short chimney, typically at a height of approximately six to ten feet (see Figure 3). Chimney extensions are sometimes added to increase the height.

⁴ Adapted from Valenti, J. and Clayton, R., *Emissions from Outdoor Wood-Burning Residential Hot Water Furnaces*, EPA-600/R-98-017 (February 1998).

Figure 3: Comparison of Chimney Heights



OWBs are increasingly becoming a primary method of heating homes in winter and providing hot water year-round. The number of OWBs sold annually in New York State has tripled from approximately 600 units in 1999 to 1,880 units in 2004. Sales across the United States have similarly increased, from about 4,800 in 1999 to over 15,000 in 2003. Based on partial data for 2004, it is estimated that 24,500 OWBs were sold across the U.S. in 2004. Since 1999, of the 77,500 units sold nationwide, nearly 7,500 OWBs have been sold in New York State (see Table 1).

Table 1: Number of OWBs Sold in NYS and Nationwide, 1999 to 2004

	1999	2000	2001	2002	2003	2004*	TOTAL
NY State	606	1037	1721	947	1272	1880	7463
U.S.	4828	6865	15330	10552	15340	24560	77475

*Estimated based on partial data for 2004 and assuming continued rate of growth

There are at least 23 manufacturers of OWBs that sell units in the United States (see Appendix E for names and contact information). Manufacturers typically sell OWBs to customers both directly and through more than 300 distributors and local dealers in New York State. One manufacturer accounts for approximately one-third of the United States sales since 1999.

II. OWB Pollution

State health and environmental agencies have received a growing number of complaints from owners and neighbors that OWBs produce thick, acrid, foul smoke that permeates buildings and homes, causing not only a nuisance, but also environmental degradation and health problems. Even when operated using clean seasoned wood, OWBs can emit significant pollution because the basic design of the OWB causes fuel to burn incompletely, or smolder, resulting in thick smoke and high particulate emissions. The problem is aggravated when other materials, such as wet wood, processed wood, and garbage are burned. The short OWB chimney and reduced draft often fail to disperse the smoke, resulting in more concentrated pollution at lower heights reaching residents and neighbors. Exposure to this smoke, like other pollutants, can cause or contribute to short-term health harms such as eye, nose, throat, and lung irritation, coughing and shortness of breath, and may exacerbate asthma or trigger asthma attacks. Chronic exposure to smoke can cause long-term effects such as asthma, heart and lung disease, and cancer.



A. OWB Operation and Smoke

Wood smoke is one of the primary contributors to certain types of air pollution in the United States,⁵ especially in rural areas. Even though wood combustion accounts for only about nine percent of the nation's home heating needs, it accounts for an estimated forty-five percent of the total fine particulate matter directly released by all fuel combustion used for residential heating.⁶

To obtain the most efficient – and thus cleanest – burn from a wood combustion device, dry wood should be burned in a manner that allows airflow and oxygen to the greatest amount of surface area. OWBs create smoldering conditions which in turn produce excess smoke. An efficient fire should produce clear exhaust during warmer months, and white exhaust (steam) during colder months. An inefficient fire produces gray, black, or thick smoke and releases much more harmful particulate matter. Because OWBs are designed to respond to the thermostat setting by smoldering when less heat is required, they produce heavy smoke emissions more often than most other wood combustion devices.

Smoke from OWBs becomes more problematic when the owner burns items other than dry seasoned wood. Burning wet, damp, or green wood reduces the efficiency and heat output of any wood combustion device and increases particulate emissions.⁷ The energy that could be released in the form of heat is instead used to boil off the water content of the wood, which in freshly cut, green wood can be as much as fifty percent of the total weight. Thus, to generate the same amount of heat, more wood must be burned, increasing emissions of carbon dioxide – the most important pollutant responsible for global warming. In addition, when energy is expended to change water into steam, the temperature of the fire is decreased leading to incomplete combustion of the wood fuel. When that happens, increased amounts of unburned particulates will be emitted with the steam and combustion gases.⁸ Finally, all wood combustion, but particularly incomplete combustion such as in OWBs, produces a variety of toxic

⁵ Fisher, L., et al., *Long-Term Performance of EPA-Certified Phase 2 Woodstoves, Klamath Falls and Portland, Oregon: 1998/1999*, EPA/600/SR-00/100 (2000); McDonald, J., et al., *Fine Particle and Gaseous Emission Rates from Residential Wood Combustion*, Environmental Science and Technology 34(11): 2080-2091(2000).

⁶ EPA, *National Air Quality and Emissions Trends Report, 2003 Special Studies Edition*, Office of Air Quality Planning and Standards, EPA 454/R-03-005 (September 2003); Houck, J., et al., *Air Emissions from Residential Heating: The Wood Heating Option Put into Environmental Perspective*, Proceedings of the U.S. EPA and Air Waste Management Association Conference. Emissions Inventory: Living in a Global Environment, V.1, pp. 373-384 (1998). While wood accounts for nine percent of residential heating, fossil fuels – most burned in a home furnace but some burned in a power plant to produce electricity – are used for most US residential heating. Electricity-generating power plants emit the majority of their pollution as gases that are, in part, converted in the atmosphere to fine particles so that their overall contribution to fine particulate pollution in the ambient air is greater than that of wood combustion.

⁷ EPA, *Reducing Air Toxics in Your Community*, EPA-453/F-03-001 (October 2004); American Lung Association, *Woodburning* (April 2000).

⁸ Burning wet wood will result in creosote build-up inside the firebox and chimney. Creosote is a flammable sticky tar-like substance that is often responsible for chimney fires if it is allowed to accumulate from an initial gray powdery dusting into a thick crystalized build-up. Cleaning the firebox and chimney regularly will increase air flow in the wood heater, thereby reducing the rate of creosote build-up.

emissions including carbon monoxide, formaldehyde, benzene, naphthalene, and polycyclic aromatic hydrocarbons.⁹

When construction materials, packaging crates, and home garbage (which often includes plastics, rubber, batteries, electronics, and other materials unsuited for disposal by backyard combustion) are burned, the emission of harmful pollutants increases.¹⁰ While emissions from OWBs that burn household items have not been studied, studies of backyard burning of garbage have found that emissions include, but are not limited to, carbon monoxide, hydrogen chloride, hydrogen cyanide, benzene, styrene, formaldehyde, arsenic, lead, chromium, benzopyrene, dioxins, furans, and PCBs. According to a study conducted by EPA, the New York State Department of Health (DOH), and the New York State Department of Environmental Conservation (DEC), burning approximately ten pounds of household trash in a burn barrel releases as much air pollution as a modern, well-controlled municipal waste incinerator burning 400,000 pounds of trash.¹¹

Although OWBs have not been subjected to extensive testing, limited testing (shown in Table 2 and Appendix A) has indicated that emissions of fine particulate matter (defined as particulates smaller than 2.5 millionths of a meter in diameter, and referred to as PM 2.5) from burning wood in OWBs are about four to 12 times higher than the emissions from indoor woodstoves.¹² Conventional wood stoves manufactured prior to 1992, which were not airtight and had no pollution controls, generated an average of 18.5 grams PM 2.5 per hour, whereas the newer EPA-certified wood stoves averaged about six grams per hour.¹³ In similar tests, OWB emissions ranged from 18 to 147 grams PM 2.5 per hour and averaged

⁹ Larson, R. and Koenig, J., *Summary of the Emissions Characterization and Noncancer Respiratory Effects of Wood Smoke*, EPA-453/R-93-036 (1993); Washington State Department of Ecology, *Health Effects of Wood Smoke* (March 1997).

¹⁰ Not surprisingly, for this reason the Hearth, Patio, and Barbecue Association advises homeowners to never use the following: trash, plastics, gasoline, rubber, naphtha, household garbage, material treated with petroleum products (particle-board, railroad ties, pressure treated wood), leaves, paper products, and cardboard. Hearth, Patio, and Barbecue Association, *Smoke Troubleshooting Checklist for Outdoor Furnaces*, (April 2004), available at www.hpba.org/govrelations/troubleshootingGuidlines.pdf (last accessed May 31, 2005).

¹¹ Lemieux, P., *Project Summary. Evaluation of Emissions from the Open Burning of Household Waste in Barrels (with Errata)*, EPA/600/SR-97/134 (October 2003).

¹² Particulate pollution is typically measured using EPA Test Method 5 which collects PM as small as 0.3 microns. An additional test can then be used to distinguish between particles larger or smaller than 2.5 microns. Studies have shown that nearly all of the PM emitted in woodsmoke is PM2.5 or smaller. Houck, J., and Tiegs, P., *Residential Wood Combustion – PM2.5 Emissions*, WESTAR PM2.5 Workshop, Reno, Nevada (July 1998) (93% of the particulate emissions from wood combustion is PM2.5). In its assessment, The Mid-Atlantic Regional Air Management Association assumes that 100 percent of PM emissions from wood combustion is PM2.5 or smaller. See *Technical Memorandum No. 6: MANE-VU Residential Wood Combustion Emission Inventory*, Mid-Atlantic Regional Air Management Association (April 30, 2004).

¹³ Valenti, J. and Clayton, R., *Emissions from Outdoor Wood-Burning Residential Hot Water Furnaces* EPA-600/R-98-017 (February 1998). EPA has established emission limits on indoor wood stoves, distinguishing between those with catalysts (through which the smoke passes, causing additional combustion) and those without catalysts. The EPA limits are 4.1 and 7.5 grams PM 2.5 per hour respectively. As can be seen in Table 2, however, testing indicates that many catalytic stoves are not, in fact, meeting the legal limit.

about 72 grams per hour.¹⁴ In comparison to other emission sources, one OWB produces approximately as much PM 2.5 per hour as two heavy duty diesel trucks, 45 passenger cars, 1000 oil furnaces, or 1800 gas furnaces.¹⁵ A comparison of PM 2.5 emissions from various home heating devices is shown in Figure 4. (Coal, while used extensively for electricity production, is not used extensively in New York for home heating.)

Table 2: Comparison of Emissions from Various Wood Combustion Units

Type of Wood Combustion Unit	Particulate Matter, Average (grams per hour)	Polycyclic Aromatic Hydrocarbons, Average (grams per hour)
OWB	71.6 ⁱⁱ	0.96 ⁱⁱ
Conventional (non-EPA Certified) Wood Stove ⁱ	18.5 ⁱⁱⁱ	0.36 ^{iv}
EPA Certified Catalytic Wood Stove ⁱ	6.2 ⁱⁱⁱ	0.15 ^{iv}
EPA Certified Non-Catalytic Wood Stove ⁱ	6.0 ⁱⁱⁱ	0.14 ^{iv}
EPA Phase-II Certified Woodstove ^v	4.1: EPA limit for catalytic woodstoves 7.5: EPA limit for non-catalytic woodstoves	Not Available

ⁱ Assumes 1.0 kg/hr burn rate.

ⁱⁱ Appendix A.

ⁱⁱⁱ Houck, J. and Tiegs, P., *Residential Wood Combustion Technology Review, Volume 1. Technical Report*, EPA-600/R-98-174a. (1998).

^{iv} Fisher, L., et al., *Long-Term Performance of EPA-Certified Phase 2 Woodstoves, Klamath Falls and Portland Oregon: 1998/1999*. EPA-600/SR-00-100 (2000).

^v Subpart AAA-Standards of Performance for New Residential Wood Heaters, 40 CFR §§ 60.530-60.539b.

¹⁴ These tests were conducted either by EPA or laboratories on behalf of manufacturers. See Appendix A.

¹⁵ OWB, conventional wood stove, and EPA certified wood stove emission rates from Table 2; emission rates of 0.07 g/hr and 0.04 g/hr from *EPA Emission Factors AP-42*, Fifth Edition, Volume I, available at www.epa.gov/ttn/chief/ap42/ch01/index.html (last accessed May 31, 2005); EPA, *Emission Standards Reference Guide of Heavy-Duty and Nonroad Engines*, EPA 420-F-97-014 (September, 1997); EPA, *Federal Certification Exhaust Emission Standards for Light-duty Vehicles (Passenger Cars) and Light-duty Trucks: Federal Test Procedure (FTP), Cold CO, and Highway and Idle Tests*, EPA 420-B-00-001 (February, 2000).

**Figure 4: Relative Emissions of Fine Particulate Matter
From Home Heating Devices**



B. Human Health Impacts of OWB Smoke

Exposure to various components of wood smoke and the contaminants found in wood smoke has been associated with adverse human health impacts, as discussed below. The likelihood of health effects depends on many factors, such as the amount of smoke to which one is exposed, the frequency and duration of exposure, and the sensitivity of the individual exposed.

Fine Particulate Matter (PM 2.5)

Exposure to PM 2.5 can cause short-term health effects such as eye, nose, throat, and lung irritation, coughing, sneezing, runny nose, and shortness of breath and can also affect lung function and worsen medical conditions such as asthma and heart disease. While the upper respiratory system will filter out particles larger than ten millionths of a meter (or microns), PM 2.5 can bypass the body's natural filtering mechanisms to lodge deep in the lungs.¹⁶ Scientific studies have linked increases in daily PM 2.5 exposure with increased respiratory and cardiovascular hospital admissions, emergency department visits and deaths. Recent studies suggest that long-term exposure to PM 2.5 may be associated with increased rates of bronchitis and reduced lung function, and increased cancer risk. People with breathing problems (such as asthma, bronchitis, emphysema, or pneumonia) and/or heart problems, and certain members of

¹⁶ EPA, *EPA Announces Final Designations for First Fine Particulate Standard*, Press Release (Dec. 17, 2004), available at www.epa.gov/pmdesignations (last accessed May 31, 2005).

the general population (such as children and the elderly) may be particularly sensitive to PM 2.5.¹⁷ More than 60,000 deaths each year in the United States can be attributed to exposure to air polluted with PM 2.5.¹⁸

Respiratory and cardiovascular diseases have been associated directly with wood smoke emissions.¹⁹ For example, a Seattle area study noted increases in asthma and other respiratory disease and declines in lung function among children exposed to wood smoke.²⁰ Long term exposure to wood smoke, like other emissions containing PM 2.5, can lead to chronic bronchitis, obstructive lung disease, and an increased risk of cancer.²¹

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a group of chemicals that are formed during the incomplete combustion of coal, oil, gas, wood, garbage, and other organic substances such as tobacco. PAHs generally occur as complex mixtures often containing hundreds of different PAHs. Tests on mice show that exposure to PAHs during pregnancy results in higher rates of birth defects, lower birth weights, and difficulty reproducing. Animal studies have also shown that both short-term and long-term exposure to PAHs can inhibit the body's ability to fight disease. Some PAHs have been categorized as probable human carcinogens (cancer causing chemicals) by the U.S. Department of Health and Human Services, and by the International Agency for Research on Cancer.²²

¹⁷ New York State Department of Health Fact Sheet, *Fine Particles (PM 2.5) Questions and Answers* (Feb 2003, revised July 2004), available at www.health.state.ny.us/nysdoh/indoor/pmq_a.htm (last accessed May 31, 2005).

¹⁸ Washington State Department of Ecology, Air Quality Program, *Health Effects of Wood Smoke* (March 1997, updated August 2004).

¹⁹ Zelikoff, J., et al., *The Toxicology of Inhaled Woodsmoke*, J. Toxicology and Environmental Health, Part B, 5: 269-282 (2002).

²⁰ Koenig, J., et al., *Pulmonary Function Changes in Children Associated with Fine Particulate Air Pollution*, Environmental Research 63(1): 26-38 (1993); Larson, R. and Koenig, J., *Wood Smoke: Emissions and Noncancer Respiratory Effects*. Annu. Rev. Public Health 15: 133-56 (1994).

²¹ American Lung Association, *Wood Smoke Affects Your Health* (1990); Ammann, H., *Summary Overview of Health Effects Associated with Residential Wood Combustion: Health Effects Issue Assessment*, Internal Report, EPA, Research Triangle Park, NC (1986); Larson, T., et al., *Urban Air Toxics Mitigation Study: Phase I*, University of Washington report submitted to the Puget Sound Air Pollution Control Authority (1988); Morris, K., et al., *Wood Burning Stoves and Lower Respiratory Tract Infections in American Indian Children*, American Journal of Diseases of Children 144: 105-108 (1990); Stevens, R., et al., *Sources of Mutagenic Activity in Urban Fine Particles*, Toxicol. Industrial Health 6: 81-94 (1990).

²² Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Polycyclic Aromatic Hydrocarbons* (August 1995).

Carbon Monoxide

At low concentrations, carbon monoxide can cause fatigue in healthy people and chest pain in people with heart disease. At higher concentrations, it can cause impaired vision and coordination, headaches, angina, dizziness, confusion, and nausea. Exposure can cause flu-like symptoms that stop after exposure ends. It can also be fatal at very high concentrations, due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen uptake.²³

Benzene

Exposure to benzene can cause both short and long term health effects. At high concentrations, exposure to benzene can cause drowsiness, dizziness, rapid heart rate, headaches and tremors. Long term exposure to lower levels are associated with adverse effects in the blood and bone marrow (leukemia), the immune system, the reproductive system, and increased cancer risk.²⁴

Chlorinated Dioxins

Chlorinated dibenzo-p-dioxins (CDDs) are a family of 75 different compounds with varying harmful effects. CDDs are released to the environment during combustion of fossil fuels (coal, oil, natural gas) and wood, and during incineration processes. Burning materials that may contain chlorine, such as plastics, wood treated with pentachlorophenol, pesticides, polychlorinated biphenyls (PCBs), and even bleached paper can produce CDDs. Exposure to CDDs generally occurs through breathing contaminated air, or through skin contact with materials containing CDDs. Effects of exposure depend on the amount, but can range from skin disease, changes in blood, urine, and liver chemistry, as well as potential reproductive or developmental effects. Certain CDDs have been determined to be likely carcinogens.²⁵

Other Chemicals

Wood smoke contains inorganic and organic irritants such as formaldehyde and other aldehydes, nitrogen oxides and sulfur oxides. Inhalation of wood smoke containing irritants can lead to inflammation and swelling of the lung tissue and can contribute to respiratory distress. Irritants can interfere with the normal flow of mucus that removes particles from the respiratory tract, thereby increasing the amounts of particulate matter entering the lungs. These irritants can also contribute to allergic reactions.²⁶

C. Neighborhood Problems Created by OWB Smoke

²³ EPA, *Indoor Air Quality Tools for Schools Kit*, IAQ Coordinator's Guide, available at www.epa.gov/iaq/schools/tfs/guidee.html (last accessed May 31, 2005).

²⁴ Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Benzene*, Public Health Statement (September 1997).

²⁵ Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Chlorinated Dibenzo-p-Dioxins*, Public Health Statement (December 1998).

²⁶ Agency for Toxic Substances and Disease Registry, *TOXFAQs for Formaldehyde* (June 1999), *Sulfur Dioxide* (June 1999), and *Nitrogen Oxide* (April 2002).

During summer months and calm winter days, wood smoke is slow to rise and disperse. With OWB chimneys not high enough to carry the smoke past the heights of surrounding homes and local terrain, wood smoke, soot, and toxins may enter homes and yards of owners and neighbors who are situated close to OWBs. Wood smoke particulates, due to their small size, can remain suspended in the air for long periods of time, can cause a smokey haze, and can easily enter homes through air intakes, cracks, doors and windows. Effects on neighbors are especially apparent when OWBs are installed at the outermost limit of the owner's property, and in close proximity to structures on adjacent properties.

The OAG has received more than 50 complaints from individuals who are affected by OWB-generated smoke and odors.²⁷ The complaints filed with the OAG note the following:

1. Smoke from OWBs has led to a variety of symptoms including upset stomach, headaches, dizziness, respiratory effects, and throat and eye irritation.
2. Smoke from OWBs has prevented residents from enjoying activities inside and around their homes. Residents have been unable to use their porches and backyards or conduct normal activities such as walking the dog, gardening, or hanging laundry outside. Some residents do not allow their children to play outside because of the smoke.
3. Smoke from OWBs has forced residents to close their windows, doors, and air conditioning units, in an effort to keep the smoke and smoke odors from entering their homes. Residents have complained of wood smoke odors on items inside the home, such as clothing, curtains and upholstery. Smoky conditions indoors have sometimes set off carbon monoxide detectors.
4. Materials besides natural wood are burned in the OWBs, producing even greater amounts of noxious smoke and odors.
5. In a few cases, the unhealthy and nuisance conditions created by OWBs have caused complainants to sell their homes.

²⁷ Complaints have been received from people in the following counties: Broome, Cattaraugus, Chautauqua, Chemung, Chenango, Clinton, Dutchess, Franklin, Jefferson, Onondaga, Saratoga, St. Lawrence, Suffolk, Tioga, Ulster, Warren, and Wyoming. One OWB was adjacent to a public school.

III. OWB Efficiency, Costs, and Performance

According to the EPA, since OWBs are “designed to be installed outside of the home, and to heat by an indirect method, they are exempt from the EPA regulation(s)”²⁸ that cover indoor wood stoves. Currently, no standard test methods are available to evaluate the performance of OWBs. Approached by the Hearth, Patio, and Barbecue Association (HPBA) in an effort to make test data on OWBs comparable, the Association for Standards and Testing Materials (ASTM) established a committee to develop a consensus-based standard testing method for OWBs.²⁹

Until a test method is established, it is impossible to assess with precision the claims of manufacturers regarding efficiency and costs of OWBs. Some limited testing information, however, suggests that OWBs may be not only less environmentally sound but may also be less efficient and economical than other common heating sources, such as indoor wood stoves, and gas- or oil-fueled furnaces.

A. Heating Efficiency

Heating efficiency is a measure of heat output relative to the input value of the fuel – the actual heat output in comparison to the potential heat output of the fuel. The EPA has found heating efficiencies of about 54 percent for conventional wood stoves, and 68 to 72 percent for EPA-certified wood stoves.³⁰ In comparison, data obtained from manufacturers on tests conducted on OWBs found that they have heating efficiencies ranging from 28 to 55 percent, with an average of 43 percent (see Appendix B).

B. Costs

One of the benefits of OWBs, as advertised by some manufacturers, is that customers will save thousands of dollars in heating costs over the course of a year. One manufacturer, for example, claims: “Over a ten-year period, a homeowner or business may save \$10,000 to \$50,000 dollars or more on heating costs.”³¹ Another advertises that one can “save 69 to 78% on your heating costs,” and “you will save up to 90% on your heating and hot water bills.”³² However, these claims of cost savings may not withstand scrutiny. The initial cost of OWBs is significantly higher than that of other heating devices such as gas and oil furnaces (see Table 3), many of which will already be installed in the home. In addition, OWB

²⁸ Excerpted language is from an EPA exemption letter provided to an OWB manufacturer in response to a request for determination of exempt status in 1999. Letter from EPA Office of Enforcement and Compliance, Energy and Transportation Division, J. Rasnic, Director, dated November 30, 1999.

²⁹ ASTM, *E06.54.08, Task Group on Outdoor Wood-Fired Hydronic Heaters*, Sheraton Hotel and Convention Center, Madison Wisconsin, December 1-2, 2004. The committee, with representatives from OWB manufacturers, and state and federal governments, is in the process of developing testing methods that can be applied to OWBs. While generally agreeing that a standard test method should be adopted, committee members are deliberating the quantity, quality, moisture content, and stacking position of the wood for the test burns. Ideally the adopted test method will be realistic and reproducible, to enable “factory-tested” comparable results among OWBs.

³⁰ EPA, *Residential Wood Combustion Technology Review*, Volume I. Technical Report. EPA-600/R-98-174a. (December 1998).

³¹ Central Boiler, Inc., available at www.centralboiler.com (last accessed Feb. 18, 2005).

³² Taylor Manufacturing, Inc., available at www.taylormfg.com (last accessed Feb. 23, 2005).

manufacturers' claims apparently do not take into account the cost of purchasing or harvesting wood fuel. When the latter cost is accounted for, any savings may vanish (see Table 4).

Table 3: Initial Cost of Various Heating Systems

Type of Heating System	Average Cost ⁱ
Outdoor Wood Boiler ⁱⁱ (43% Efficient)	\$5500
Indoor Wood Stove ⁱⁱⁱ Non-catalytic (68% Efficiency) Catalytic (72% Efficiency)	\$2075 \$2425
Gas or Oil Fueled Forced Air Furnace ^{iv} (80% Efficient)	\$1860
Gas or Oil Fueled Forced Air Furnace ^{iv} (90% Efficient)	\$2690
Gas or Oil Hot Water Radiator ^{iv} (80% Efficient)	\$3320
Gas or Oil Hot Water Radiator ^{iv} (90% Efficient)	\$4260

ⁱ Costs are estimated based on average cost of unit plus installation. Does not include cost of internal home piping or duct work. Actual costs may vary widely based on manufacturer, efficiency, and region of the United States.

ⁱⁱ The estimated initial cost of an OWB is the average of the minimum unit cost of the five largest manufacturers plus the average cost of installation materials, based on information obtained by OAG from manufacturers.

ⁱⁱⁱ Houck, J. and Tiegs, P., *Residential Wood Combustion—PM 2.5 Emissions*, OMNI Environmental Services, Inc., Emission Inventory Workshop, Reno, Nevada (July 1998).

^{iv} The average costs of the gas and oil systems are based on surveys conducted by the Consumer Energy Council of America, reported in March 2001 in a report entitled, “*Oil, Gas, or...? An Evaluation of the Economics of Fuel Switching Versus Home Energy Conservation*,” available at www.cecac.org/Publications/MiscPub/FuelSwitchingReport.pdf.

Table 4: Fuel Costs for Various Heating Systems

Type of Fuel	Fuel Price ⁱ	Price per million BTU (Dollars)	Efficiency ⁱⁱ	Price per mmBTU adjusted for efficiency (Dollars)	Total Household Energy Cost per year (Dollars) ⁱⁱⁱ
Wood (for use in OWB)	\$170 per cord	\$8.50	43%	\$19.77	\$1,977 (or less if not all purchased)
Wood (for use in catalytic indoor wood stove)	\$170 per cord	\$8.50	72%	\$11.81	\$1,181 (or less if not all purchased)
Wood (for use in non-catalytic indoor wood stove)	\$170 per cord	\$8.50	68%	\$12.50	\$1,250 (or less if not all purchased)
Oil	\$1.99 per gallon	\$14.35	78%	\$18.40	\$1,840
Gas	\$1.13 per therm	\$11.30	78%	\$14.49	\$1,449
Electricity	\$0.094 per kilowatt hour	\$27.46	97%	\$28.31	\$2,831

ⁱ Average efficiencies and price per million BTU for oil, gas, and electricity based on calculations by the Energy Information Administration, United States Department of Energy. "How do I compare Heating Fuels" (April 7, 2005), available at www.eia.doe.gov/neic/experts/expertanswers.html (last accessed May 31, 2005). We note that wood prices may vary widely compared to oil, gas and electricity. The heating fuel comparison calculator (Rev H-c 4/21/05) is available for download in Microsoft Excel format, available at www.eia.doe.gov/neic/experts/heatcalc.xls.

ⁱⁱ Average wood efficiency based on OWB efficiency testing provided in Appendix B of this report, and EPA, *Residential Wood Combustion Technology Review, Volume I. Technical Report*. EPA-600/R-98-174a. (December 1998).

ⁱⁱⁱ The assumed approximate household energy consumption per year (100 million BTU) is based on the 2003 Annual Energy Review by the Energy Information Administration of the United States Department of Energy, available at www.eia.doe.gov/emeu/aer/consump.html (last accessed April 22, 2005).

C. Environmental Performance

OWB manufacturers have made a variety of claims regarding environmental performance, which do not have technical or scientific basis. One OWB manufacturer claims that its devices are smokeless and create “no creosote, no smoke, and no waste.”³³ Another manufacturer claims that “the tangible proof of complete combustion is no visible smoke.”³⁴ However, any combustion device will create gaseous and particulate emissions³⁵ and all wood combustion will create ash requiring disposal.

In addition, certain claims regarding potential fuels may not be entirely accurate. For example, some manufacturers claim erroneously that wood with high moisture content will create an efficient fire. One manufacturer claims that its OWB “doesn’t smolder, it either burns hot or shuts down. Hotter fire will burn almost any material – even green wood.”³⁶ Another states without basis that “we burn up to ½ less wood and emit up to ½ less smoke.”³⁷ Additionally, some manufacturers, distributors, and dealers of OWBs advise their customers, both in print and verbally, that the stove will burn almost anything, including rotten wood, freshly cut and green wood, old building scraps, wood scraps (including nails), newspapers, corrugated cardboard boxes, pine cones, grass, yard trimmings, and sawdust.³⁸ One manufacturer claims that “our injection air furnace burns any type and quality of wood, wet or dry, unsplit and in lengths of up to 72 inches. The burn time average can reach 48 hours or more per fill.”³⁹ One manufacturer claims that its device can help control allergies, stating, “many people suffer from allergies. With the furnace outside, smoke, fuel odors, and fumes are kept outside.”⁴⁰ Manufacturers and dealers also claim that OWBs will heat large structures while “eliminating waste,” without making clear that household waste should not be burned in the OWB.

IV. Current Regulation of OWBs

³³ Dectra Corporation, available at www.dectra.net/garn (last accessed May 24, 2005).

³⁴ Turbo Burn, Inc., available at www.turboburn.net (last accessed Feb 25, 2005).

³⁵ One claimed benefit of burning wood in OWBs (and wood stoves) is that wood combustion has the potential to contribute less to global warming than the combustion of fossil fuels if the wood burned is replaced by new trees, which remove carbon from the atmosphere. However, the absence of particulate controls on OWBs may negate any such benefit because the black carbon soot emitted by OWBs also contributes to global warming.

³⁶ Aqua-Therm, LLC., available at www.aqua-therm.com (last accessed Feb 18, 2005).

³⁷ Heatmor, Inc., available at www.heatmor.com (last accessed May 27, 2005), and OWB owner’s manual, page 25.

³⁸ Mahoning Outdoor Furnace, Inc., available at www.shol.com/mahoning (last accessed Feb 25, 2005); Taylor Manufacturing, Inc., available at www.taylormfg.com (last accessed May 31, 2005) and OWB sales brochure; Innotech Developments, available at www.outdoorfurnaces.com (last accessed Feb 23, 2005).

³⁹ Outside Heating Systems, available at www.wooddoctorfurnace.com (last accessed May 26, 2005).

⁴⁰ Freedom Outdoor Furnace, OWB sales brochure.

A. Federal and State Regulations

The EPA does not currently regulate the manufacture, sale, or efficiency claims of OWBs. OWBs are not subject to the federal regulations governing indoor stoves and fireplaces, which are tested and regulated by the EPA for safety, emissions, and efficiency. Any new residential wood stove sold in the United States after July 1, 1992 must be “Phase 2” certified, meaning that it does not emit more than 4.1 grams of particulate matter per hour for catalytic stoves and 7.5 grams of particulate matter per hour for noncatalytic stoves.⁴¹ All of the OWB units tested to date for PM (see Table 2 and Appendix A) far exceed the PM limits that apply to EPA-certified wood stoves.

In New York State, there are no regulations directed particularly at OWBs. DEC regulations provide that “no person shall cause or allow emissions of air contaminants to the outdoor atmosphere of such quantity, characteristic or duration which are injurious to human, plant, or animal life or to property, or which unreasonably interfere with the comfortable enjoyment of life or property.”⁴² Operation of OWBs may also violate the DEC smoke regulation which states, in part, that “no person shall operate a stationary combustion installation which exhibits greater than twenty percent opacity, except for one six-minute period per hour of not more than twenty-seven percent opacity.”⁴³ DEC has taken enforcement actions involving OWB owners on several occasions based on these regulations.

The states of Vermont and Washington do regulate OWBs. The Vermont regulations⁴⁴ include the following provisions:

- (1) Installation of an OWB must be at least 200 feet from the nearest neighboring residence;
- (2) The stack on the furnace must be higher than the roof line if the furnace is between 200 feet and 500 feet from the nearest neighboring home;
- (3) The OWB must comply with local ordinances and its operation must not create a nuisance;
- (4) Dealers and sellers of OWBs must provide buyers with a legal notice stating that: only untreated natural wood may be burned; installation is subject to the distance and stack height requirements stated above; and that the OWB, even if meeting the above requirements, may not be used if the terrain is inappropriate and renders the OWB to be a nuisance or public health hazard. This legal notice must be signed by both the buyer and seller and filed with the Air Pollution Control Division of Vermont prior to delivery of the OWB to the buyer.

⁴¹ Fisher, L., et al., *Long-Term Performance of EPA-Certified Phase 2 Woodstoves, Klamath Falls and Portland, Oregon: 1998/1999*, EPA/600/SR-00/100 (2000); see also, Subpart AAA - Standards of Performance for New Residential Wood Heaters, 40 CFR §§ 60.530-60.539b.

⁴² 6 NYCRR § 211.2.

⁴³ 6 NYCRR § 227-1.3. Opacity is defined as: “The degree to which emissions other than water reduce the transmission of light and obscure the view of an object in the background.” 6 NYCRR§200.1(ay). The generally applicable opacity limit of twenty percent is roughly equivalent to a light grey smoke.

⁴⁴ Vermont Air Pollution Regulation, section 5-204, Outdoor Waterstoves (September 1997).

The Washington regulation⁴⁵ establishes emission standards, certification standards and procedures, curtailment rules, and fuel restrictions for solid fuel burning devices. OWBs are considered solid wood burning devices, which, after January 1, 1995, must be shown to comply with an emission standard of 4.5 grams PM per hour before they can be offered for sale in the State of Washington. Prohibited fuels include garbage, treated wood, plastic and plastic products, rubber products, animal carcasses, asphaltic products, waste petroleum products, paints and chemicals, and any substance that normally emits dense smoke or obnoxious odors. OWBs, like other solid fuel burning devices, must comply with an opacity standard not to exceed an average of 20 percent opacity for six consecutive minutes in any one-hour period. Retailers must provide information on the proper operation of the unit, including information that opacity levels of ten percent or less are attainable through proper operation.

B. Local Requirements

Some local governments in New York State have deemed OWBs a nuisance because of smoke and toxic emissions. Several towns and villages have placed restrictions on OWBs ranging from meeting certain requirements for setback distances, chimney height, terrain, population density and other factors, to outright bans. These municipal requirements are shown in Table 5.



⁴⁵ Washington Administrative Code 173-433-100 (3), Solid Fuel Burning Devices (January 1995).

Table 5: Municipalities with Requirements Pertaining to OWBs

Town / Village and County	Date	Regulate*	Ban
Barneveld, Village of (Oneida County)	Apr 2005		X
Camden, Village of (Oneida County)	June 1999		X
Canton, Town of (St. Lawrence County)	Dec 2003		X
Edwards, Village of (St. Lawrence County)	June 2003		X
Heuvelton, Village of (St. Lawrence County)	Nov 2003		X
Holland Patent, Village of (Oneida County)	Apr 2005		X
Kingsbury, Town of (Washington County)	Sep 2004	X	
Lowville, Village of (Lewis County)	Dec 2001		X
Marcellus, Village of (Onondaga County)	Jan 2004		X
Moreau, Town of (Saratoga County) (proposed)	Oct 2004	X	
Otego, Village of (Otsego County)	Mar 2001	X	X
Prospect, Village of (Oneida County)	Mar 2005		X
Queensbury, Town of (Warren County)	May 2004	X	
South Glens Falls, Village of (Saratoga County)	Dec 2003	X	
Watertown, City of (Jefferson County)	Oct 2003		X

* See Box on following page for further details on requirements.

Specific Requirements of New York State Municipalities Regarding OWBs.

Town of Kingsbury - Installation of an OWB requires a permit and must meet the following requirements: (a) installed, operated, and maintained according to manufacturer instructions, (b) fueled with natural untreated woods, (c) set back at least 25 feet from nearest property line, and (d) minimum chimney height of 15 feet.

Town of Moreau (proposed) - A permit, issued by the Town Building Inspector or Code Enforcement Officer, is required for operation of an OWB and must meet the following requirements: (a) only firewood and untreated lumber may be burned, (b) may be installed only in permitted zones, (c) must be installed on a lot of three acres or more, (d) must be set back at least 500 feet from nearest lot line, (e) may only be operated between September 1st and May 31st, and (f) must be equipped with a properly functioning spark arrestor.

Village of Otego - The construction and operation of OWBs are prohibited with the exception of OWBs already in operation. No OWB already in operation may be extended, enlarged, or restored beyond 75% of its value, and/or re-established after use is discontinued for more than seven months.

Town of Queensbury - A permit is required for operation of an OWB and must meet the following requirements: (a) only firewood and untreated lumber may be burned, (b) may be installed only in permitted zones, (c) must be installed on a lot of three acres or more, (d) must be set back at least 200 feet from nearest lot line, (e) may only be operated between September 1st and May 31st, and (f) must be equipped with a properly functioning spark arrestor.

Village of South Glens Falls - Installation of any OWB must meet the following requirements: (a) smokestack must exceed four feet and be higher than any adjacent structure within 50 feet of the furnace, (b) must be installed at least 200 feet from the closest residential property line, (c) may only burn wood, and (d) may not be used as a waste incinerator.

V. Recommendations

A. Develop Federal and State Regulations

The adoption of federal regulations is the best way to address effectively the problems identified in this report. Ideally, such regulations would require emissions testing, performance standards, and control technologies to ensure that OWBs are environmentally sound and do not pose a health hazard to users and neighbors. Given the complexities of establishing testing protocols and emission limits, there are significant advantages to manufacturers of federal regulation, instead of a multitude of state and local limits. Consistent with all other Clean Air Act programs, however, it must be clear that any federal regulations only set a floor for health protections, and that states are free to enact stricter protections.

In the absence of federal regulations, DEC could fill the regulatory void by developing an air quality regulatory program that would effectively address OWB problems across the state. DEC could establish siting, operation, and disclosure standards and perhaps emission limits. A DEC rulemaking would offer the additional advantage of providing interested affected parties with the opportunity to shape policy through submission of comments and participation in rulemaking hearings.

B. Adopt Local Requirements

Towns and villages can evaluate the suitability of OWB operation in their jurisdictions. Just as local zoning codes can address activities that create nuisances and require permits or establish conditions for certain activities, communities can consider requiring permits before installation of an OWB, especially in more densely settled areas. In evaluating permit applications, determinations can be made whether local conditions such as setback distances, terrain, and sensitive neighbors such as schools, hospitals and residences are compatible with OWB operation.

Local requirements could limit acceptable fuel to dry, natural, and untreated wood. A document acknowledging that limitation, signed by the OWB purchaser, could be filed with the local code officer, thereby becoming an enforceable condition of the usage of the OWB. The Town of Queensbury's ordinance is shown in Appendix D, as an example.

C. Improve Performance of and Information About OWBs

Even in the absence of regulation, manufacturers can take steps to reduce OWB emissions by adding pollution control devices such as catalytic converters, installing taller stacks for smoke dispersal, or re-designing OWB units to minimize the smoldering and smoke that are inherent in the majority of the OWBs currently on the market.

Even before OWBs are improved, manufacturers should ensure that their advertising and marketing materials reflect the basis for any claims about efficiency, cost, and environmental performance and that handling instructions make clear that only dry seasoned wood be burned. Retailers should help prospective customers assess the suitability of an OWB in light of the customer's property, taking into account such factors as proximity of neighboring residences, terrain, and nearby property uses (residential, commercial, industrial, size of OWB, etc.).

Finally, OWB manufacturers and distributors should commit to provide technical assistance in the event that an OWB creates a smoke nuisance for an OWB owner or neighbors, or is not working as advertised. The manufacturer or distributor, by phone or personal visit, should evaluate the situation and recommend technical solutions, such as extending the smoke stack to a height that is greater than the height of the neighboring roof line or the installation of a control apparatus, such as a catalytic device.

D. Increase Consumer Awareness

Before purchasing an OWB, potential buyers should consider the size and location of their property, their heating needs, and suitable wood availability in addition to local laws and regulations. Consumers should carefully scrutinize manufacturer claims.

For people who have already purchased an OWB or who live near an OWB that is creating smoky conditions, these steps may help resolve the situation:

- (1) OWB owners should make sure they are operating the OWB only with suitable materials. If smoky conditions persist despite burning of proper materials, contact the manufacturer or distributor of the OWB unit. The manufacturer may be able to assess, adjust, and/or retrofit the unit to reduce the smoke or emissions problem by, for example, installing a taller smoke stack and/or catalytic device.
- (2) If the manufacturer or distributor cannot or will not provide assistance, or if the OWB operator will not contact the manufacturer or distributor, contact the regional DEC office that serves the county. The DEC may be able to assist in evaluating the smoke opacity to determine whether excessive smoke is present and may be able to suggest ways to improve the situation. Contact information for local officials, regional offices of the DEC, and county health departments is listed in Appendix C.
- (3) OWBs should not be used to burn pressure treated wood, painted wood, household garbage or other waste materials. Local zoning or building code officers, local fire officials, a regional DEC office, or county health departments should be called for assistance.
- (4) If experiencing conditions detrimental to health (smoke in the home causing respiratory difficulties, for example), contact the public health department that serves the county (See contact list in Appendix C). The county or state DOH may be able to assist in evaluating the situation to determine if a condition exists that is detrimental to life or health.
- (5) If neither DEC nor DOH is able to assist, contact the Environmental Protection Bureau at the New York State Office of the Attorney General for further advice and assistance at 1-518-474-8096 or 1-800-771-7755.

APPENDIX A: EMISSIONS FROM OUTDOOR WOOD BOILERS AS DETERMINED IN EPA OR LABORATORY TESTS ⁱ

OWB	Particulate Matter (grams per hour)	Polycyclic Aromatic Hydrocarbons (grams per hour)	Number of Tests
OWB A ⁱⁱ	73	1.2	4
OWB B ⁱⁱ	26	0.72	4
OWB C ⁱⁱⁱ	84	NA	5
OWB D ⁱⁱⁱ	60	NA	4
OWB E ⁱⁱⁱ	108	NA	2
OWB F ⁱⁱⁱ	18	NA	2
OWB G ⁱⁱⁱ	49	NA	7
OWB H ⁱⁱⁱ	33	NA	2
OWB I ^{iv}	147	NA	2
OWB J ^{iv}	118	NA	2
OWB K ^v	179	NA	1 cordwood
OWB L ^v	269	NA	1 lumber
Average ^{vi}	71.6	0.96	

ⁱ The results from Intertek and Omni laboratories were provided to the OAG by the manufacturers. Note that due to the current lack of an established test methodology, the tests used may have differed. Thus, the results should be considered as a whole; comparisons between boilers may not be appropriate. For this reason, manufacturers' names are omitted.

ⁱⁱ Valenti, J. and Clayton, R., *Emissions from Outdoor Wood-Burning Residential Hot Water Furnaces*, EPA-600/R-98-017 (February 1998); names of OWB manufacturer 'A' and 'B' not provided in report.

ⁱⁱⁱ Intertek Laboratories 2004.

^{iv} Omni Laboratories 2004.

^v Intertek Laboratories 2004. Data provided on behalf of ASTM Committee to develop testing methods, using old 'nameless' OWB; data excluded from calculation of average.

^{vi} Average of OWB units A through J; data excluded for OWB units K and L.

APPENDIX B: HEATING EFFICIENCY OF OUTDOOR WOOD BOILERSⁱ

OWB	Heating Efficiency	Number of Tests
OWB A ⁱⁱ	45%	4
OWB B ⁱⁱ	55%	4
OWB C ⁱⁱⁱ	30%	5
OWB D ⁱⁱⁱ	37%	4
OWB E ⁱⁱⁱ	28%	2
OWB F ⁱⁱⁱ	31%	2
OWB G ⁱⁱⁱ	55%	7
OWB H ⁱⁱⁱ	37%	2
OWB I ^{iv}	55%	2
OWB J ^{iv}	53%	2
OWB K ^v	45%	1 cordwood
OWB L ^v	46%	1 lumber
Average^{vi}	43%	

ⁱ The results from Intertek and Omni Laboratories were provided to the OAG by the manufacturers. Note that due to the current lack of an established test methodology, the tests used may have differed. Thus, the results should be considered as a whole; comparisons between boilers may not be appropriate. For this reason, manufacturers' names are omitted.

ⁱⁱ Valenti, J. and Clayton, R., *Emissions from Outdoor Wood-Burning Residential Hot Water Furnaces*, EPA-600/R-98-017 (February 1998); names of OWB manufacturer 'A' and 'B' not provided in report.

ⁱⁱⁱ Intertek Laboratories 2004.

^{iv} Omni Laboratories 2004.

^v Intertek Laboratories 2004. Data provided on behalf of ASTM Committee to develop testing methods, using old 'nameless' OWB; data excluded from calculation of average.

^{vi} Average of OWB units A through J; data excluded for OWB units K and L.

APPENDIX C: NEW YORK STATE CONTACTS FOR OWB PROBLEMS

(1) Local Zoning, Health, and Code Enforcement Officials

New York State County, City, Town, and Village Contact Information is available in local telephone directories or is *available at*

www.nysgov.com/citguide.cfm?context=citguide&content=munibycounty1

(2) Regional Department of Environmental Conservation (DEC) Offices

Region	County	DEC Regional Office
1	Nassau and Suffolk	631-444-0205
2	Bronx, Brooklyn, Manhattan, Queens, and Staten Island	718-482-4944
3	Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, and Westchester	845-256-3045
4	Albany, Columbia, Delaware, Greene, Montgomery, Otsego, Rensselaer, Schoharie, and Schenectady	518-357-2350
5	Clinton, Essex, Franklin, Fulton, Hamilton, Saratoga, Warren, and Washington	518-623-1212
6	Herkimer, Jefferson, Lewis, Oneida, and St. Lawrence	315-785-2513
7	Broome, Cayuga, Chenango, Cortland, Madison, Onondaga, Oswego, Tioga, and Tompkins	315-426-7552
8	Chemung, Genesee, Livingston, Monroe, Ontario, Orleans, Schuyler, Seneca, Steuben, Wayne, and Yates	585-226-5311
9	Allegany, Cattaraugus, Chautauqua, Erie, Niagara, and Wyoming	716-851-7130

(3) County Health Department

County	Health Department	County	Health Department
Albany	518-447-4620	Niagara	716-439-7444
Allegany	585-268-9250	Oneida	315-798-5064
Bronx (NYC)	212-268-7185	Onondaga	315-435-6623
Broome	607-778-2887	Ontario	315-789-3030
Cattaraugus	716-373-8050	Orange	845-291-2331
Cayuga	315-253-1405	Orleans	585-589-3272
Chautauqua	716-753-4481	Oswego	315-349-3564
Chemung	607-737-2019	Otsego	607-432-3911
Chenango	607-337-1673	Putnam	845-278-6130
Clinton	518-565-4870	Queens (NYC)	212-268-7185
Columbia	518-828-3358	Rensselaer	518-270-2674
Cortland	607-753-5035	Richmond (NYC)	212-268-7185
Delaware	607-432-3911	Rockland	845-364-2608
Dutchess	845-486-3404	St. Lawrence	315-386-1040
Erie	716-858-7677	Saratoga	518-793-3893
Essex	518-891-1800	Schenectady	518-386-2818
Franklin	518-891-1800	Schoharie	518-295-8382
Fulton	315-866-6879	Schuyler	607-324-8371
Genesee	585-344-8506	Seneca	315-539-1945
Greene	607-432-3911	Steuben	607-324-8371
Hamilton	518-891-1800	Suffolk	631-853-3058
Herkimer	315-866-6879	Sullivan	845-794-2045
Jefferson	315-785-2277	Tioga	607-687-8566
Kings (NYC)	212-268-7185	Tompkins	607-274-6688
Lewis	315-785-2277	Ulster	845-340-3150
Livingston	585-243-7280	Warren	518-793-3893
Madison	315-366-2526	Washington	518-793-3893
Monroe	585-274-6067	Wayne	315-789-3030
Montgomery	315-866-6879	Westchester	914-813-5000
Nassau	516-571-3410	Wyoming	585-786-8894
New York (NYC)	212-268-7185	Yates	315-789-3030

(4) New York State Office of the Attorney General
Environmental Protection Bureau: 800-771-7755

APPENDIX D: TOWN OF QUEENSBURY ORDINANCE

LOCAL LAW NO.: ___ OF 2004

A LOCAL LAW TO AMEND THE QUEENSBURY TOWN CODE BY REPLACING CHAPTER 119 ENTITLED “OUTDOOR FURNACES” WITH A NEW CHAPTER 119 REGULATING THE USE OF OUTDOOR FURNACES IN THE TOWN OF QUEENSBURY.

BE IT ENACTED BY THE TOWN BOARD OF THE TOWN OF QUEENSBURY AS FOLLOWS:

1. Title and Authority – This Local Law shall be known as the Town of Queensbury Outdoor Furnace Local Law. It is adopted pursuant to Municipal Home Rule Law § 10.

2. Legislative Intent – Although outdoor furnaces may provide an economical alternative to conventional heating systems, concerns have been raised regarding the safety and environmental impacts of these heating devices, particularly the production of offensive odors and potential health effects of uncontrolled emissions. This Local Law is intended to ensure that outdoor furnaces are utilized in a manner that does not create a nuisance and is not detrimental to the health, safety and general welfare of the residents of the Town.

3. Definitions – “Outdoor Furnace” means any equipment, device or apparatus, or any part thereof, which is installed, affixed or situated outdoors for the primary purpose of combustion of fuel to produce heat or energy used as a component of a heating system providing heat for any interior space.

“Untreated Lumber” means dry wood which has been milled and dried but which has not been treated or combined with any petroleum product, chemical, preservative, glue, adhesive, stain, paint or other substance.

“Firewood” means trunks and branches of trees and bushes but does not include leaves, needles, vines or brush smaller than three inches (3”) in diameter.

4. Permit Required – No person shall cause, allow or maintain the use of an Outdoor Furnace within the Town of Queensbury without first having obtained a permit from the Town Fire Marshal. Application for permit shall be made to the Fire Marshal on the forms provided.

5. Existing Outdoor Furnaces – Any Outdoor Furnace in existence on the effective date of this Local Law shall be permitted to remain provided that the owner applies for and receives a permit from the Town Fire Marshal within one (1) year of such effective date; provided, however, that upon the effective date of this Local Law all the provisions hereof except paragraphs 6(B), (C) and (D) shall immediately apply to existing Outdoor Furnaces. All of the provisions of this Local Law shall continue to apply to existing Outdoor Furnaces which receive permits except paragraphs 6(B), (C) and (D). If the owner of an existing Outdoor Furnace does not receive a permit within one (1) year of the effective date of this Local Law, the Outdoor Furnace shall be removed. “Existing” or “in existence” means that the Outdoor Furnace is in place on the site.

6. Specific Requirements –

A. Permitted Fuel – Only Firewood and Untreated Lumber are permitted to be burned in any Outdoor Furnace. Burning of any and all other materials in an Outdoor Furnace is prohibited.

B. Permitted Zones – Outdoor Furnaces shall be permitted only in the LC-10A, LC-42A, RR-5A zoning districts as shown on the Town’s Zoning Map.

C. Minimum Lot Size – Outdoor Furnaces shall be permitted only on lots of three (3) acres or more.

D. Setbacks – Outdoor Furnaces shall be set back not less than 200 feet (200’) from the nearest lot line.

E. Months of Operation – Outdoor Furnaces shall be operated only between September 1st and May 31st.

F. Spark Arrestors – All Outdoor Furnaces shall be equipped with properly functioning spark arrestors.

7. Suspension of Permit – A permit issued pursuant to this Local Law may be suspended as the Fire Marshal may determine to be necessary to protect the public health, safety and welfare of the residents of the Town of Queensbury if any of the following conditions occurs:

A. Emissions from the Outdoor Furnace exhibit greater than 20 percent (20%) opacity (six minute average), except for one continuous six-minute period per hour of not more than 27 percent (27%) opacity, which shall be determined as provided in 6 NYCRR 227-1.3(b);

B. Malodorous air contaminants from the Outdoor Furnace are detectable outside the property of the person on whose land the Outdoor Furnace is located;

C. The emissions from the Outdoor Furnace interfere with the reasonable enjoyment of life or property;

D. The emissions from the Outdoor Furnace cause damage to vegetation or property; or

E. The emissions from the Outdoor Furnace are or may be harmful to human or animal health.

A suspended permit may be reinstated once the condition which resulted in suspension is remedied and reasonable assurances are given that such condition will not recur. Recurrence of a condition which has previously resulted in suspension of a permit shall be considered a violation of this Local Law subject to the penalties provided in paragraph 9 hereof.

8. Waivers; Board of Health Ratification – Where the Town Board of Health finds that extraordinary and unnecessary hardships may result from strict compliance with this Local Law, it may vary the regulations so that substantial justice may be done and the public interest secured, provided that such variations will not have the effect of nullifying the intent and purpose of this Local Law or of jeopardizing the health, safety or welfare of the public. In varying any regulations, the Board of Health may impose such conditions and requirements as it deems reasonable and prudent. The Board of Health may, at its discretion, hold a public hearing as part of its review. If the Board of Health grants the waiver, a permit shall be issued for the Outdoor Furnace. If the Board of Health denies the waiver, the Outdoor Furnace must either be brought into compliance with this Local Law or removed. If the Board of Health does not take any action with respect to the waiver within sixty (60) days from its receipt of an

application for waiver, the waiver shall be deemed denied.

9. Enforcement; Revocation of Permit – Failure to comply with any of the provisions of this Local Law shall be a violation and, upon conviction thereof, shall be punishable by a fine of not more than \$500 or imprisonment for a period of not more than ten (10) days, or both, for the first offense. Any subsequent offense shall be punishable by a fine of not more than \$1,000 or imprisonment for a period of not more than thirty (30) days, or both. In addition, any permit issued pursuant to this Local Law shall be revoked upon conviction of a second offense and the subject Outdoor Furnace shall not be eligible for another permit. Each day that a violation occurs shall constitute a separate offense. The owners of premises upon which prohibited acts occur shall be jointly and severally liable for violations of this Local Law. Any fine imposed hereunder shall constitute a lien upon the real property where the Outdoor Furnace is located until paid.

10. Effect of Other Regulations – Nothing contained herein shall authorize or allow burning which is prohibited by codes, laws, rules or regulations promulgated by the United States Environmental Protection Agency, New York State Department of Environmental Conservation, Adirondack Park Agency, Lake George Park Commission any other federal, state, regional or local agency. Outdoor Furnaces, and any electrical, plumbing or other apparatus or device used in connection with an Outdoor Furnace, shall be installed, operated and maintained in conformity with the manufacturer’s specifications and any and all local, State and Federal codes, laws, rules and regulations. In case of a conflict between any provision of this Local Law and any applicable Federal, State or local ordinances, codes, laws, rules or regulations, the more restrictive or stringent provision or requirement shall prevail.

11. Severability – The invalidity of any clause, sentence, paragraph or provision of this Local Law shall not invalidate any other clause, sentence, paragraph or part thereof.

12. Repealer – All Local Laws or ordinances or parts of Local Laws or ordinances in conflict with any part of this Local law are hereby repealed.

13. Effective Date – This Local Law shall take effect upon filing in the office of the New York State Secretary of State or as otherwise provided by law.

APPENDIX E: REFERENCES AND ADDITIONAL INFORMATION

American Lung Association, *Wood Smoke Affects your Health* (September 1990).

Bascom, R., *Health effects of outdoor air pollution*, *Am J Respir Crit Care Med* 153:477-498 (1996).

Brook, R., et al., American Heart Association, *AHA Scientific Statement: Air Pollution and Cardiovascular Disease. A statement for Healthcare Professionals from the Expert Panel on Population and Prevention Science of the American Heart Association*, 109: 2655-2671 (June 1, 2004), available at <http://circ.ahajournals.org/cgi/reprint/109/21/2655>

Consumer Energy Council of America. "*Oil, Gas, or...? An Evaluation of the Economics of Fuel Switching Versus Home Energy Conservation.*" Final Report (March 2001), available at www.cecac.org/Publications/MiscPub/FuelSwitchingReport.pdf

Dockery, D. and Pope, C., *Acute respiratory effects of particulate air pollution*, *Annu Rev Public Health* 15: 107-132 (1994).

Energy Information Administration, United States Department of Energy. Heating Fuel Cost Comparison Calculator, available at www.eia.doe.gov/neic/experts/heatcalc.xls

Fairley, D., *The relationship of daily mortality to suspended particulates in Santa Clara County, 1980-1986*, *Environ Health Perspect* 89: 159-168 (1990).

Ostro, B., *Fine particulate air pollution and mortality in two Southern California counties*, *Environ Res* 70: 98-104 (1995).

Pope, C., et al., *Daily mortality and PM10 pollution in Utah Valley*, *Arch Environ Health* 47: 211-217 (1992).

Pope, C., et al., *Particulate air pollution and daily mortality on Utah's Wasatch Front*, *Environ Health Perspect* 107: 567-573 (1999).

Samet, J., et al., *Fine particulate air pollution and mortality in 20 U.S. cities, 1987-1994*, *New England Journal of Medicine* 343: 1742-1749 (2000).

Schwartz, J., *Air pollution and daily mortality in Birmingham, Alabama*, *Am J Epidemiol* 137: 1136-1146 (1993).

Schwartz, J., *What are people dying of on high air pollution days?* *Environ Res* 64: 26-35 (1994).

Schwartz, J., et al., *Is daily mortality associated specifically with fine particles?*, *J Air Waste Manag Assoc* 46: 927-939 (1996).

Tesfaigzi, Y., et al., *Health effects of subchronic exposure to low levels of wood smoke in rats*, *Toxicological Sciences* 65: 115-125 (2002).

Vedel S., *Ambient particles and health: lines that divide*, *J Air Waste Manag Assoc* 47: 551-581(1997).

Wordley, J., et al., *Short term variations in hospital admissions and mortality and particulate air pollution*, *Occup Environ Med* 54: 108-116 (1997).

Zelikoff, J., et al., *The toxicology of inhaled woodsmoke*, *J Toxicology and Environmental Health, Part B*, 5: 269-282 (2002).

Select Websites for More Information

American Lung Association, available at www.lungusa.org

Woodburning, available at www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=23354

Clean Air Revival, Inc. Burning Issues, available at www.BurningIssues.com

Department of Environmental Conservation, New York State, available at www.dec.state.ny.us

Environmental Protection Agency, United States.

Main Web Page, available at www.epa.gov

Fine Particulate Matter, available at www.epa.gov/pmdesignations/index.htm

Puget Sound Clean Air Agency, available at www.pscleanair.org

Hearth, Patio, and Barbecue Association, available at www.hpba.org

Smoke Troubleshooting Checklist for OWBs, available at

www.hpba.org/govrelations/troubleshootingGuidlines.pdf

Office of the Attorney General, New York State, available at www.oag.state.ny.us

Washington State Department of Ecology

Outdoor Burning, available at www.ecy.wa.gov/pubs/9204.pdf

Health Effects of Wood Smoke, available at www.ecy.wa.gov/biblio/92046.html

OWB Manufacturers

Alternate Heating Systems, Inc.

2395 Little Egypt Road

Harrisonville, PA 17228

www.alternateheatingsystems.com

Aqua-Therm LLC

48301 State Hwy 55

Brooten, MN 56316

www.aqua-therm.com

Central Boiler, Inc.

20502 160th Street

Greenbush, MN 56726

www.centralboiler.com

Charmaster Products, Inc.

2307 Highway 2 West

Grand Rapids, MN 55744

www.charmaster.com

Dectra Corporation

3425 33rd Ave NE

St. Anthony, MN 55418

www.dectra.net/garn

Freedom Outdoor Furnace

7958 Curwensville Tryone Hwy

Olanta, PA 16863

www.freedomoutdoorfurnace.com/

Global Hydronics
Box 717
Winkler, Manitoba CANADA R6W 4A1
www.globalhydronics.com

Heatmor Inc.
105 Industrial Park Court NE
Warroad, MN 56763
www.heatmor.com

Heatsource1
2201 Ridgeview Drive
Beatrice, NE 68310
www.heatsource1.com

Horstmann Industries, Inc.
301 Second Street
Elroy, WI 53929
www.royalfurnace.com

Johnson Manufacturing
N5499 County E
Ogdensburg, WI 54962
www.hud-son.com/woodfurnaces.htm

Noonan's Welding & Heating
105 1st Street South
Keewatin, MN 55753
www.northlandoutdoorwoodfurnace.com

Outside Heating Systems - Wood Doctor
Box 567
Stewiacke, NS
B0N 2JO Canada
www.wooddoctorfurnace.com

Tarm USA, Inc.
Main Street Box 285
Lyme, NH 03768
www.woodboilers.com

Timber Ridge, Inc.
2020 Highway 11-E
Jonesborough, TN 37659
www.freeheatmachine.com

Hardy Manufacturing
12345 Road 505
Philadelphia, MS 39350
www.hardyheater.com

Heat Innovations
499 Manitoba Road
P.O. Box 989
Winkler, MB R6W 4B1
www.heatinn.com

Hicks Waterstoves and Solar Systems
2541 South Main Street
Mount Airy, NC 27030

Innotech Developments
2015 James Street South
Thunder Bay, ON P7J1G6
www.outdoorfurnaces.com

Mahoning Outdoor Furnace
RD #1 Box 250
Mahaffey, PA 15754
www.shol.com/mahoning

Northwest Manufacturing
600 Polk Ave SW
Red Lake Falls, MN 56750
www.woodmaster.com

Pro-Fab Industries/Cozeburn
Box 112
Arborg, Manitoba, Canada ROC OAO
www.profab.org

Taylor Manufacturing, Inc.
1585 US HWY 701 South
Elizabethtown, NC 28337
www.taylormfg.com

Turbo Burn, Inc.
4225 E Joseph
Spokane, WA 99217
www.turboburn.net