

Wood Burning Primer



Wood Burning Primer

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Requirements for Burning Wood

- Temperature: At least 1000 degrees F
- Air (oxygen) in the right amounts
- Fuel-Air mixing
- Time for the gases to burn

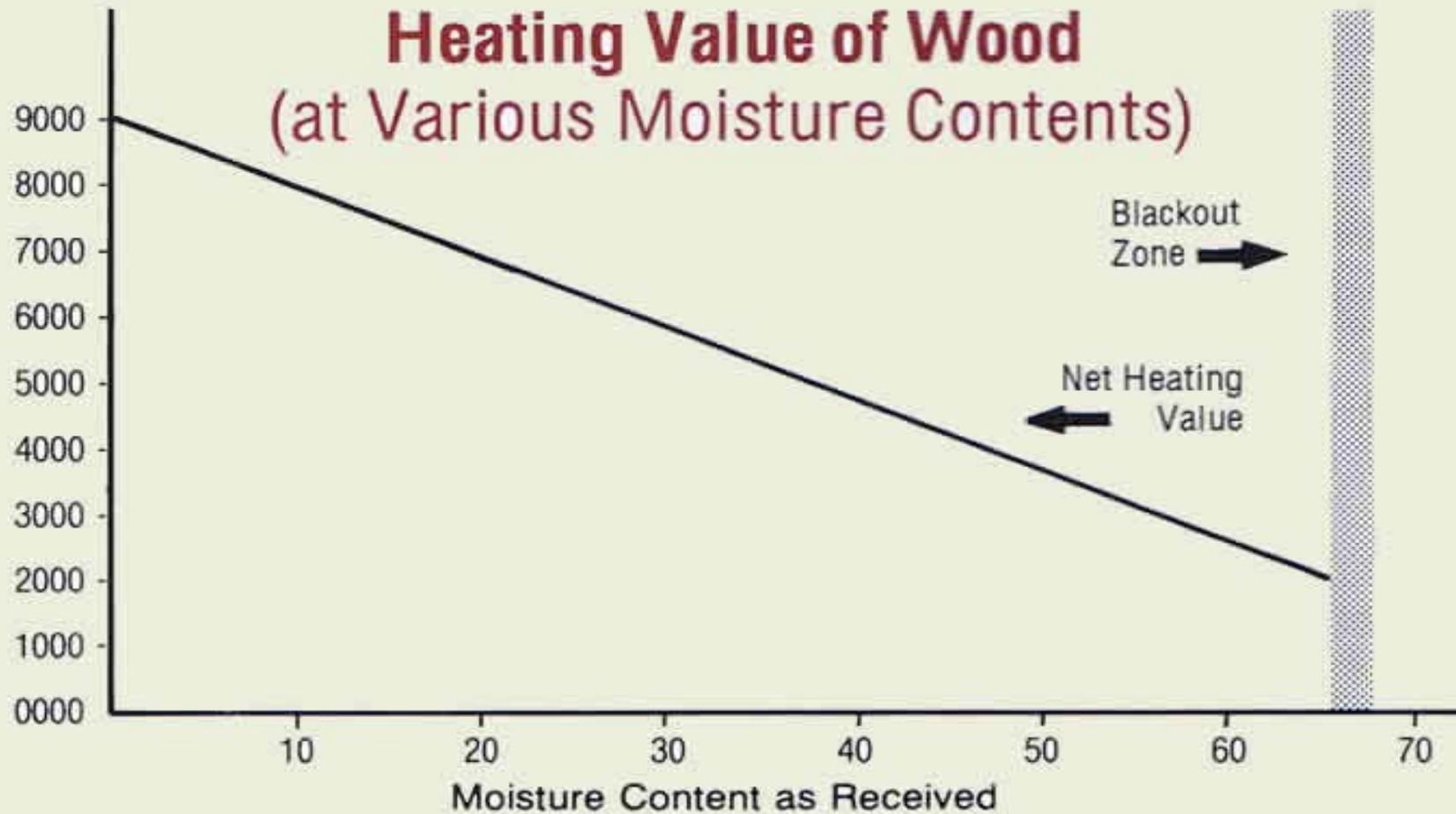
Phases of Wood Burning

- Driving off the moisture
- Volatilization phase
- Charcoal phase

Wood Moisture

- Green wood contains roughly 50% water depending on the species and time of cutting
- A 34 lb load of green wood may contain roughly 17 lbs (about 2 gallons) of water
- Dried to 25% moisture, this same load of wood weighs roughly 23 lbs and contains about 5.6 lbs of water

Heat Loss Due to Moisture



Source: Tillman, David A., **Wood as an Energy Resource**

Volatilization Phase

- When heated to a certain temperature, much of the wood content vaporizes.
- Most of the vapors are combustible and will burn given the proper amounts of oxygen and high temperatures.
- Unburned gases are emitted as white or bluish smoke.
- Characterized by flames.

Volatilization Phase



Volatilization Phase



Charcoal Phase

- Charcoal remains after the volatiles are driven off
- The charcoal is mostly carbon which is converted into carbon dioxide under good conditions, or carbon monoxide under air starved conditions
- Characterized by red coals and little if any flame

Charcoal Phase



Wood Burning Devices for Home Heating

- Woodstoves—Catalytic and non-catalytic
- Wood pellet stoves
- Gas stoves (NG or propane)
- Fireplace inserts—EPA Certified
- New “exempt” wood stoves (not subject to EPA standards)
- Wood-fired boilers and furnaces

USEPA Indoor Woodstove Standards

- Standards apply at the manufacturing level.
- These standards also apply to indoor wood pellet stoves and fireplace inserts.
- Models must be tested and labeled
- Particle Standards:
 - Catalytic Stoves: 4.1 grams/hr
 - NonCatalytic Stoves: 7.5 grams/hr

US EPA Woodstove Website

<http://www.epa.gov/woodstoves/index.html>

U.S. ENVIRONMENTAL PROTECTION AGENCY



Clean Burning Wood Stoves and Fireplaces

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You are here: [EPA Home](#) » [Air & Radiation](#) » Clean Burning Wood Stoves and Fireplaces

Wood Stove Home

Basic Information

Wood Burning Efficiency and Safety

Healthier Home, Cleaner Environment

Health Effects of Wood Smoke

Technical Information

Partners & Useful Links

Cleaner Burning Fireplaces

For Air Quality Program Officials

How-To Guide for Implementing a Wood Stove Changeout Campaign

A wood stove or fireplace adds warmth and ambiance to your home. This site offers information to help you choose an [EPA certified stove \(PDF\)](#) (67 pp., 1.0 MB, [About PDF](#)) or another cleaner burning hearth appliance (e.g., gas or pellet stove) and use it efficiently and safely. Air quality program officials will find information to help them support and develop programs for addressing residential wood smoke.

[Basic Information](#) - What you need to know to select a cleaner burning hearth product for your home, including retailers and installers in your area.

[Wood Burning Efficiency and Safety](#) - Tips on proper stove installation, good wood burning practices, and how you can ensure safer heating of your home. Also, see our [Clean Burn Fact Sheet \(PDF\)](#) (1 pg., 391 KB, [About PDF](#))

[Healthier Home, Cleaner Environment](#) - Learn the impacts of wood smoke on your health and the environment, as well as the quality of the air where you live.

[Technical Information](#) - Learn why newer wood stoves burn cleaner and safer and review test data on stove emissions.

[Partners & Useful Links](#) - Links to non-EPA partners assisting us with our wood stove changeout campaigns, and other information related to wood stoves and air quality.

[Cleaner Burning Fireplaces](#) - If you have a fireplace, learn more about the clean burning, safer, more efficient fireplace options available.

[For Air Quality Program Officials](#) - Information to help tribal, state and local air quality officials address wood burning emissions in their air quality planning.

[How-To Guide for Implementing a Wood Stove Changeout Campaign](#) - A step-by-step guide and reference for air quality program officials to use in putting together a wood stove changeout campaign.

Announcements

- Video featuring the Libby Wood Stove Changeout [\[EXIT Disclaimer\]](#)
- Video News coverage from the NBC affiliate in Washington, DC [\[EXIT Disclaimer\]](#)

Information



Basic Information: A more efficient, safer, cleaner model that saves money and time



Wood burning efficiency and safety: Efficient burning and effective heating with less smoke



List of EPA Certified Woodstoves

(one page of 110 Pages)

Model Name		Emissions (g/hr)	Efficiency	Heat Output (BTU/hr)
Hearthstone Quality Home Heating Products Inc.				
317 Stafford Avenue				
Morrisville VT05661 ,				
USA				
802-888-5232				
http://www.hearthstonestoves.com/				
Bennington	Noncatalytic	3.6	63 %	11900-32600
Clydesdale Model 8490	Noncatalytic	3.1	63 %	11,900-33,100
Craftsbury 8390				

Woodstove “Change-out” Programs

- Old, dirtier woodstoves are still far more common than new, cleaner certified units
- Woodstove change-out programs provide for financial incentives to replace old woodstoves with new cleaner units
- Ask your local woodstove dealer about the availability of change-out programs
- Vermont’s change-out program is focused on Rutland City, but may be available elsewhere

Choosing a Wood Heating Device

Wood and Pellet Stoves

- Choose the smallest unit for the job—it will burn hotter and more efficiently.
- Clean burning and efficient units are best. Check the emission data on certification labels.
- Consider convenience: Pellets are cleaner and easier to handle, but cordwood may be cheaper.
- Consider the use—something pretty for the living room, or a less decorative but perhaps less expensive unit.

Choosing a Wood Heating Device

Wood and Pellet Stoves

- Loading may be a factor for cordwood
 - Front loading
 - Side loading—left or right side
 - Top loading
- Always choose a unit certified to burn cleanly and efficiently.
- Have a lot of power outages?
Woodstoves work without power, but pellet stoves require power for operation.

Choosing a Wood Heating Device

Other Heating Devices

- Traditional fireplaces—”recreational”
 - Not considered heating devices because most of the heat goes up the chimney
- Fireplace inserts (EPA certified)
 - These are just as efficient as certified woodstoves and are far better than traditional fireplaces
- New “exempt” woodstoves
 - Cheap, but these act more like fireplaces because most of the heat goes up the chimney
- Indoor/outdoor boilers and furnaces
 - Major investment, but may be cost effective if you cut your own wood

Outdoor Wood-fired Boilers

Outdoor Wood-fired Boilers (OWBs), a.k.a.:

- ❑ Waterstoves
- ❑ Outdoor Wood-fired Furnaces
- ❑ Outdoor Wood-fired Hydronic Heaters (OWHH)
- ❑ Outdoor Wood-fired Hydronic Heating Appliances

Outdoor Wood-Fired Boilers



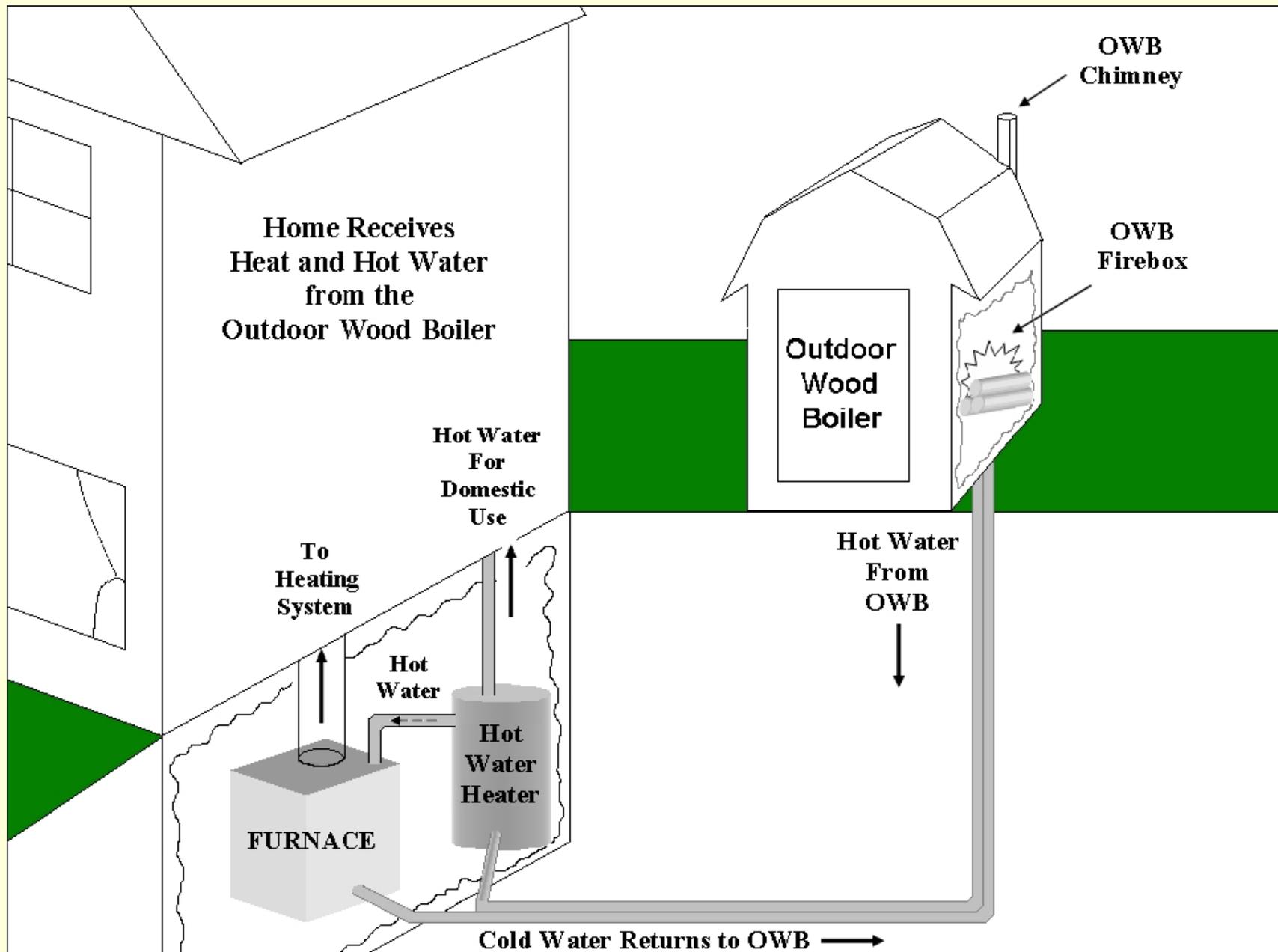






What are they & how do they work?

- An OWB is basically a wood-fired boiler in a small insulated shed some distance from the house. Water pipes run underground to transfer heat for both space heat and domestic hot water. They are used primarily for residential heating and hot water, but can be used in commercial applications.
- Size range: 115,000 to 3.2 MM BTU/hr; most common size is 500,000 BTU/hr [Wood stoves range from 35 to 75,000 BTU/hr]



Why are Vermont and other States concerned?

- **Citizen complaints:** Vt has received >60 complaints about >48 OWBs since 1995 from neighbors affected by smoke and odors. Other NE and mid-west states have also received complaints.
- Some complaints allege serious health or other effects (asthma, forced to sell house).
- **Air quality impacts:** Residential wood combustion is one of the largest sources of PM_{2.5} emissions to the atmosphere in North America, and old style OWBs emit 10 to 20 times more PM_{2.5} than wood stoves. Other air pollutants emitted: VOCs (benzene), PAHs (benzo(a)pyrene), CO, Nox, etc.

Why are Vermont and other States concerned?

- **Sales trends:** OWB sales are increasing dramatically:
 - ❑ Over 155,000 units nationwide since 1990
 - ❑ Sales growing at 30-128% annually
 - ❑ NESCAUM estimates 500,000 units by 2010, if trend continues
 - ❑ Sales concentrated in nineteen NE and midwest states (95% of sales)

Aren't OWBs just big, outside wood stoves?

NO!

OWBs have unique design features
and operational issues --

1. Primitive combustion design

- Cold combustion chamber (water jacket)
- Little or no secondary combustion
- Combustion air dampers are automatic:
full open or full closed only
- Oversized firebox

2. Cyclic operation

- Air damper opens/closes based on temperature in water jacket – no manual adjustments (Hi set point $\sim 180^\circ$)
- On idle: low temps, O_2 starved; heavy creosote deposits on cold walls
- When damper opens & fire restarts, organics volatilize \implies high emissions





3. Poor energy efficiency

- Low combustion efficiency
- Heat losses from underground pipes
- August 2005 NYS Attorney General's report collected efficiency data (next page)
[Note: This slide is from the New York State Attorney General's Report: "Smoke Gets In Your Lungs: Outdoor Wood Boilers in New York State".]

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%	

Footnotes for Appendix B from NYS AG's Report:

- 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.

4. Short stacks and low stack temps

- Most OWBs come with stub stacks (8 to 10 feet above ground)
- Stack temps typically run from 130° (in idle mode) to 600° F
- Result: smoke often stays near ground and “fumigates” neighbors



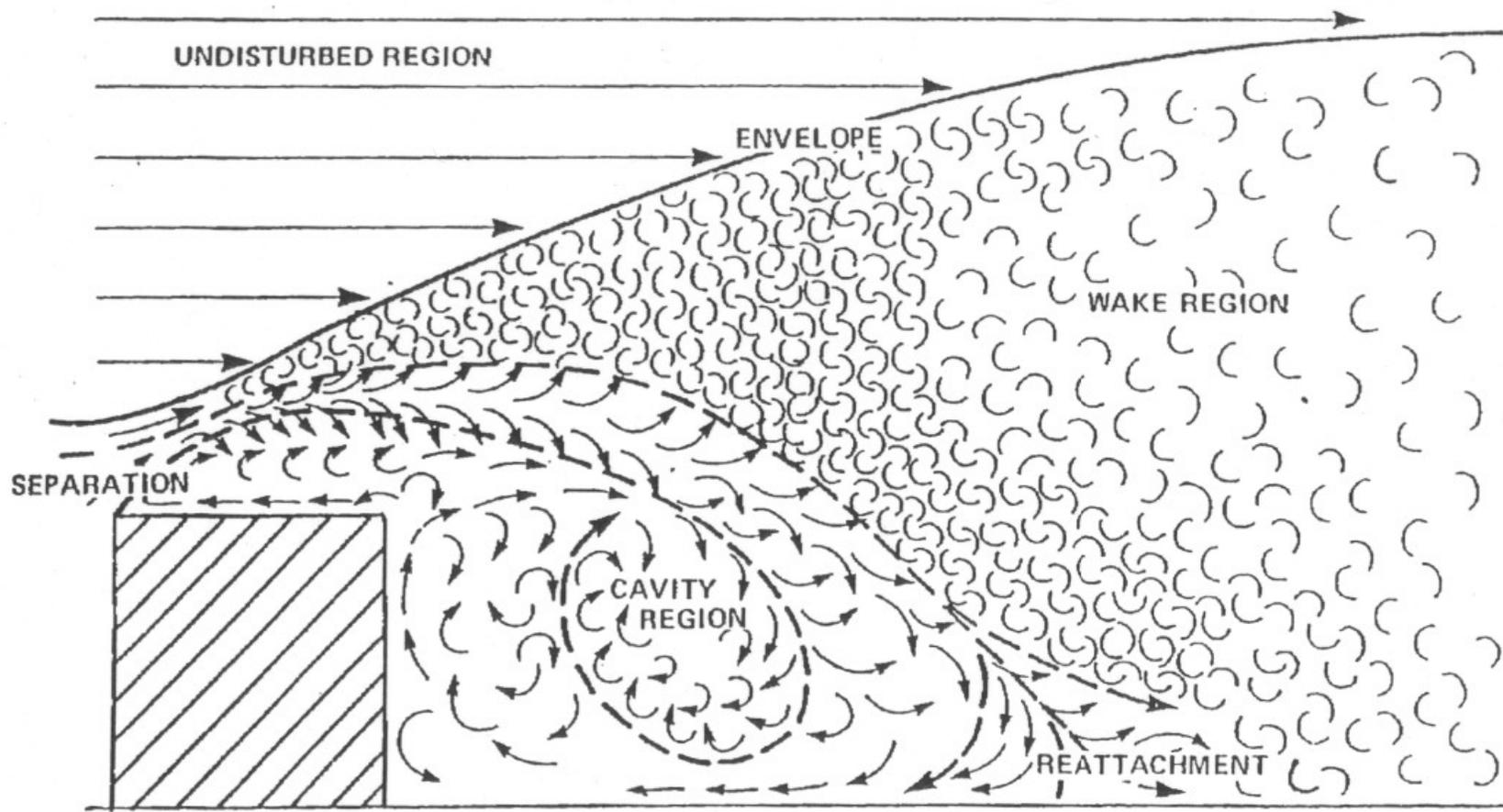


Figure 1. Diagrammatic outline of the envelope and cavity regions in the wake of a building (vertical section).





5. Year Round Operation

- OWBs provide hot water for space heat in winter
- Also, heat water for domestic use, swimming pools, hot tubs, etc. in the summer (unlike wood stoves)
- Many complaints received re: summer OWB operation, when windows open and dispersion poor.

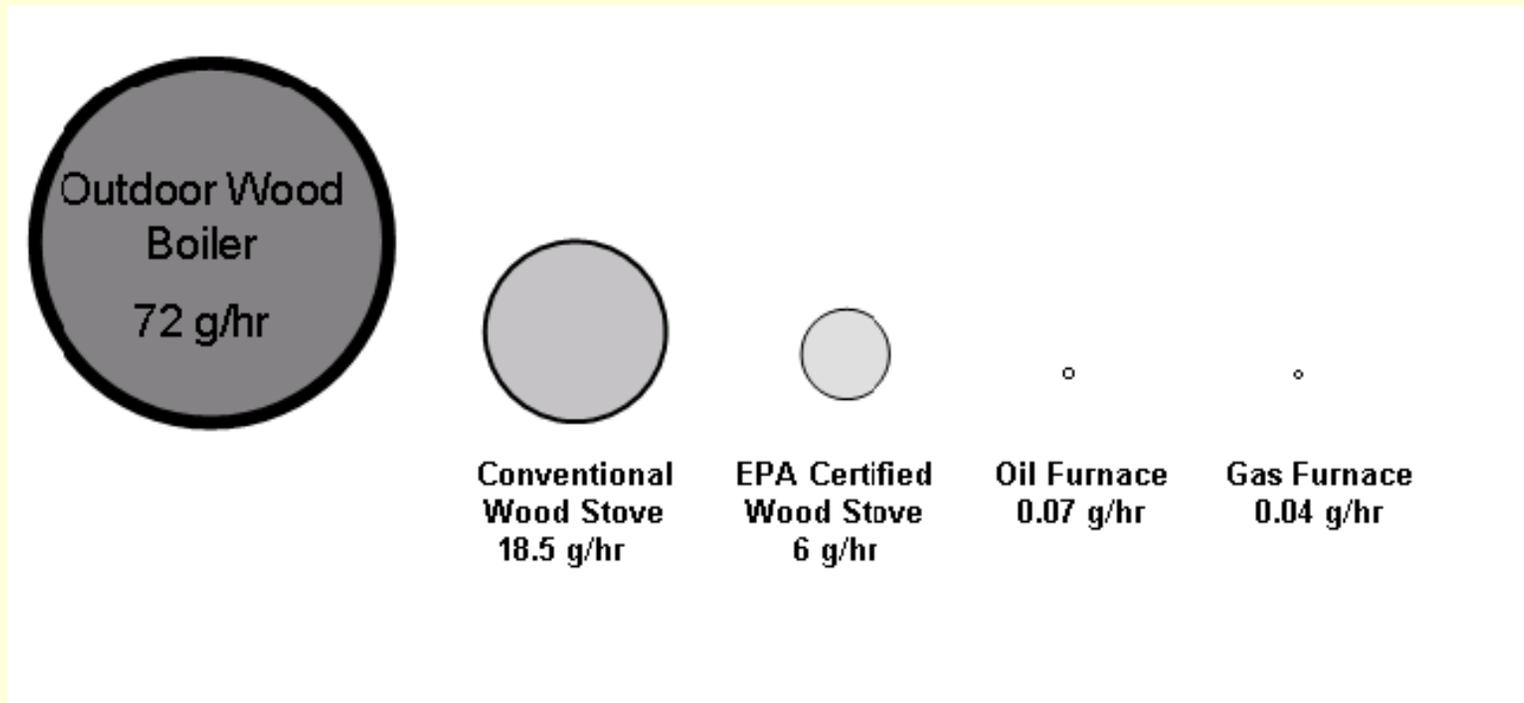


What do we know about OWB emissions?

- Particulate matter (mostly PM 2.5)
- Carbon monoxide
- Nitrogen oxides
- VOCs (e.g., benzene, toluene)
- PAHs (e.g., benzo(a)pyrene)
- Dioxins and furans

>>> LIMITED TEST DATA <<<

Particulate emissions



This and the following slide are from the New York State Attorney General's Report: "Smoke Gets In Your Lungs: Outdoor Wood Boilers in New York State".

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.

Table 1.10-3. PAH EMISSION FACTORS FOR RESIDENTIAL WOOD COMBUSTION^{a,b}

EMISSION FACTOR RATING: E

From EPA's
"Compilation
of Air Pollutant
Emission
Factors", AP-
42

Pollutant	Stove Type Emission Factor (lb/ton)			
	Conventional ^c (SCC 21-04-008-051)	Noncatalytic ^d (SCC 21-04-008-050)	Catalytic ^e (SCC 21-04-008-030)	Exempt Pellet ^f (SCC 21-04-008-053)
PAH				
Acenaphthene	0.010	0.010	0.006	ND
Acenaphthylene	0.212	0.032	0.068	ND
Anthracene	0.014	0.009	0.008	ND
Benzo(a)Anthracene	0.020	<0.001	0.024	ND
Benzo(b)Fluoranthene	0.006	0.004	0.004	2.60 E-05
Benzo(g,h,i)Fluoranthene	ND	0.028	0.006	ND
Benzo(k)Fluoranthene	0.002	<0.001	0.002	ND
Benzo(g,h,i)Perylene	0.004	0.020	0.002	ND
Benzo(a)Pyrene	0.004	0.006	0.004	ND
Benzo(e)Pyrene	0.012	0.002	0.004	ND
Biphenyl	ND	0.022	ND	ND
Chrysene	0.012	0.010	0.010	7.52 E-05
Dibenzo(a,h)Anthracene	BDL	0.004	0.002	ND
7,12-Dimethylbenz(a)Anthracene	ND	0.004	ND	ND
Fluoranthene	0.020	0.008	0.012	5.48 E-05
Fluorene	0.024	0.014	0.014	ND
Indeno(1,2,3,cd)Pyrene	BDL	0.020	0.004	ND
9-Methylanthracene	ND	0.004	ND	ND
12-Methylbenz(a)Anthracene	ND	0.002	ND	ND
3-Methylcholanthrene	ND	<0.001	ND	ND
1-Methylphenanthrene	ND	0.030	ND	ND
Naphthalene	0.288	0.144	0.186	ND
Nitronaphthalene	ND	BDL	ND	ND
Perylene	ND	0.002	ND	ND
Phenanthrene	0.078	0.118	0.048	3.32 E-05
Phenanthrol	ND	BDL	ND	ND
Phenol	ND	<0.001	ND	ND
Pyrene	0.024	0.008	0.010	4.84 E-05
PAH Total	0.730	<0.500	0.414	2.38 E-04

^a To convert from lb/ton to kg/Mg, multiply by 0.5. SCC = Source Classification Code.

ND = no data. BDL = below detection limit. < = values are below this detection limit.

^b Data show a high degree of variability within the source population and/or came from a small number of sources. Factors may not be accurate for individual sources.

^c Reference 19.

^d References 20,23-25.

^e References 13,19-20,23,26.

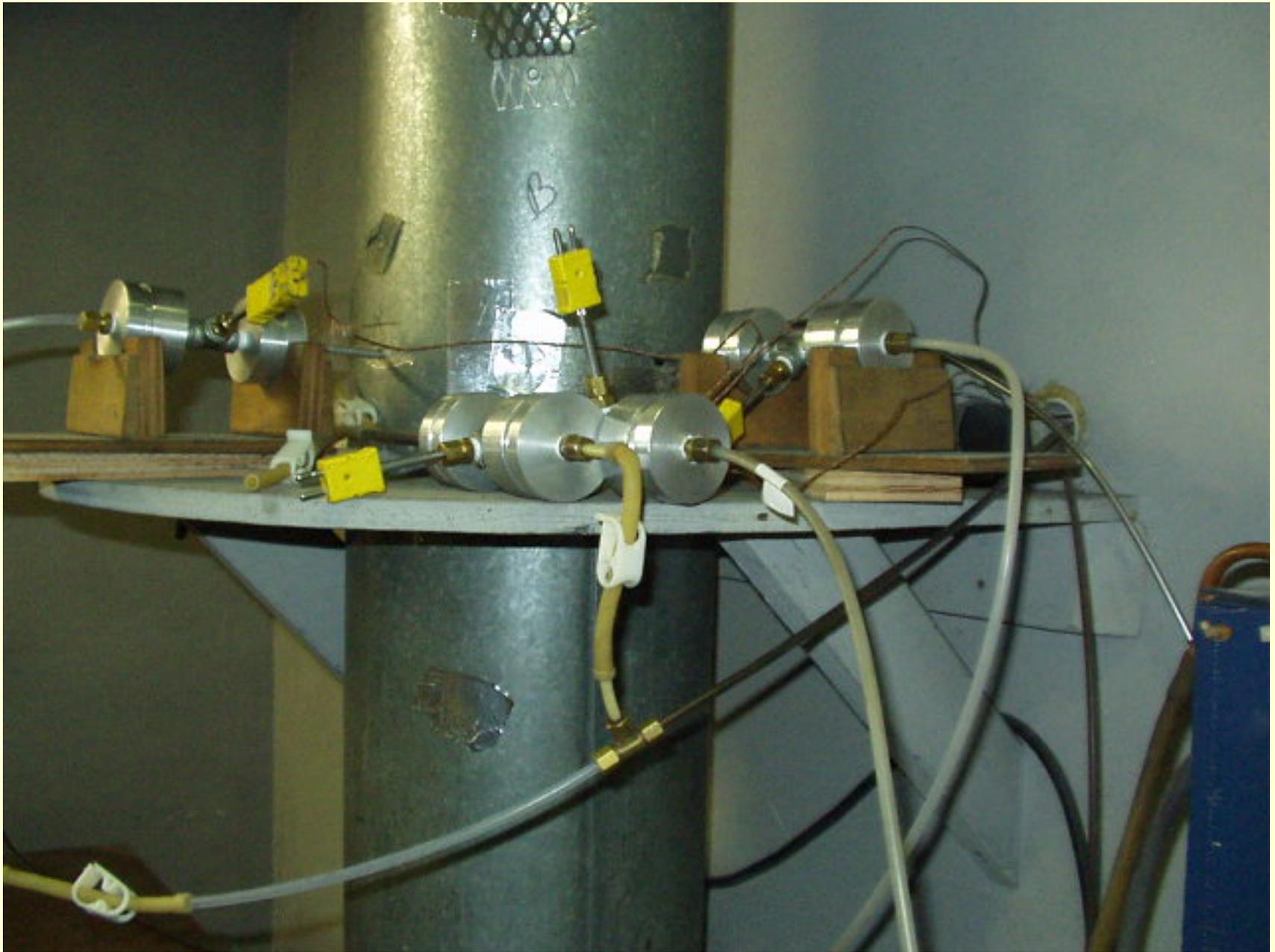
^f Reference 18. Exempt = Exempt from 1988 NSPS (i. e., air-to-fuel ratio > 35:1).

Emissions Testing

- EPA Method 28 modified for OWBs
 - A modification of woodstove certification test
 - A complex laboratory method
- ASTM draft test method similar to EPA method
- EPA Method 5 field stack test
- New field test methods under development









NESCAUM “In-Use” OWB Test

(Vermont - June 2005)

- Pilot testing: to help design future tests
- Two days & several operating cycles
- Moderate heat load in field conditions
- 2 PM test methods:
 - Continuous stack concentrations of PM_{2.5} with DataRAM nephelometer
 - Modified Method 17 – short duration gravimetric filter samples

Stack Sampling In Progress



Test Filter



RESULTS: NESCAUM “In-Use” OWB Test

➤ DataRam

- ❑ Mean DataRAM PM emission rate was **161 g/h**.
[3.5 hour average including both high and low fire modes; mean particle size: 0.1 to 1 $\mu\text{m}+$]

➤ Modified Method 17 filter

- ❑ Mean idle fire PM emission rate was **64 g/h** with a range of 13 to 148 g/h.
- ❑ Mean full fire PM emission rate was **93 g/h** with a range of 13 to 237 g/h. Probable significant low bias due to high stack and filter temperature.

What are the States doing?

➤ Vermont – 1997 Rule (Section 5-204):

- ❑ Not allowed to install OWB within 200 feet of neighbor's residence
- ❑ If OWB is within 500 feet of a neighbor's residence, the stack must be higher than the peak of the roof of the OWB owner's house
- ❑ Dealers must notify OWB buyers of the rule and have them sign a form which must be sent to the Air Division

What are the States doing?

- Vermont – 2007 Rule (Section 5-205):
 - ❑ Prohibits the sale or distribution of OWBs after March 31, 2008 unless they comply with a particulate standard of 0.44 lb/mmBTU of heat input.
 - ❑ Manufacturers are responsible for having the OWB models tested and for informing the dealers which models may be sold for use in Vermont.

What are the States doing?

- Vermont – 2007 Rule (Section 5-205):
 - ❑ Units certified for sale in Vermont are not required to have taller stacks.
 - ❑ Requires that the ANR propose a lower Phase II standard by March 31, 2008.
 - ❑ The likely Phase II standard is 0.32 lb/mmBTU of heat output.

What are the States doing?

➤ Connecticut:

- ❑ Act passed in 2005 includes 200 foot set back and stack height requirements for new OWBs (similar to Vt's rule)

➤ Massachusetts:

- ❑ Funded March 2006 NESCAUM report: "Assessment of Outdoor Wood-Fired Boilers"
- ❑ DEP and local Health Boards have investigated several complaints & taken enforcement action in some cases requiring units to meet opacity or other limits, or not operate in summer.
- ❑ Drafted regulation based on the NESCAUM Model Rule.

What are the States doing?

➤ Maine:

- ❑ Legislation and emergency regulation passed including a Phase I particulate standard of 0.60 lb/mmBTU input (effective 4/1/08) and a Phase II standard of 0.32 lb/mmBTU output (effective in 2010).
- ❑ Regulations are being adopted to implement the legislation.

➤ New York State:

- ❑ Complaints to DEC about OWBs are being handled under nuisance and opacity regulations; some enforcement actions have been taken [no summer operation; no waste burning]
- ❑ Many towns have adopted ordinances banning or controlling installation of OWBs

What are the States doing?

- ❑ OWB report issued by AG in August 2005 recommends adoption of state or federal regs to control OWBs
- ❑ August 2005 petition to EPA from NYS AG and other NE states asks EPA to adopt emission standards (NSPS) for OWBs. No response yet from EPA.

➤ Ohio:

- ❑ Taking comments on draft regulations until March 7, 2008.
- ❑ Regulations include a Phase I standard of 0.44 lb/mmBTU input and a Phase II standard of 0.32 lb/mmBTU output.
- ❑ The draft regulations also address existing OWBs.

What are the States doing?

➤ New Hampshire:

- ❑ Legislative hearings on house bill held in January 2008.

➤ Other states:

- ❑ Washington imposes 4.5 g/hr PM limit on OWBs.
- ❑ Wisconsin DNR – model OWB ordinance & public education
- ❑ Indiana DEM is holding public meetings to discuss options for regulating OWBs.

What are the States doing?

➤ Rulemaking petitions to USEPA in 2005:

The petition initiated by NYS, or a similar letter, asking EPA to adopt a NSPS for OWBs were signed by New York, Connecticut, Maryland, Massachusetts, Michigan, New Jersey, Vermont, Maine, and NESCAUM.

➤ ASTM test method development:

- ❑ A number of NE and midwest states and NESCAUM have been working with OWB manufacturers and EPA to develop method
- ❑ ASTM Subcommittee formed in June 2004
- ❑ Lab method to measure particulate emissions and heating efficiency
- ❑ Test method is now in draft form; likely to be adopted in 2008.

What Is the US EPA Doing?

- Worked with OWB manufacturers, states and NESCAUM on ASTM Committee
- Developed an OWB laboratory test method similar to the EPA woodstove test method.
- Has implemented a voluntary program that establishes emission targets for OWBs and promotes cleaner burning units.
- Includes a labeling program for OWBs.

US EPA Voluntary Program

- Phase I EPA guideline is 0.60 lb/mmBTU of heat input.
- The Phase II guideline will likely be 0.32 lb/mmBTU of heat output, the same as the NESCAUM Model Rule and some state rules.
- Numerous OWBs being tested and at least one unit already meets Phase II limit.

From the EPA Hydronic Heater Website



Outdoor Wood-fired Hydronic Heaters

Contact Us Search: All EPA This Area

You are here: [EPA Home](#) » [Air & Radiation](#) » [Outdoor Wood-fired Hydronic Heaters](#) » List of Cleaner OWHH

List of Cleaner OWHH

Below is a list of cleaner burning outdoor wood-fired hydronic heaters. As indicated by the information in the orange column, these models meet the EPA voluntary program Phase 1 emissions level (EPA Phase 1 level) because they emit no more than 0.60 pounds (lbs) of particulate matter (particle pollution) per million BTUs of heat input (i.e., wood burned). This information was generated by an accredited third party laboratory. When purchasing a wood heater, look to see if the [orange EPA OWHH tag \(PDF\)](#) (1pg, 55k) appears on the unit. The orange tag indicates that the model pollutes less than other models.

Outdoor Wood-fired Hydronic Heater Model Information

Manufacturer	Model Name & Number	8-hr Heat Output Rating	"Year round" Weighted Average	Annual Average Emission Rates	Heat Input* Annual Average Emission Level	Heat Output Annual Average Emission Level	Highest Individual Test Run
Central Boiler	E - Classic 1200	89,613 BTU/hr	Yes	7.5 grams/hr 0.15 grams/hr/10,000 BTU heat output	0.33 lbs/million BTU heat input	0.59 lbs/million BTU heat output	19.94 grams/hr
Central Boiler	E - Classic 2300	160,001 BTU/hr	Yes	6.4 grams/hr 0.06 grams/hr/10,000 BTU heat output	0.20 lbs/million BTU heat input	0.31 lbs/million BTU heat output	17.60 grams/hr

* EPA Phase 1 level is 0.60 lbs/million BTU.
Emission levels are annual averages unless qualified for heating season use only.

- Outdoor Wood-fired Hydronic Heaters Home
- Basic Information
- Where You Live
- Health and Environment
- Best Burn Practices
- EPA's OWHH Program
- List of Cleaner OWHH
- Program Partners
- Resources

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**Outdoor Wood-fired Hydronic Heater Model Information
"Year Round" Label**

Manufacturer	Model Name & Number	8-hr Heat Output Rating	Annual Average Emission Rates	Heat Input* Annual Average Emission Level	Heat Output Annual Average Emission Level	Highest Individual Test Run
Central Boiler	E - Classic 1200	89,613 BTU/hr	7.5 grams/hr 0.15 grams/hr/10,000 BTU heat output	0.33 lbs/million BTU heat input	0.59 lbs/million BTU heat output	19.94 grams/hr
Central Boiler	E - Classic 2300	160,001 BTU/hr	6.4 grams/hr 0.06 grams/hr/10,000 BTU heat output	0.20 lbs/million BTU heat input	0.31 lbs/million BTU heat output	17.60 grams/hr
Heatmor	200 SSR	71,923 BTU/hr	20.3 grams/hr 0.42 grams/hr/10,000 BTU heat output	0.35 lbs/million BTU heat input	0.76 lbs/million BTU heat output	33.4 grams/hr
Hardy	KB175	66,681 BTU/hr	16.3 grams/hr 0.31 grams/hr/10,000 BTU heat output	0.54 lbs/million BTU heat input	0.87 lbs/million BTU heat output	42.7 grams/hr
Sequoyah Paradise	E3400	101,020 BTU/hr	21.88 grams/hr 0.42 grams/hr/10,000 BTU heat output	0.488 lbs/million BTU heat input	2.37 lbs/million BTU heat output	34.77 grams/hr

**Outdoor Wood-fired Hydronic Heater Model Information
"Heating Season Only" Label**

Manufacturer	Model Name & Number	8-hr Heat Output Rating	Heating Season Average Emission Rates	Heat Input* Heating Season Average Emission Level	Heat Output Heating Season Average Emission Level	Highest Individual Test Run
Sequoyah Paradise	E3400	101,020 BTU/hr	20.10 grams/hr 0.31 grams/hr/10,000 BTU heat output	0.37 lbs/million BTU heat input	1.48 lbs/million BTU heat output	34.77 grams/hr

* EPA Phase 1 level is 0.60 lbs/million BTU.
Emission levels are annual averages unless qualified for heating season use only.

U.S. Environmental Protection Agency 2007 Outdoor Wood-Fired Hydronic Heater Program

This Outdoor Wood-Fired Hydronic Heater has been tested
and meets a certain air quality emissions level.*

By meeting this level, this model is cleaner and pollutes less than those
models that have not met this emissions level. Exposure to wood smoke
has been associated with respiratory illness and other health problems.
Models that have lower smoke emissions may reduce your family's risk.

For more information go to www.epa.gov/woodheaters

OUTDOOR WOOD-FIRED HYDRONIC HEATERS SMOKE EMISSIONS RANGE



Outdoor wood-fired hydronic heaters with lower emissions
produce less smoke when installed and operated properly.

MANUFACTURER: XXXXXXXXXXXX
MODEL NO: XXXXXXXX
8-HOUR HEAT OUTPUT RATING: 58,000 BTU/HR
EMISSIONS: XXX GRAMS/HR
0.5 LBS/MILLION BTU HEAT INPUT
XXX LBS/MILLION BTU HEAT OUTPUT
XX GRAMS/HR/ 10,000 BTU HEAT OUTPUT

* - This model has been tested by an accredited independent laboratory according
to EPA method 26 CWSH and meets the emissions level for U.S. EPA's Phase I
Voluntary Program.

Can Any Boilers Meet the New Standards?

- YES, technologies to meet standards are available and in use.
- Five “cleaner burning” OWBs are now listed on the EPA website (“Year Round”)
- Most common technologies include down draft gasification, mass storage or a combination of the two.
- Other innovative designs are being developed.

Table of Converted Standards

Standard	Standard limits	Lbs/mmBTU Input	Lb/mmBTU output
Vermont Proposed	0.2 gr/dscf	0.436	0.61 (@ 72% effic.)
AAA Non Catalytic	7.5 g/hr	0.73	1.16 (@ 63% effic.)
AAA Catalytic	4.1 g/hr	0.40	0.55 (@ 72% effic.)
*WA catalytic	2.5 g/hr	0.24	0.34 (@ 72% effic.)
WA All Others	4.5 g/hr	0.44	0.7 (@ 63% effic.)
CSA \leq 5.3 kg/hr	See AAA		
CSA $>$ 5.3 kg/hr	0.137 g/MJ output	0.23 (@ 72% effic.)	0.32









Outdoor Wood-Fired Boilers Facts & Information

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Welcome to the Vermont Department of Environmental Conservation website on Outdoor Wood Boilers (OWBs). With the rising cost of heating oil, more Vermonters are looking to wood as a source of heat and hot water. Not all wood heat is the same. While indoor wood stoves have been tested and certified by EPA for emissions since 1990, outdoor wood boilers are not. OWBs cause dense smoke and are equipped with very short smoke stacks so the smoke does not disperse well. This smoke endangers the health of you, your family and neighbors as well as the environment.

The claims of some OWB manufacturers are not proving to be accurate with time and testing. We want you to have the facts before making an investment. OWBs are regulated in VT and may also be regulated or banned by your town. This site is designed to help you get the facts. If you have any questions about OWBs, please [contact us](#).

New: [NY Introduces Bill to Reduce Air Pollution from OWBs](#) pdf 4/13/06

New: [NESCAUM Report on Outdoor Wood Furnaces](#) pdf 3/06





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