1998 EPA Test

- 1998 study conducted lab tests on two OWBs
- Lab method used modified Method 5G and tested under two heat loads using seasoned cordwood.
  - Testing indicates that lab tests using cordwood yield test results 20-30% cleaner than those using dimensional lumber.
Results of McCrillis Test

• Results
  – PM levels 55.4 g/hr at low heat and 143.2 g/hr at high heat
  – PAH levels of 0.64 g/hr at low heat and 2.8 g/hr at high heat
  – indicated maximum operating efficiency of 50 percent without taking into account delivery losses

• Industry cites this test to show that emissions from OWHH are no higher on a g/kg basis than indoor woodstoves
NESCAUM Emission Characterization Field Stack Test

• First known field test conducted on an OWB

• Conducted stack test on June 2005 using two test methods: filter and continuous monitor

• Unit was a 250,000 Btu used for space heating, domestic hot water and heating a swimming pool

• Unit was charged with a small fuel load - ~40% of capacity
VT Outdoor Wood Furnace Stack Sampling
Continuous PM (Data RAM) 21-June 2005
VT Outdoor Wood Furnace Stack Sampling
Continuous PM (Data RAM) 22-June 2005

Condensable PM Emissions (grams/hour)

Temperature (F)

Diameter (µm)

--- damper closed (idle burn) ---
--- damper open (full burn) ---
--- filter start ---
--- filter end ---

DataRam Saturated

--- filter = 52.3 g/h ---

10:32 to 10:54
VT Outdoor Wood Furnace Stack Sampling
Continuous PM (Data RAM) 22-June 2005

Condensable PM Emissions (grams/hour)

Temperature (F)

Diameter (µm)

PM emissions (g/h)

Temp (F)

Diameter (µm)

damper closed (idle burn)
damper open (full burn)
damper closed (idle burn)
filter start
filter end
filter start
filter end
open oven door to check fuel

(109 g/h)

filter = 21.2 g/h

328x124
291x405
207x517
218x517
207x517
218x517
435x748
518x960
518x690
VT Outdoor Wood Furnace Stack Sampling
Continuous PM (Data RAM) 22-June 2005

Condensable PM Emissions (grams/hour)
Temp (F)
Diameter (µ)

- damper open (full burn)
- damper closed (idle burn)

Saturated
filter start
filter end

PM Emissions (g/h)
Temp (F)
Diameter (µ)

--- filter = 17.4 g/h ---
--- filter = 147.7 g/h ---
--- filter = 13.3 g/h ---
--- filter = 12.9 g/h ---
Both methods measuring most of condensables (filter T is ~120 to 180 F)

Damper closed (Idle burn):
Mean DR: 1.59 g/m³
Mean Filter: 1.17 g/m³
R² = 0.93

Dataram measuring most of condensables; filter is losing most (filter T is ~300 to 550 F)

Damper open (full burn):
Mean DR: 1.56 g/m³
Mean Filter: 0.23 g/m³
R² = 0.02 (not significant)
Stack Test Results

Findings

- DataRam
  - mean DataRAM PM emission rate was 161 g/hr
  - Measurement obtained over 3.5 hour period measuring both high and low fire modes approximately 3 hours after initial fuel charge
  - This average does not include emission rates from initial charge and cycles or charcoal end of cycle (high and low and represents the middle range of the fuel charge).
  - Does not represent a full fuel load which will increase results.

- Filter
  - comparisons of emission rates from the two burn modes based on the filter data presented here should be done with caution. The filter data from full fire samples is likely to be biased low by a large factor because of loss of condensable PM from the hot filter.
  - Mean full fire PM emission rate was 93 g/h with a range of 13 to 237 g/h.
  - Mean idle fire PM emission rate was 64 g/h with a range of 13 to 148 g/h.
Emissions from OWB’s Near Field Ambient Monitoring

• Few if any assessments of OWB in-field ambient emissions have been conducted
• March 2005, NESCAUM conducted exploratory field monitoring of ambient PM2.5
  – to assess the potential for elevated exposures within 50-150 ft of an OWB emissions source
  – Continuous sampling (15-second average intervals)
Continuous field measurements of PM2.5 in proximity to an OWB during air intake and starved operating modes about 25 hr after fuel loading.\textsuperscript{11}
Continuous field measurements of PM2.5 in proximity to an OWB during air intake and starved operating modes during and immediately after fuel loading.\textsuperscript{11}
Ambient Monitoring Findings

• Recorded periodic PM2.5 values >1,000 µg/m3

• Frequent values >400 µg/m3

• Elevated levels were found at all sampled distances

• Values upwards of 4,000 µg/m3 were recorded over distances of 50, 100, and 150 ft

• A maximum value of 8,880 µg/m3 was observed at 50 ft.

• Results indicate that residences located in proximity to OWBs can experience elevated ground-level concentrations of PM2.5 dominated by submicron aerosols.
NESCAUM Ambient Study Findings

• Levels largely influenced by variable wind direction, time from most recent OWB fuel loading, and OWB air intake mode.

• Highest values were recorded within about 1 hr after fuel loading relative to values recorded about 24 hrs after loading, although these levels were also elevated.

• Air intake appeared to influence recorded values, although elevated samples were recorded during both damper open and damper closed modes.

• The average particle diameter across all samples ranged from 0.27-0.59 µm and minimum particle diameters ranged from 0.09-0.16 µm.
Summary of OWB Risk Assessment
Brown, et al Study

• Cancer appears to be the sensitive endpoint with a 7-months-a-year, lifetime exposure of 6 µg/m³
  – It yields over 1 in 100,000 risk of cancer.

• An exposure level of 18 µg/m³ (6 hr average) is a threshold risk for health problems such as asthma.

• An exposure level of 24 µg/m³ is a moderate risk for hospitalization due to asthma or COPD

• An exposure level of 30 µg/m³ is a high risk for serious health problems, hospitalization, and even death from asthma COPD and cardiovascular disease.
Limitations and Uncertainties

• Only particulate measured. Other toxics are present including CO and NOx.
• Wood stove data used which could underestimate adsorbed fraction in OWB.
• Synergistic effect between PM and gases not evaluated
• Safety factors are not included, should be at least 10.
• Others
• State Air Toxics Review Committee reviewed risk assessment and determined that the Brown study used conservative figures to determine risk
Current thinking on conventional OWB emissions

• NESCAUM stack test
  – smallest unit emitted 161 g/hr this compares with most woodstoves today emitting under 4.5 grams per hour particulate matter
  – Smallest unit potential to emit 1.5 tons per year total particulate matter

• NESCAUM ambient monitoring indicated that local impacts could be substantial

• Modeling analysis should current units have potential to create local exceedences of fine particulate NAAQSs at distances of 500 feet

• Dave Brown risk assessment indicates that cancer risk for people living within 1,000 ft of OWB is 1 in 100,000
OWBs Don’t Compare Well

1 OWB’s PM emissions ~=
   - 4 non-certified wood stoves, or
   - 18 certified wood stoves, or
   - 205 oil furnaces, or
   - 3,000-8,000 natural gas furnaces

*From CT DEP*
Best Management Practices for existing OWBs

- Avoid summer operations
- Burn small, hot fires
- Use dry, well seasoned wood
- Locate greater than 500’ from neighbors
- Consider Stack extensions
Increased stack heights, are they the answer????
The Future

- Several units moving towards cleaner burns
- One unit meets tested and approved by EPA but not yet available for sale
- Several “unofficial” lab tests indicate that cleaner emissions can be achieved
- Questions about environmental performance in the field