STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

N ELIAS BALDACCI
GOVERNOR

DAVID P. LITTELL
COMMISSIONER

December 30, 2008

Senator Seth A. Goodall, Co-chair
Representative Robert S. Duchesne, Co-chair
Members of the Natural Resources Committee
100 State House Station
Augusta, Maine 04333-0100

Dear Senator Goodall, Representative Duchesne and Members of the Joint Standing Committee on Natural Resources:

I am pleased to provide you with this report pursuant to Resolve 2007, Chapter 190, *Resolve Regarding Legislative Review of Portions of Chapter 150: Control of Emissions from Outdoor Wood Boilers, a Major Substantive Rule of the Department of Environmental Protection, Bureau of Air Quality Control* and Public Law 2007, Chapter 442, *An Act to Regulate Outdoor Wood Boilers.*

The report details the implementation of Chapter 150 (Control of Emissions from Outdoor Wood Boilers), an evaluation of several unintended consequences and the Department's recommendations for improvements to the rule (Attachment #I). In addition, Attachment #II includes a review of outdoor wood boiler technology and the achievability of the particulate emission limits of outdoor wood boilers.

The Department is also in the process of rulemaking to incorporate biomass pellet boiler requirements into the Chapter 150 rule pursuant to Resolve 2007, Chapter 190; and Chapter 160 (Outdoor Wood Boiler Replacement and Buy Back Program) pursuant to Public Law 2007, Chapter 680, *An Act Establishing an Outdoor Wood Boiler Fund.*

During the implementation of the Chapter 150 rule and the rulemaking process for the Chapter 160 rule, the Department identified several unintended consequences and the following is a summary of the recommendations for legislative action:

- **Directive.** Legislative language requiring the Department to make the following recommended rulemaking changes:
    - Substitute "qualified professional, including professional engineer and master solid fuel technician," for "professional engineer". (Chapter 150 Section 3(D))

GUSTA
TATE HOUSE STATION
GUSTA, MAINE 04333-0017
) 287-7688 FAX: (207) 287-7826
BLDG., HOSPITAL ST.

BANGOR
106 HOGAN ROAD
BANGOR, MAINE 04401
(207) 941-4570 FAX: (207) 941-4584

PORTLAND
312 CANCO ROAD
PORTLAND, MAINE 04103
(207) 822-6300 FAX: (207) 822-6303

PRESQUE ISLE
1235 CENTRAL DRIVE, SKYWAY PARK
PRESQUE ISLE, MAINE 04769-2094
(207) 764-0477 FAX: (207) 760-3143

ite: www.maine.gov/dep

- Amend the following Chapter 150 rule definition: "'Commercial Outdoor Wood Boiler' means any outdoor wood boiler, excluding those outdoor wood boilers used for space heating and/or domestic hot water, used to service a commercial establishment.'" (Chapter 150 Section 2(B))

- Amend the Chapter 150 rule to add a technology-forcing emission standard (lower emission standard) as an incentive to manufacturers to produce cleaner burning units, and to reward these cleaner burning units with reduced setbacks. This would be a voluntary emission standard provision, unlike the mandatory Phase 1 or Phase 2 emission standards.

- **Statute Changes.** The Department recommends the following statutory language changes:

  - Eliminate the February 1, 2008 deadline associated with buy back program eligibility requirement.

  - Amend the OWB definition to read as follows:

  'Outdoor Wood Boiler' means a fuel burning device:

  A. Designed to burn wood, biomass fuel products or other solid fuels;
  B. That the manufacturer specifies for outdoor installation or in structures not normally occupied by humans, including indoor rated devices housed in modular or containerized structures; and
  C. That heats building space and water through the distribution, typically through pipes, of a fluid heated in the device, typically water or a mixture of water and antifreeze.

The Department recommends no change to the current emission limits or compliance dates for Phase 1 and Phase 2 outdoor wood boilers based on several factors: 1) there are OWBs in the present marketplace (for sale) that meet the Phase 2 standard; 2) there are new cleaner burning or control technologies emerging in the U.S. and Europe marketplace; and finally, the Phase 1 and Phase 2 standards and compliance dates are consistent with other New England states' OWB requirements.

I would be happy to present this report to the committee at your request and convenience.

Sincerely,

James P. Brooks

James P. Brooks
Director, Bureau of Air Quality
Maine Department of Environmental Protection
Telephone: 207-287-7044
James.P.Brooks@Maine.gov

ATTACHMENT I

Implementation of Chapter 150, Control of Emissions from Outdoor Wood Boilers, Unintended Consequences and Recommendations for Improvement of the Rule

Introduction: During the 123rd Legislature, second regular session, legislation was enacted (Resolve 2007, Chapter 190) requiring the Department to submit a report to the Joint Standing Committee on Natural Resources detailing the implementation of Chapter 150 (Control of Emissions from Outdoor Wood Boilers) of the Department's rules. Within this report, the Department is required to include an evaluation of any unintended consequences of the rule and recommendations for improvement of the rule.

This report details the outdoor wood boiler legislative and rulemaking history, implementation of the rule (outreach, compliance tools, complaint summaries, technology and achievable emission limits), unintended consequences, and a summary of the recommendations. The unintended consequences are identified as those needing legislative action and those resolved by interpretation of the rule; and also include current issues associated with the development of Chapter 160 (Outdoor Wood Boiler Buy Back and Replacement Program).

A. Chronological Legislative and Rulemaking Summary

June 2007. The Legislature enacted legislation, Public Law 2007, Chapter 442 (38 MRSA Section 610-B), that established emissions standard requirements for new outdoor wood boilers: a Phase 1 particulate emission standard of 0.60 lbs/MMBTU effective April 1, 2008 and a Phase 2 particulate emission standard of 0.32 lbs/MMBTU effective April 1, 2010. The Legislature also directed the Department to adopt a rule including the emission standards, setbacks and stack height requirements, operation and label requirements, dealer and manufacturer reporting, and definition of nuisance conditions specifically relating to the operation of outdoor wood boilers. Rules adopted pursuant to Section 610-B were adopted as emergency major substantive rules pursuant to Title 5, section 8073 and had to be submitted to the Legislature for review by January 15, 2008.

August 16, 2007. The Board of Environmental Protection held a public hearing on the Department's proposed Chapter 150 (Control of Emissions from Outdoor Wood Boilers). The comment period remained open until August 31, 2007 and the BEP adopted Chapter 150 on November 1, 2007, which became effective November 9, 2007. The Department submitted Chapter 150 to the Legislature for review prior to the January 15, 2008 deadline. Chapter 150 established requirements for the sale and installation of new outdoor wood boilers, including: particulate emission standards; requirements for setback and stack height; analysis requirement for commercial boilers; certification; sell-through of existing inventory; and labeling. The rule also contained general provisions that apply to all outdoor wood boilers (OWBs). These provisions included prohibited and allowed fuels, visible emissions standards, a notice to buyers, and owner's manual requirements. Additionally, pursuant to the legislation, for the purpose of this rule, the Department proposed a definition of "nuisance" and a method by which a nuisance condition can be identified.

April 2, 2008. The Maine Legislature enacted Resolve 2007, Chapter 190, *Regarding Legislative Review of Portions of Chapter 150: Control of Emissions from Outdoor Wood Boilers, a Major Substantive Rule of the Department of Environmental Protection, Bureau of Air Quality Control*. This legislation required amendments to Chapter 150 in several areas:

- **Sell-through exemption:** In order to be eligible for the sell-through exemption contained in the rule, the OWB must have been purchased, paid for in full, and located in the State of Maine prior to April 1, 2008.

- **Setbacks to neighbors:** The legislation authorized the alternative setbacks from neighboring dwellings for the installation of new outdoor wood boilers in addition to the setbacks to the nearest property line. OWBs with a particulate emission limit greater than 0.60 lbs/MMBTU heat input, those with a particulate emission limit of 0.60 lbs/MMBTU heat input and those with a particulate emission limit of 0.32 lbs/MMBTU heat output may be installed 270 ft, 120 ft and 70 ft, respectively, to the nearest dwelling that is not on the same property as the boiler.

- **Setbacks to facilities:** Setbacks from state licensed school, daycare or healthcare facilities must conform to the general setback requirements. Therefore, the 500 foot setback requirement to these facilities was deleted from the rule.

In addition, this legislation requires the Department adopt rules regarding OWBs that combust biomass pellets (currently the Department is in the midst of this rulemaking process), and requires the Department to report back on the implementation of the OWB, including unintended consequences, and a review of OWB technology and its achievability to meet Maine's emission standards.

April 9, 2008. The Resolve 2007, Chapter 190 became effective April 9, 2008, the day the Governor signed the enacted law.

May 15, 2008. The Board of Environmental Protection adopted amendments to Chapter 150 incorporating the Legislative changes. No public hearing or comment period was required for this rulemaking because the Board was only incorporating the Legislative Directive.

July 4, 2008. Amendments to Chapter 150 became effective.

July 18, 2008. Public Law, Chapter 680, *An Act Establishing an Outdoor Wood Boiler Fund* became effective. This legislation directed the Department to adopt rules establishing an OWB buy back and replacement program for OWBs creating nuisance conditions; and gave the Commissioner emergency powers to deal with severe OWB nuisance issues.

October 16, 2008. The Board of Environmental Protection held a public hearing on amendments to Chapter 150 (Control of Emissions from Outdoor Wood Boilers) which incorporates the outdoor pellet boilers requirements and Chapter 160 (Outdoor Wood Boiler Buy Back and Replacement Program). The Department expects the BEP to adopt these rules by April 2009.

B. Implementation of the Rule

Information and Education

Department Outreach. After Chapter 150 (Control of Emissions from Outdoor Wood Boilers) became effective in November 2007, the Department sent copies of the regulation to the standard list of recipients of new regulations and an additional list of contacts specific to the Chapter 150 rule. The Department also utilized its membership in the American Society of Testing and Materials (ASTM) and the EPA Outdoor Wood Boiler workgroup to notify manufacturers about the new regulation. Manufacturers were asked to inform their dealers about the regulation. The Department also published a companion fact sheet to the regulation and a set of 'Good Operating Procedures for Outdoor Wood Boilers.' Both of these publications and other information were included on the Department's new web page on OWBs (http://www.maine.gov/dep/air/woodsmoke/woodcombustion.htm). This web site is used as a resource by the public both inside and outside the state.

Out-of-State Outreach. In the summer of 2008, the Department received information that out-of-state dealers were selling OWBs which were not EPA certified to people in the State of Maine. In response, the Department sent letters to 19 outdoor wood boiler dealers in New Hampshire, Massachusetts and New Brunswick. The Department found one dealer in New Hampshire and one in New Brunswick actively advertising uncertified OWBs for sale in the state. The Department sent these two dealers letters warning them that the sale of these OWBs violated Maine regulations.

Code Enforcement Officer Assistance. Although the Chapter 150 rule is not enforceable by local officials, municipal Code Enforcement Officers (CEO) have been helpful to the Department. Often they are the first to hear about problem boilers and may have local municipal ordinances that apply to OWBs. In the fall of 2007, the Department presented an overview of the regulation to the annual Code Enforcement Officer workshop sponsored by the State

Planning Office. The Department has also invited, and partially financed, Code Enforcement Officers to the semi-annual Visible Emission Observer Training and Certification that the Department sponsors. So far, 23 CEOs have been trained and received Visible Emission certifications.

Compliance Tools to Regulate Existing Outdoor Wood Boilers

Visual Observation of Smoke Opacity (Use of EPA Method 9). There are several methods that can be used to measure particulate matter emissions from combustion sources and in the atmosphere. Most of the methods require sophisticated and expensive monitoring equipment, which are prohibitively expensive (in terms of human resources and capital) to install and operate. Currently, there are small portable instruments that can measure particulate matter, but these devices are expensive and, in our determination, lack the accuracy and precision necessary for determining compliance. However, the visual observation of smoke opacity, using EPA's Method 9 procedure, has long been used to regulate emissions from larger smokestack combustion sources. EPA Method 9 relies on trained and certified human observers and has been a reliable and proven compliance method since the 1970s.

Prior to the adoption of Chapter 150, the Department had only part of one regulation that applied to OWBs. Within the Department's Chapter 101, there was a visible emission opacity section that was applicable to OWBs. The "wood waste/biomass unit" section applied to OWBs and limited visual smoke opacity from OWBs to 30% averaged over 6 minute periods. However, applying this regulatory requirement to OWBs proved to be problematic for the Department. Visual observation by a trained and certified observer is the simplest way of determining the opacity of an emission. In practice, it was difficult to get a certified DEP observer to an OWB location when complainants reported OWB smoke impacts. Unfortunately, the official EPA Method 9 process also doesn't allow for the use of photographs or videos to make these visual opacity determinations. Lastly, these visual smoke opacity observations can only be conducted with sufficient daylight. In the winter, observations are restricted to the hours after the sun comes up at 7 AM and before it sets at 4 PM.

Visual observation of Smoke Opacity crossing property line (Use of EPA Method 22). The adoption of Chapter 150 added a new and innovative tool to assist with compliance determinations. Section 5(A) of the rule defines nuisance smoke as "any opacity totaling twelve minutes in any hour, that cross onto any land or buildings immediately adjacent to a dwelling or commercial building not owned by the owner of the outdoor wood boiler." The regulation also specifies that EPA Method 22 can be used to determine compliance. Method 22 does not require the actual determination of opacity as EPA Method 9, but rather allows for documenting the presence or absence of smoke. Certified visual smoke opacity observers are not required to perform Method 22, so the range of people and the means that can be used to document violations is much broader. In some cases, the Department has deployed a programmable time-lapse digital video system for long term smoke observation of OWBs. In actual practice, this system has proven very useful in making compliance determinations and corrective actions. In fact, complainants have also provided videos of smoke incidents that have been helpful in our complaint investigation process.

Compliance Tool Limitations:

- **Video Technology Limitations.** The use of videos to document nuisance smoke from OWBs is helpful but has its limitations. Most video recorders are not as sensitive as the human eye. The video will tend to produce a lower number of minutes of impact than a human observer. Proper lighting is needed for video recording as it is for a human observer.

- **Time Limitations.** In the winter, the smoke impact can occur before the sun comes up at 7 AM or after is sets at 4 PM. This time period renders compliance determinations using present compliance tools obsolete. The Department continues to investigate other means to measure the impact of smoke from OWBs on neighboring property. Neither method (video or use of the human eye) can be used to observe emissions that occur between sunset and sunrise.

- **Time Consuming.** Documenting nuisance smoke is still a time consuming effort. DEP staff has found it hard to coordinate their observation of OWBs to the conditions that cause nuisance smoke complaints. The use of video recording also involves significant amounts of staff time to effect a complete review.

Summary of Complaints to Date

History. In December 2007, there were 54 active complaints regarding OWBs. The Department considers a complaint resolved if changes have occurred (higher stack, new location, removal, etc.) that will prevent or significantly alleviate nuisance smoke conditions on a complainant. An inactive complaint is one where changes have occurred, where impacts have ceased, but a potential for impact remains. An example would be an OWB that is no longer in use because a house or business is vacant but could produce smoke impacts if it were to be used again. The Department also considers a complaint inactive if the complainant has not contacted the Department in 2008, or has reported the last impact as occurring in 2007.

Between January 1, 2008 and December 23, 2008, the Department received 42 additional complaints of smoke impacts from OWBs, for a total of 96 complaints. Many of the complaints come from OWBs that were installed and placed into operation during that timeframe, and we saw a rise in OWB complaints from summertime OWB operation. A number of complaints came from boilers that were installed in 2007 during the time period preceding the effective date of Chapter 150. Most of these OWBs were located closer to homes and property lines than the specified set backs in the adopted Chapter 150.

Complaint Status. Of the total 96 complaints currently on file:

- 64 are active cases of reported OWB nuisance;
- 26 cases are considered closed as a result of the OWB being relocated, removed or improved; the complainant moving away; lack of contact from the complainant in 2008; or a municipality or court taking jurisdiction; and
- 6 cases are in an inactive status due to property served by the OWB being vacant, inability to contact the original complainant or at the request of the complainant.

Survey of Complainants. In the summer of 2008, the Department conducted a phone survey of complainants who submitted complaints before November 9, 2007, the effective date of Chapter 150. The Department was able to contact 31 complainants, of which 29 volunteered to respond. Eleven complainants reported improved conditions since the adoption of Chapter 150, however 17 reported no change. One complainant did not know. Twenty of the respondents reported that the most recent impact from OWB smoke or odor occurred in the spring or summer of 2008 including six respondents who reported improved conditions since the adoption of Chapter 150. Of the 29 respondents, 20 households (including 23 persons) reported being diagnosed with respiratory or cardiac problems. Four of the respondents reported visits to their doctor or a hospital as a result of impact from an OWB. Two respondents were trying to selling their house as a result of the OWB impact.

Department's Note. The Department has found it useful to describe the following factors when describing nuisance smoke conditions and analyzing for potential solutions:

> ***Nuisance smoke emissions*** = (siting, sizing, set-up) (type of fuel) (OWB operation).
>
> ***Influence of weather and time.*** The severity of nuisance smoke conditions are also influenced by weather conditions and times of operation.

Applicable Technology and Achievable Emission Limits

OWB manufacturer compliance with Maine's Phase 1 emission standards. In the summer of 2008, there were ten OWB models certified by EPA for the Phase 1 particulate emission standard of equal to or less than 0.60 lb/million British Thermal Units per hour (MMBTU) heat input. Although ten OWBs were certified, only six are commercially available. Maine statute and rules require that all OWBs sold in Maine, starting April 1, 2008, meet the Phase 1 requirement.

OWB manufacturers meeting Maine Phase 2 emission standards. Presently, there are six OWBs (three outdoor cord wood boilers and three outdoor pellet boilers) from five manufacturers that have met the Phase 2 emission standard prior to the Maine statute and rule deadline of April 1, 2010. The Maine Phase 2 particulate emission standard for OWBs is established at, equal to or less than, 0.32 lb/MMBTU heat output. The particulate emission rates of the certified Phase 2 OWBs range from 0.31 lb/MMBTU heat output to 0.06 lb/MMBTU heat output.

EPA's voluntary partnership with OWB manufacturers. As of December 2008, 11 OWB manufacturers had signed EPA's Voluntary Phase 2 Partnership Agreements and have committed "to use (their) best efforts to develop, manufacture, and market one or more (Phase 2) qualified models." The Phase 2 particulate emission standard of EPA's voluntary program is the same as Maine's Phase 2 particulate emission standard.

Increased thermal efficiency. A benefit of the Phase 2 program is the increase in the efficiency of OWBs. The efficiency of the heat delivery of conventional OWBs ranged from 25% to 50%. The Phase 2 OWBs have generally increased heat delivery efficiency by a factor of 2 or 3. EPA reports that one cordwood boiler had a delivered efficiency of 75%. One pellet boiler had an efficiency of 88%. As a result, users of Phase 2 boilers will burn less wood and the wood that is burned will emit 80% to 90 % fewer particulates compared to conventional OWBs.

Other New England states adopt OWB rules. New England states continue to serve as a model for the rest of the nation at addressing OWBs. Vermont was the first to regulate the boilers in 2003, and, in April 2007, required a particulate emission standard of 0.44 lb/MMBTU. Maine followed in 2007 with a requirement that outdoor wood boilers meet a Phase 1 emission standard by April 1, 2008 and Phase 2 by April 1, 2010. Since Maine adopted its regulation, New Hampshire adopted a regulation that requires OWBs that are sold after January 1, 2009 to meet Phase 1 or Phase 2 emission standards. New Hampshire's regulation also restricts the sale of OWBs to Phase 2 boilers after April 1, 2010. The State of Massachusetts has adopted a regulation that will restrict the sale of OWBs as of December 26, 2008 to models that meet the Phase 2 emission standard. Many other states across the northern tier of the US are also considering regulating OWBs. The number of municipalities and counties with their own OWB regulations in these states keeps increasing. As the cleaner and more efficient OWBs have come on the market, nationwide demand for them has increased even in areas where they are not regulated.

C. Unintended Consequences and Recommendations

The Department has identified several unintended consequences during the implementation of the Chapter 150 rule that can be corrected by legislative action. In addition, there is one other issue that the Department believes can be resolved without new action of Chapter 150.

Unintended consequences that require legislative action:

1. Analysis by a professional engineer: The Department received complaints of excessive smoke emissions from several commercial facilities that did not have the properly- sized OWB for its intended use. There have been several cases of undersized OWBs at commercial facilities using large amounts of hot water, such as car washes and laundries. These OWBs have the potential to emit excessive amounts of smoke as the demand for hot water fluctuates, and the OWB struggles to heat the cold water. Some OWBs were oversized for the space heating demand at residences resulting in excessive smoke emissions. As a result of these issues, the Department created provisions in Chapter 150 that required an analysis by a professional engineer (to ensure the proper OWB sizing for a customer's intended use) for all commercial OWBs or OWBs larger than 350,000 BTU/hr.

Unintended consequence: Consumers have found it difficult to find professional engineers to perform the required analysis, and some dealers and heating professionals have questioned the specificity of the requirement (suggesting there are other trained professionals capable of doing this analysis).

Recommendation: The Department recommends substituting "qualified professional, including professional engineer and master solid fuel technician," for "professional engineer" which will provide a wider range of options for consumers. Because of the size of the OWBs and the potential for impact to the public, it is important the OWBs are sized correctly for their intended uses and that they are installed according to manufacturers' recommendations as well as the required setbacks and stack heights in the rule.

2. Commercial outdoor wood boiler definition: A commercial OWB is defined in Chapter 150 as any OWB used to service a commercial establishment. The Department's intent was to include all commercial OWBs to ensure installation of the proper size boiler for the intended use.

Unintended consequence: Questions arose at the public hearing as to what sources are included as commercial. For example, does the logger who heats his shop with an OWB to maintain his equipment or a carpenter who chooses to burn his clean scrap wood need to hire a professional engineer to determine proper boiler size and siting.

Recommendation: The Department recommends the following language change to the commercial OWB definition:

> **"**Commercial outdoor wood boiler" means any outdoor wood boiler, excluding those outdoor wood boilers used solely for space heating and/or domestic hot water, used to service a commercial establishment.

This change will exempt those facilities that use their OWB for space heating and domestic hot water while those facilities whose hot water demands fluctuate will be subject to this section of the regulation.

3. Small wood chip boilers: With the increased interest by the public and businesses in burning with wood, there has been an increase in the number and types of wood heating appliances on the market.

Unintended consequences: The definition of OWB and outdoor pellet boiler do not specifically identify wood chip boilers as being subject to the regulation.

Recommendation: The Department recommends the definition of OWB be amended to include all biomass fuels including, but not limited to, wood chips.

4. Additional emission categories: The current Chapter 150 rule structure lacks incentives for manufacturers to produce cleaner OWB units. There is no incentive for manufacturers to develop units that go beyond the Phase 2 emission standard. One outdoor pellet boiler in the EPA Phase 2 Program has proven that technology exists to achieve particulate emissions as low as 0.06 lb/MMBTU output.

Unintended consequences: As Chapter 150 rule is written, there is little incentive for OWB manufacturers to provide cleaner emitting OWBs that exceed the current emission standard requirements. By creating a 'forward looking' emission standard and providing incentives such as less restrictive setback and stack height requirements, manufacturers may voluntarily develop cleaner burning OWB units.

Recommendations: The Department recommends the Legislature direct the Department to adopt a technology-forcing emission standard (lower emission standard) as an incentive for manufacturers to produce cleaning burning OWB units. This voluntary emission standard, if met, would allow for less stringent setbacks than existing Phase 2 requirements; and will reward those manufacturers, dealers, and homeowners who produce, sell, and buy cleaner and more efficient technology.

5. Buyback Program: Public Law 2009, Chapter 680, *An Act Establishing an Outdoor Wood Boiler Fund* directed the Department to adopt rules for a buyback and replacement program for nuisance OWBs. The Legislation established February 1, 2008 as the installation deadline for an older technology OWB to qualify for the buyback program even though the sell-through for certain older technology OWBs is April 1, 2009.

Unintended consequence: The BEP heard personal testimony, at the October 16, 2008 hearing, that recommended the February 1, 2008 deadline be eliminated. Based on our experience in the field with some controversial nuisance smoke complaints, the Department agrees with these suggestions. We believe that if an OWB is causing a nuisance, it should qualify for the buyback program as long as the installation met all regulatory requirements at the time of installation.

Recommendation: The Department recommends the February 1, 2008 statutory deadline be eliminated; and any OWB, that is causing a nuisance condition, be eligible for the buyback program.

6. Modular systems: A modular system, consisting of an indoor rated wood or pellet boiler installed in a modular structure or container with hot water connections to the building being heated/served by the boiler, is a new product on the market in Maine. These 'commercial sized' (500,000 to 3,000,000 MMBTU/hr input) systems are designed for installation at schools, small hospitals, colleges, supermarkets, hotels, offices and business parks and light and medium industrial facilities. Several companies interested in selling or buying this type of heating system believe they are exempt from Chapter 150, and from Department air emission licensing requirements.

Unintended consequence: During the extensive legislative and rulemaking hearings on OWBs, there were no discussions concerning these modular boiler systems. In fact, the Department hadn't anticipated this issue, and had only recently heard about the availability of some of these units for sale in the marketplace. With no regulation on particulate emissions, setbacks or stack heights, emissions from these modular units could potentially have significant local impacts.

Recommendation: The Department believes the definitions of OWB apply to stand-alone units and modular units made of components which together function as an OWB; and recommends statutory changes to clarify this issue. We also believe these modular systems should meet the particulate emission standards and setback and stack height requirements that apply to all outdoor wood boilers and outdoor pellet boilers.

Unintended consequences that can be resolved through interpretation of Chapter 150:

7. EPA's Voluntary Hydronic Heater Program: In January 2007, the Environmental Protection Agency and manufacturers of outdoor wood-fired hydronic heaters (OWHH), otherwise known as OWBs, initiated Phase 1 of the Voluntary EPA Outdoor Wood-fired Hydronic Heater Program to encourage the development and market availability of new, cleaner OWB models. As of October 15, 2008, the Phase 2 Program has begun. The Phase 2 Program includes OWBs that can burn biomass material other than wood (e.g. corn, pellets, etc) in addition to cordwood-fueled OWBs. It also includes hydronic heaters that are designed for indoor use and hydronic heaters that are equipped with heat storage units. Unfortunately, EPA's Phase 2 program does not include models that are either: 1) too large for manufacturer or laboratory scales, or 2) commercial models (i.e. models that generate 350,000 BTU/hr heat output or more). EPA evaluates OWB particulate emissions test data and lists units that qualify for the Phase 2 limit of 0.32 lbs/million BTU heat output on their website.

Under Chapter 150, those OWBs that have been certified through EPA's Phase 2 program can be sold in Maine. Although the Department has the ability to approve alternative certification methods for an OWB, at this time we rely primarily on the EPA Phase 2 certification program.

Unintended consequence: The EPA Phase 2 program no longer qualifies OWBs with a heat output rating greater than 350,000 BTU/hr., thus potentially placing the certification burden upon Department staff for those OWB units rated at 350,000 MM/BTUs/hr to 3,000,000 MM/BTUs/hr. The Department's workplan didn't take into account this potential additional workload. If a unit is not certified to meet the emission standards, it cannot be sold in Maine.

Recommendation: The Department recommends using the following alternative certification procedures: 1) allow for the submission of a European OWB certification provided it meets or exceeds Maine's particulate emission standard limits; 2) allow for submission of independent third party verification report that an OWB meets the emission standards of our regulation; and 3) allow for certification through the EPA's Environmental Technology Verification Program outside of EPA's Phase 2 OWB Program. Each of these methods is allowed under our existing Chapter 150 rules and no legislative action is required.

Summary of Recommendations for Legislative Action

- Legislative language requiring the Department to make the following recommended rulemaking changes:
    - Substitute "qualified professional, including professional engineer and master solid fuel technician," for "professional engineer". (Chapter 150 Section 3(D))

- Amend the following Chapter 150 rule definition: "'Commercial Outdoor Wood Boiler' means any outdoor wood boiler, excluding those outdoor wood boilers used for space heating and/or domestic hot water, used to service a commercial establishment.'" (Chapter 150 Section 2(B))

- Amend the Chapter 150 rule to add a technology-forcing emission standard (lower emission standard) as an incentive to manufacturers to produce cleaner burning units, and to reward these cleaner burning units with reduced setbacks. This would be a voluntary emission standard provision, unlike the mandatory Phase 1 and Phase 2 emission standards.

- The Department recommends the following statutory language changes:

  - Eliminate the February 1, 2008 deadline associated with buy back program eligibility requirement.

  - Amend the OWB definition to read as follows:

  'Outdoor Wood Boiler' means a fuel burning device:

  A. Designed to burn wood, biomass fuel products or other solid fuels;
  B. That the manufacturer specifies for outdoor installation or in structures not normally occupied by humans, including indoor rated devices housed in modular or containerized structures; and
  C. That heats building space and water through the distribution, typically through pipes, of a fluid heated in the device, typically water or a mixture of water and antifreeze.

Attachment II

Technology Review of Wood-Burning Hydronic Heating System Design

Date: **December 22, 2008**
Prepared For: **State of Maine**
Bureau of Air Quality
Department of Environmental Protection

Prepared By: Paul Tiegs, PE Oregon 52312
OMNI-Test Laboratories, Inc.
Portland, Oregon

INTRODUCTION

It is most likely that outdoor wood-burning hydronic heating systems (OWHHs), also known as outdoor wood boilers, outdoor wood furnaces and water stoves, were first used for heating homes and commercial spaces in significant numbers during the 1980s in the Mid-Atlantic States of the U.S. OWHHs are almost exclusively used in rural areas and over the last 10 years or so have gained widespread use in the Northern Tier of U.S. States, most of New England, and all of the Canadian Provinces and Territories. OWHH technology has also been adapted by several manufacturers for year-round utilization as domestic water heaters and even swimming pool heating.

OWHHs are generally large appliances some of which are large enough to produce up to 1 to 3 million Btus of wood-fired heat per hour. Typical residential OWHHs deliver upwards of 100,000 Btu per hour. Their fireboxes are more than 20 cubic feet and many have factory standard exhaust stack (ie, chimney) heights that only reach to about 12 feet above ground level. All OWHHs have a water jacket or other liquid-mediated heat-exchange system that surrounds the firebox, absorbs the heat produced by wood burning within the OWHH firebox, and transports it via insulated pipelines to the space(s) being heated.

In February of 2007, the U.S. EPA implemented a new two-phase emissions reduction program for OWHHs called a "Voluntary Partnership Program." In order for an OWHH model to qualify for participation in Phase 1 of the program, it must be tested and certified to have emissions of not more than 0.64 lb/million Btus of heat input. To qualify for Phase 2 of the program, which was implemented in October 2008, an OWHH model will have to be tested and certified to have emissions of not more than 0.32 lb/million Btus of heat output.

Figure 1 shows a schematic diagram of typical OWHH systems before the advent of Phase 1 of the U.S. EPA's Voluntary Partnership Program for Reducing OWHH Emissions and Figure 2 is a photograph of a typical OWHH installation.

Some common features of OWHHs are:

- They are located outdoors at convenient distances from the space(s)/homes being heated. This separation is unique to these types of fuel-burning residential or commercial heaters;

- They can usually accommodate split or un-split cordwood fuel pieces that are larger than 6 inches in diameter and 4 feet in length;

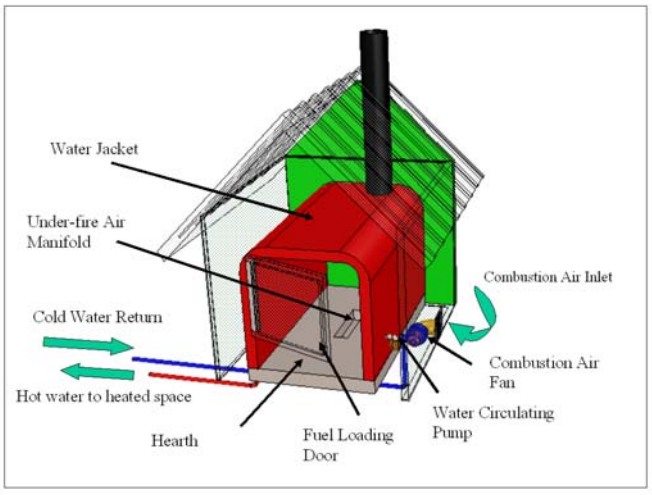

Figure 1. Schematic Diagram of Pre-2008 OWHH System.

Figure 2. Typical OWHH installation.

- Although most OWHH fireboxes can hold 1 to 3 days worth of fuel, there are some that can hold enough wood for a week's worth of heating during the heating season. The length of time between fueling will vary depending on operator practices and heat demand of the building(s) being served;

- Their heat output is controlled by increasing or decreasing their combustion air supply by way of a thermostatically controlled damper and/or an electrically powered air-supply fan; and

- ❖ At times, these units can produce and release large amounts of smoke (ie, particulate emissions) at times near-ground-level elevations causing nuisance and sometimes noxious air quality conditions at and around nearby residential areas or workplaces.

OWHH WOOD COMBUSTION

The general overall process of wood combustion is a series of heating stages and chemical reactions. The first stage of cordwood combustion, or any solid fuel for that matter, is general surface heating of fuel pieces which is usually accomplished by burning newspaper under or near some small fuel pieces (ie, kindling). As the surface of the kindling first starts to heat up, water on the surface of the wood is evaporated. As the surface moisture becomes depleted, the evaporation of water within the cellular and interstitial structure of the wood (ie, the true wood moisture) begins. Once the cellular and interstitial water within the wood structure becomes depleted, a chemical process called pyrolysis starts taking place.

Pyrolysis is a chemical reaction process that can take place with or without any oxygen from the surrounding air. It starts out as sort of a melting process whereby the cellular structure of the wood (consisting mostly of cellulose, lignin, etc.) breaks down and forms a tar-like liquid containing a milieu of organic and inorganic molecules. As this tar-like liquid, generally the bulk of which becomes what is commonly called "creosote," heats up further more molecular cracking and reformation reactions take place producing a multitude of new organic and inorganic chemicals including some that are gaseous like methane (ie, natural gas), carbon monoxide, and some that are liquid substances like benzo-a-pyrene, chlorinated dioxins, acetic acid, formic acid, and formaldehyde that can be toxic and/or carcinogenic to humans.

As the creosote, with its milieu of organic molecules, is heated further it evaporates into combustible vapors and migrates away from the surface of the wood. If oxygen from the surrounding air mixes with these vapors and their temperature is high enough to ignite them, they will oxidize rapidly (ie, burn) which in most cases produces enough heat to make luminescent flames and further heats the remaining raw or partially burned wood located in close proximity. If there is not enough oxygen mixing with the creosote vapors or their temperature is not high enough to ignite them, they will not burn. If these vapors remain unburned they move away from the heated wood, cool, and condense into tiny droplets or particles of liquid creosote; ie, wood smoke and aka, particulate emissions. Once all of the pyrolysis products have been evaporated and burned or emitted to the atmosphere as emissions, the remaining structural materials of the wood contain almost pure elemental carbon. This stage is characterized by glowing embers or coals, an increase in the production of carbon monoxide, a decrease to virtually zero particulate emissions, and is referred to as the charcoal stage of a burn cycle.

Virtually all wood smoke condensation produces very small particles; usually under 1 micron (one millionth of a meter) in diameter. This is an important fact because health scientists have found that particles of less than 2.5 microns are considered more dangerous than usually much larger common dust particles. This is due in large part to the fact that they are not filtered out by the usually effective dust filtering mucus membranes of the nasal and pharyngeal passages through which air has to pass on its way to the lungs. These small particles thereby penetrate deep into the lungs for direct deposition onto and absorption into lung tissues.

PARTICULATE EMISSIONS FROM OLD-DESIGN, PRE-2008, OWHHs

The basic combustion process that takes place in OWHHs, and other cordwood burning appliances as well, involves all of the wood-burning stages described above except that virtually all of those stages are taking place simultaneously at various locations within each fuel piece and/or across an entire fuel load. Combustion in old-design OWHHs is characterized by large amounts of the creosote vapors escaping the combustion zone unburned, condensing into particulate emissions, and then being discharged to the outdoor atmosphere as smoke.

Particulate emissions rates from old, pre-2008 OWHHs have been measured at up to 187 grams per hour (g/hr) as a weighted average of 4 tests conducted over a full range of low to high burn rates (or approximately equivalent to a weighted average of 15 lb/million Btus of heat output from the OWHH). The EPA's Phase 2 New Source Performance Standard for woodstoves promulgated in 1991[1] is a 4-test weighted average of 7.5 g/hr (or approximately equivalent to 1 lb/million Btus of heat output). This stark difference is not just due to the fact that the pre-2008 technology was not initially developed to provide low emissions, it is also due in part to the fact that OWHHs are mostly used for providing much more heat than the EPA-certified stoves can provide. In general, OWHHs are designed for whole-house heating whereas the EPA-certified stoves are generally referred to as "room heaters."

The disproportionately greater amount of emissions generated per hour by pre-2008 OWHHs when compared to most other types of wood-burning heaters is due to the following:

1. OWHHs are typically heating whole houses or buildings, not just parts of a house as is the case with most other wood-fired heaters including those regulated by the U.S. Environmental Protection Agency (U.S. EPA) under Title 40 of the Code of Federal Regulations Part 60 SubPart AAA;

2. OWHHs accommodate much larger fuel loads. Because the fuel loads for just about all cordwood-burning heaters are stacked into one pile in the firebox, when some of the fuel is burning, all of the fuel gets unavoidably heated to some extent. Of course, the fuel pieces closest to where combustion is taking place are heated the most while the fuel pieces that are further away are heated less. The fact that the old-design OWHHs have larger fuel loads than any other kind of wood-fired heater, not only causes greater amounts of wood to be subjected to the heating stage that generates the combustible gasses which form smoke particles, they also promote creosote formation.

3. Their burn rates are controlled mostly by thermostatically increasing or decreasing the combustion air supply in response to increasing or decreasing heat demands from the space(s) being heated. Because of this characteristic, the air supplied to vigorously burning fuel loads generated by heat demands from the space being heated is significantly reduced which, in turn, decreases the amount of combustion taking place as well as the amount of heat being produced. These air supply reductions cause the combustion of the gasses being released from the heated fuel to become air-

[1] Title 40 of the Code of Federal Regulations Part 60 SubPart AAA.

starved and significantly decrease or stop. The unburned gasses are then exhausted to the atmosphere as smoke.

4. Much of the combustion air entering the firebox enters from under the fuel load (ie, "under-fire air"). Air supplied from under the fuel load concentrates combustion zone heat under the fuel load invariably resulting in excessive amounts of gaseous combustible gasses being released without enough air to burn them.

5. Their fireboxes have heat exchange surfaces that transfer heat directly from the combustion zone to a liquid (most use water) being circulated in a water jacket around the firebox and then pumped to the space(s) being heated. This characteristic creates a combustion condition referred to as "quenching." Quenching is when the combustible gasses generated by the heated wood fuel are cooled below the temperature at which they will burn. Again, as these gasses condense they are exhausted to the atmosphere as smoke.

ACHIEVABILITY OF PHASE 2 PARTICULATE EMISSION STANDARDS FROM THE NEW 2008 OWHH DESIGNS

The U.S. EPA participated for over 4 years with the OWHH industry and several other air quality agencies from 4 states (including Maine), the Northeast States for Coordinated Air Use Management (NESCAUM), and Canada to develop a test method and emissions standard for OWHHs. A new two-phase U.S. EPA-managed voluntary emissions reduction program for OWHHs also resulted from this effort.

EPA Qualified Phase 2 OWHH Design

As noted above, the EPA initiated Phase 1 of this program early in 2007. Currently there are at least 10 OWHH manufacturers participating with new designs meeting Phase 1 requirements and among the first 10 models there are 3 cordwood boilers and 3 pellet boilers that already meet the Phase 2 requirements. It is estimated that the new designs now being built and sold will reduce emissions by a minimum of 80%. One of the cordwood models that is already meeting EPA's Phase 2 requirements reduces OWHH emissions by 92%. It is expected that by 2010, all new OWHH designs will be capable of reducing emissions by a minimum of 90%.

An added benefit to the combustion technology improvements of the Phase 2 OWHH is a corresponding improvement to efficiency of delivering heat from the fuel burned to the building(s) being served. Conventional OWHH heat efficiency ranged from 25% to 50%. The products of incomplete combustion (creosote) were released through the chimney without burning and utilizing the caloric value of these organic compounds. Additionally, the water jacket configuration provided a limited surface area for heat transfer. The new Phase 2 OWHH models provide better combustion and improved heat transfer. The delivered heat efficiency of the current Phase 2 OWHH cordwood models range from 66.3% to 74.94% based on the higher heating value of the fuel. A Phase 2 pellet OWHH achieve a delivered heat efficiency of 87.8% based on higher heat value of the fuel.

The significantly reduced emissions and improved efficiency from new OWHHs are due primarily to the following design improvements:

1. The use of under-fire combustion air in the combustion chamber/firebox is either being eliminated or has been significantly reduced in the OWHH designs in the market today. This new design concept helps prevent the excessive heating and concurrent gasification of whole fuel loads in a short period of time thereby significantly reducing a primary source of excessive emissions from OWHHs.

2. The typical water-jacket heat exchanger most commonly found up until now in OWHH designs is being replaced by first providing an insulated primary combustion chamber that is separate from an insulated secondary combustion chamber. The insulation serves to maintain the highest temperatures possible in both of those chambers. The combustion that takes place in the primary combustion chamber is very much like the combustion that takes place in the single combustion chamber (ie, firebox) of the older designs and therefore generates the same amounts and kinds of combustible gasses. However, as mentioned above, the older designs did not have a secondary combustion chamber and therefore those combustible gasses were exhausted directly into the chimney to become creosote deposition on the walls of the chimney and/or particulate emissions discharged to the atmosphere.

3. As combustible gasses leave the primary combustion chamber and enter the secondary combustion chamber in the new OWHH designs, additional combustion air (ie, secondary air) is added to enhance and optimize the combustion of the remaining combustible gasses leaving the primary combustion chamber. The separate primary and secondary chambers provides for the best combustion conditions for burning the gasses generated by batch loaded cordwood; ie high temperatures, additional oxygen, and additional time to complete the combustion reactions. In addition, the bulk of the fuel mass or fuel pile is not exposed to the really high temperatures attained in the secondary combustion chamber, and therefore, do not generate excessive amounts of the combustible gasses that would otherwise not have high enough oxygen and/or not enough time to burn to completion and therefore go on to form particulate emissions when exhausted to the atmosphere.

   Some of the new models also have “down-drafted” flue-gas pathways downstream from the secondary combustion chamber giving combustible gasses more time to complete the combustion process. Once the combustion gasses leave the secondary combustion chamber, they pass over either a re-located water jacket or a set of heat-exchange tubes that extract the heat from the hot exhaust gasses, transfers that heat into the circulating liquid media, and convey it to the space(s) being heated. Figure 3 shows a typical new-design OWHH system.

4. In the late 1980s a new pelletized-wood-burning technology was introduced in the market place for residential and commercial space heating. Since their introduction, the technology has seen a continuous line of improvements in combustion and overall thermal efficiencies with the most recent models having the capability to produce very low emissions. Although some of the newer models are designed to burn other biofuels like dried corn kernels and pellets made from other bio-feedstocks like nut shells, cheat grass, and olive pits, the overwhelming majority of pellets currently being burned for residential and commercial space heating are made from wood. Because of their efficient and clean-burning characteristics and the growing availability of pelletized biofuels, pelletized fuel burning technologies are being adapted to work in some of the newest OWHH models. It is estimated by this author that emissions from new pelletized-wood-burning technology can be as low as 0.1 lb/million Btus of heat output.

Pelletized fuel-burning systems provide cleaner and more efficient combustion than can be attained by cordwood burning systems because they are designed to control how fast or slow fuel is burned, the ratio between the combustion air supply and the amount of fuel being burned, the amounts of fuel burning at any one time, and even the mechanics of how the combustion air and fuel are mixed in a "burn pot." Most pellet-burning heaters use a motor-driven auger to deliver fuel pellets to the burn pot within which the proportionally-metered combustion air is supplied. In virtually all models the rates at which these processes take place is governed by the heat demand sensed by a thermostat located in the space being heated. All of these processes are coordinated by electronic logic boards that have been developed specifically for optimizing pelletized fuel combustion and providing high thermal efficiencies and low emissions. These logic boards are intended to optimize the combustion process by receiving input from temperature sensors located at critical indicator locations in the combustion system. In addition, there are at least two new pellet-burning models that use lambda oxygen sensors to optimize the ratio between the amount of combustion air and the amounts of fuel being metered into the burn pot.

5. Other Possible OWHH Emissions Reduction Design Considerations

    a) Catalytically-Active Combustors: Some OWHH manufacturers are experimenting with catalytically-active combustors (i.e., afterburners) to reduce emissions. The catalytic combustors being considered are virtually the same as the catalysts used in EPA-certified woodstoves and very much like the ones used to burn emissions from automobile exhaust gasses. These combustors consist of a ceramic honeycomb or ceramic sponge-like structure that allows exhaust gasses to pass through a bundle of honeycomb-like channels or sponge-like reticular pathways that are typically 2 to 4 inches long. As the unburned components of the exhaust gases pass through the catalyst structure they react with the catalyst-containing wash-coat that has been applied to ceramic surfaces that come in contact with the exhaust gasses.

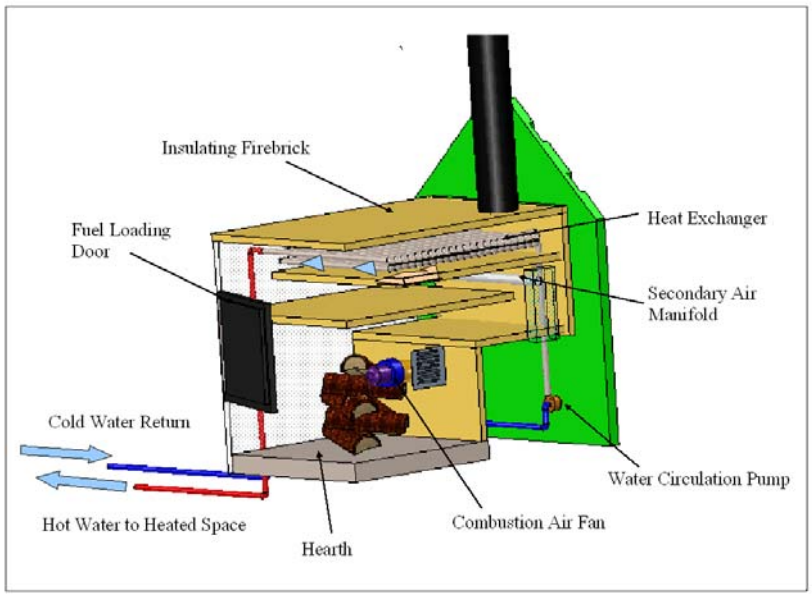

Figure 3. Typical New OWHH Technology Design

The wash-coats used in most catalysts contain catalytically-active materials which are mostly oxides of metals such as platinum and/or palladium and sometimes rhodium. The catalytically-active materials act to lower the temperature at which combustible gasses, like those from car engines and the primary combustion of burning wood, burn. When these catalytically-mediated combustion reactions take place, they further heat the combustion gasses which, in turn, further enhance the combustion of the flowing gasses coming from the wood in and OWHH primary combustion chamber. Catalytic combustors used in this way serve as a secondary combustion chamber.

b) Heat Storage: Since the combustible gasses from wood burn most efficiently when they are at high temperatures, high concentrations, and mixed with adequate air, they burn best when the wood is burned hot and fast. Because OWHH heat demands are very seldom at maximum capacity all of the time, an OWHH system consistently running at maximum would have to waste a lot of heat when heat demand inevitably decreases. To overcome this problem, there are some OWHH manufacturers experimenting with storing the heat produced by hot, fast, and clean combustion and using it at a later time when heat demand calls for it. The large quantities of heat being produced by hot, fast and clean combustion can be stored in media such as water or anti-freeze until it is needed. The heat storage approach has been used for many years in other types of heating systems made in Europe and in North America. Adapting heat storage to OWHH designs will most likely occur in the next few years.

c) Afterburners: Afterburners are also a type of secondary combustion chamber. They are devices that are installed into the exhaust stream that contains combustible gasses and burn those combustible gasses by adding or injecting heat energy from external sources, into the exhaust gasses that contain

combustible matter. The heat for these devices can be generated by electricity or some fuel like natural gas or propane. The problem so far with adapting afterburner technology to OWHHs has been the amount of energy that is required to accomplish a significant reduction in emissions. The amount of energy needed to eliminate all of OWHH emissions has been reported to equal the total amount of heat generated by the burning fuel in an OWHH.

d) Precipitators: Precipitators use electrically-charged probes located in the exhaust stream of a wood-burning appliance to put a negative electrical charge on emissions particles passing by the probes. The precipitator then uses a positively charged electrical field to attract those particles to the surfaces of some metal plates thereby removing them from the exhaust stream. This process works very much like the attractions that occur between objects that are charged by static electricity. Although there have been considerable efforts made to adapt precipitators to all kinds of wood-burning appliances, there has not been any reported successes. The problem has not only been the amount of energy it takes to impose charges on the emissions particles but once deposited on the collection plates, the emissions particles, which when accumulated have a consistency of thick tar, are very difficult to clean for maintaining their effectiveness.

ABOUT THE AUTHOR

Paul Tiegs, P.E.
Vice President
OMNI Environmental Services, Inc.

SUMMARY OF PROFESSIONAL QUALIFICATIONS

Mr. Tiegs has over 36 years of experience in the technical engineering and management fields. He remains involved with the development and revision of national and international standards pertaining to the safety, efficiency, and emission performance of hearth products.

Mr. Tiegs is recognized internationally as an expert in the field of hearth product emissions characterizations, safety testing, and engineering evaluations. Mr. Tiegs was involved in several projects that generated information and data used in support of the development of the U.S. EPA's wood-fired heater New Source Performance Standard (NSPS: 40 CFR Part 60, Subpart AAA), and in 1998 he managed an OMNI project for the EPA to evaluate the NSPS and define states-of-the-art for residential wood combustion technology and testing. He has also managed several projects to develop methods for woodheater emissions and thermal efficiency testing. Under contract to Washington State, he provided technical support for the development of the States fireplace emissions standard. He also provided technical support for the development of masonry heater standards by the State of Colorado and fireplace standards proposed by the Northern Sonoma County, California Air Pollution Control District. He has participated on the ISO Technical Sub-Committee ISO TC116(3) for the development of a solid fuel room-heater standard addressing the thermal output, efficiency, flue gas emissions, and clearance from combustible surfaces. He has provided consultation to the Hearth, Patio & Barbecue Association for the ASTM development of air emissions test methods for fireplaces, masonry heaters, and outdoor hydronic boilers. He holds patents for a virtual witness testing procedure which allows manufacturers the convenience and cost benefits of certification testing new heating appliances at their own plant facilities with their own engineers and technicians.

EXPERTISE
Standards Development
Air Emission Testing
Safety Testing
Testing Laboratory Management
Solid- and Gas-Fueled Appliance Design
Emission Measurement Instrumentation

EDUCATION AND ENGINEERING LICENSE
B.S. Biology, University of Illinois
M.S. Chemistry, Western Washington University
Registered Profession Engineer (PE), Oregon # 52312PE