
**BIOMASS BOILER & FURNACE
EMISSIONS AND SAFETY REGULATIONS
IN THE NORTHEAST STATES**

**EVALUATION AND OPTIONS
FOR REGIONAL CONSISTENCY**

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**by:
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Disclaimer

This report was prepared for the CONEG Policy Research Center, Inc. (Center) under contract to the Massachusetts Department of Energy Resources (DOER). Technical research, supporting documentation, and discussions with boiler manufacturers, regulators, and standard setting organizations was carried out by technical consultants Rick Handley & Associates, and Northeast States for Coordinated Air Use Management (NESCAUM). Preliminary findings were reviewed by an Advisory Group. Funding was provided to the Center under Cooperative Agreement # RFR ENE-2008-017 with the DOER. The findings and recommended state actions are those of the technical consultants and do not represent the official views of the DOER, the Center, nor the states, organizations and companies represented on the Advisory Group.

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PREFACE

The Massachusetts Department of Energy Resources (DOER) approached the CONEG Policy Research Center, Inc., for assistance in developing a concise, objective analysis on whether the northeast states' air emissions regulations and safety certifications for residential and institutional-scale biomass boilers and furnaces pose a barrier to creation of a viable northeast market for domestic and non-U.S. biomass heaters and boilers; and if so, various strategic actions that could be taken to reduce such barriers and create a more attractive regional market for high performance biomass boilers – either developed domestically or abroad.

The report and its findings are intended to provide public officials, state policy makers in the northeast and mid-Atlantic states, and the regional and international biomass industry with information on the role that regionally compatible air emissions and safety standards and certification can play in supporting an expanded northeast market for renewable biomass consistent with maintaining safety and the environment.

This report was prepared for the CONEG Policy Research Center, Inc. (Center) by a research team composed of Rick Handley and Associates, Ray Albrecht, and staff at the Northeast States for Coordinated Air Use Management (NESCAUM). The research team brings expertise in federal-state and multi-state policy and regulatory institutions, as well as extensive experience in technical regulations, standards, and policy for air quality, safety and certification standards for residential and institutional heating equipment, and biomass systems. The data and information were developed through a combination of surveys and analysis of all relevant U.S. (state, federal and regional) and European Union (EU) air emissions rules; a similar survey and analysis of applicable safety standards and certification procedures; interviews with state environmental and safety regulatory officials as well as representatives of boiler manufacturers and safety standards-setting organizations; and analysis of existing emissions and safety performance research reports. Where available, information on Canadian safety requirements was also examined to provide a more complete picture. Drawing upon this analysis, the research team developed a set of findings and action options for the Massachusetts DOER to consider. An Advisory Group composed of state regulators, representatives of standard-setting organizations, and manufacturers reviewed the interim report for accuracy and clarity, but was not asked to endorse its findings. The final report is submitted by the Center to DOER for its consideration and follow-up action.

This report is commissioned by the DOER as part of its mandate to promote policies and programs that ensure that Massachusetts' citizens have access to adequate, diverse energy supplies that are available at reasonable cost and with minimal impact on the environment. Funding was provided by DOER as part of the Massachusetts Sustainable Bioenergy Initiative.

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EXECUTIVE SUMMARY

The northeast region of the United States appears to be a logical market for biomass energy systems. The region has significant wood-based resources, yet is dependent upon fuel oil for residential and institutional heating more than any other region of the country. Wood combustion, however, is one of the largest sources of primary particulate matter (PM) air pollution in the United States. What will be the outcome of the potential tension between rising public interest in biomass-based heating systems and public concerns with emissions and health impacts of such systems? Emission standards are becoming more stringent. Will they limit the market for biomass heating systems – with the potential underutilization of a regionally based energy resource; or lead to the emergence of a larger northeast market featuring more energy efficient, lower emitting biomass technologies?

The report examines the U.S. federal, northeast states, and European emissions and safety regulatory requirements that shape the current technologies and markets for residential and commercial biomass-based heating and power systems. It draws upon surveys of the relevant emissions and safety regulations, analysis of research reports, and interviews with public regulatory officials and representatives of U.S. and European regulatory and standard-setting organizations and manufacturers. The report describes the similarities and differences in the U.S. and European approaches to regulating the emissions and safety performance of heating systems, the implications for emissions and safety performance, and the challenges and opportunities to obtain greater compatibility among differing U.S. and European approaches. These are briefly summarized below.

Air Emissions Regulations and Performance:

In the U.S., federal and state air emission regulations for biomass combustion devices differ on the scope of what is covered and how the devices are regulated. While the U.S. regulates by type of device, fuel, and heat outputs, the European Union (EU) regulates by heat output and fuel feeding methods. The performance based approach in Europe results in no loopholes and a leveling of the regulatory playing field.

Differing Emission Regulatory Requirements

- Federal New Source Performance Standards (NSPS) currently apply to a limited number of residential devices (primarily indoor woodstoves) and to larger industrial, commercial and institutional (ICI) boilers (> 30 MMBtu). EPA has a voluntary labeling program for such devices as outdoor wood boilers and fireplaces; and has pending regulations for all non-residential boilers, regardless of size or fuel type.
- Northeast states' emission regulations for ICI wood-fired devices vary significantly, but are more extensive in scope than federal regulations. Even so, the most stringent state emission standard for wood boilers is significantly less stringent than those for other fuel sources. Furthermore, there are limited regulations for residential wood-burning devices, and those that exist tend to focus on use (e.g., no burn days), or emissions standards more stringent than

federal regulations, or regulate devices not covered by federal regulations (e.g., outdoor wood boilers).

- EU emission standards are significantly more stringent than U.S. federal and state standards. Based on recent national and local government activity in Europe, these regulations are tending toward lower limits. While they may be challenging to manufacturers, they may also force additional research and inter-company alliances to achieve best-in-class performance capability.

Differing Emission Performance of U.S. and EU Technologies

- In the U.S., current wood-fired technologies for residential heating and small-medium size biomass boilers are lightly regulated and have higher particulate matter (PM) emissions than similar technologies using oil or natural gas.
- Since older residential devices have lengthy change-out rates and can be sold in a secondhand market, they will continue to be a major contributor to overall particulate matter levels in ambient air.
- The absence of federal or state regulations for small and medium sized biomass boilers in the U.S. does not provide the requirement or incentive for manufacturers to reduce emissions.
- European residential and ICI boilers have far better emissions performance than comparable U.S. technologies due to European design characteristics.
- Test method protocols for residential wood-fired devices differ significantly in the U.S. and EU and can affect analyses of emission data.
- Test methods for commercial devices are fairly similar and emission data results should be comparable.
- New biomass boiler technologies in the U.S. and EU are a response to government policies and regulations intended to increase energy independence and achieve economic benefits. These technologies, which approach 90 percent efficiency (compared to the 70-80 percent efficiency of current U.S. boiler technologies), demonstrate that it is possible to achieve low emissions and high efficiency.

Safety Standards and Certification Requirements

Heaters and boilers in the U.S. and Europe, regardless of fuel type, are subject to a blend of safety standards, design and construction process codes, and testing protocols. While governments – U.S. federal and state and EU – require adherence to standards and testing protocols, independent organizations actually set and test to technical specifications. Similar to the differing approaches to air emissions testing, the U.S. and EU also have different approaches to safety certifications, depending on the type of device, its use in a residential or commercial-industrial setting, and its size/heat output.

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- The U.S. sets standards, tests, and labels for materials and construction through a prescriptive code designed to ensure a safe product. It has no specific provisions for biomass units.
 - The EU sets standards, tests, and labels for performance (e.g., safety as well as heat output efficiency and emission) specifically for residential solid fuel heaters/furnaces and commercial boilers.
 - For room heaters and residential furnaces, similar testing is conducted under U.S. and EU protocols, but there is little reciprocity in testing, due in part to the EU testing for emissions and efficiency.
 - The U.S. and EU safety standards appear to provide comparable levels of safety based on field experience. However, multiple differences in U.S. and EU testing requirements affect a manufacturer's ability to implement a common design and for biomass boilers that can satisfy the code requirements of both the U.S. and EU. A manufacturer may need to satisfy multiple safety certifications with limited impact on actual safety performance.
 - Northeast states have the same testing and labeling requirements for residential wood and pellet stoves and inserts. However, standards and exemptions for boilers used in residential units vary from state to state. The inclusion of residential boilers in state or local building codes adds to the complexity of requirements, and may have unintended consequences for the purchase, installation, and use of solid fuel heating equipment.

Challenges and Opportunities for State Action

Challenges

- Higher efficiency and lower emitting biomass units may face a cost disadvantage when competing with units that have higher emissions and lower efficiency. Some factors that affect boiler efficiency and emissions performance can be designed into the technology and influence its construction costs, such as combustion chamber design, computer-based combustion control system, flue gas recirculation, automatic de-ashing, automatic heat-exchanger cleaning, automatic ignition, and the addition of thermal storage. However, other performance factors, such as fuel quality, boiler operation and maintenance, chimney height and location, and the addition of emission control devices, are not incorporated into the boiler construction and cost.
- Significant variation among northeast state air emission regulations for biomass boilers may further complicate the ability of manufacturers and distributors to achieve market "economies of scale" if a particular biomass boiler design cannot meet these varying requirements in an already small market.
- More stringent pending EPA emission rules for all boilers (regardless of fuel type) may expand the market for cleaner, more efficient boilers. Many European manufacturers of commercial biomass boilers expect to meet the pending EPA emissions standards.

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- In spite of differing regulatory systems, the emissions performance results of commercial biomass boilers tested in the U.S. and EU can be compared. However, such a comparison for residential biomass units is difficult. Additional research on European units under both test methods is needed to better understand the ramifications of test methods.
 - A comparison of the safety performance of the prescriptive U.S. code (ASME BPVC-Section IV) and the performance-based European standards (ENE-303-5) does not indicate any significant safety risks between boilers built to either requirement. However, the complexity of meeting the ASME prescriptive standard may be a deterrent for entry into the northeast market for EU manufacturers whose boilers are EN 303-5 compliant. Many states are concerned that opening up the northeast market to non-ASME certified European technologies could raise liability issues for states.

Opportunities for State Action

The availability of higher efficiency, lower emitting biomass heaters and boilers in the Northeast could be enhanced by region-wide discussions of the impact of efforts to address state safety requirements and regulatory hurdles that keep such units from the market or result in higher costs without providing corresponding public safety benefits. The establishment of consistent, lowest achievable air emission standards to reduce pollution and public health impacts could also level the playing field for the more efficient biomass units.

Northeast states may wish to consider the following individual and joint actions to encourage the availability of such high efficiency, lower emitting units in the Northeast.

- Participate in U.S. EPA's rulemaking to establish an area source rule and maximum achievable control technology (MACT) standard that protects public health and permits the expansion of biomass heating;
- Extend regulatory emission efforts to residential units to ensure protection of public health and to provide an even playing field among the various residential devices;
- To stimulate the market, work with other northeast states to identify and support federal tax incentives to fund retrofits of existing ICI units and change-outs of residential units once appropriate emission standards are in place;
- Support additional work to allow the direct comparison of efficiency and emission testing methods between the U.S. and EU technologies, and encourage the adoption of efficiency requirements for U.S. manufactured biomass technologies;
- Identify and support options to encourage research on biomass combustion technologies that can meet and exceed federal emissions requirements.
- Identify and support federal and/or regional incentives for business and homeowners to purchase new cleaner, high efficiency biomass technologies;

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- Work with state boiler boards and code officials to investigate an ASME standard that meets all safety requirements, while providing a cost effective process to achieve an ASME Code stamp for EU manufactures; and
 - Work with state economic development agencies and EU manufacturers to promote the production of EU technologies in the Northeast.

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INTRODUCTION

Can renewable biomass be part of the solution for providing adequate, diverse, reasonably priced energy supplies with a minimum impact on the environment? That is a fundamental question specifically facing policy-makers in the Massachusetts Department of Energy Resources. But it is also a question confronting other state and federal policy makers, providers of energy resources and technologies, and the many individuals and businesses who invest in residential and commercial energy systems.

The Northeast¹ appears to be a logical market for biomass energy systems. It has significant wood-based resources. More than any other region of the country, the Northeast is dependent upon fuel oil for residential and institutional heating – 36 percent or nearly six million homes in the Northeast use heating oil. Biomass technologies, including pellet stoves, furnaces, and boilers, could easily replace a portion of that market for heating oil, and also provide savings to the consumer and create regional jobs. Industrial, commercial and institutional (ICI) boilers are another potential market for biomass conversions throughout the region. Even a modest conversion of the Northeast’s heating oil market holds the potential to create a significant regional industry and related jobs in regionally-produced fuel and equipment sales.

However, wood combustion is one of the largest sources of primary particulate matter (PM) pollution in the United States.² In some localities, wood combustion has been identified as the source of 80 percent or more of all ambient particles smaller than 2.5 microns in diameter (PM_{2.5}) during the winter months.³ As wood and other biomass combustion increases in popularity particularly for residential use, local, state, regional and federal government agencies charged with protecting air quality and public health have become more concerned about the health impacts of wood combustion. Numerous health studies have linked short- and long-term exposure to elevated levels of PM-fine with a wide range of damaging impacts on the circulatory system and lungs.⁴ The public health concerns intensify when wood-burning units are located in homes, schools or hospitals in close proximity to sensitive populations, such as children, asthmatics, and individuals with pre-existing respiratory disease or cardiac problems.

What will be the outcome in the Northeast of this potential “tension” between the rising public interest in biomass-based heating systems and public officials’ concerns with emissions and health impacts? Will increasingly stringent emission standards force biomass heating systems off the market – with the potential loss of a regionally based energy resource? Or will more energy efficient, lower emitting biomass technologies emerge in the northeast market? Both biomass advocates and air quality regulators acknowledge that the expanded use of renewable

¹ “Northeast” hereafter refers to the following project study area states: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, Pennsylvania, New York, and New Jersey.

² Based on analysis of EPA wood combustion estimates and 2002 National Emissions Inventory Data.

³ McCrillis, R. C. In-House Performance of New Technology Wood Stoves, EPA/600/D-90/026, EPA/600/D-90/026. Schwartz et al. 1993.

⁴ NYSERDA. Assessment of Carbonaceous PM_{2.5} for New York and the Region. March 2008. Document available at http://www.nescaum.org/documents/assessment-of-carbonaceous-pm-2-5-for-new-york-and-the-region/carbonaceous_pm_2-5_volume_i.pdf.

biomass as a heating fuel will require the ready availability of lower-emitting biomass technologies in the northeast market.

In the United States, the market for biomass boilers is currently met by a small number of specialty biomass boilers manufactured domestically and an increasing number of imported boilers manufactured in Europe. Many U.S. boiler manufacturers have been slow to produce biomass boilers due to the perception of limited market demand and higher costs for compliant equipment that can meet the differing state emission regulations. Europe has implemented a government strategy of emission limits that ratchet down to force continual improvement, combined with a robust incentive program, to support the development and use of new technologies. This has contributed to improved biomass boiler designs and increased market penetration for manufacturers. New European designs typically incorporate the use of staged-combustion designs that achieve high energy efficiency and very low emissions of PM, PM_{2.5} and carbon monoxide. The use of wood and biomass resources and the sale of wood/biomass heating equipment have increased dramatically during the past ten years in much of Western Europe.

Many European manufactured biomass boilers and furnaces appear to be less polluting and have higher delivered heating efficiencies than similar U.S. manufactured technologies. Several U.S. companies currently import European manufactured wood and pellet furnaces and boilers. In conversations with the research team, some companies state that imported European technologies face institutional and regulatory challenges in two areas: variations among states' environmental standards for biomass boilers, and the added cost associated with meeting incompatible safety inspection and certification programs for European and U.S. markets.

U.S. (federal and state) as well as EU air emissions and safety regulations are critical determinants of the ability to market biomass-fueled furnaces and boilers in the Northeast. Can regionally compatible air and safety regulations encourage major U.S. boiler manufacturers to enter the biomass market; or will the region be dependent on a limited number of U.S. and European specialty biomass boiler manufacturers? Will states seek compatibility between U.S. and European safety certification, or will European manufacturers have to make a market-related decision to meet both U.S. and EU safety requirements? What research or documentation will states require to accept European certification programs as meeting U.S. safety requirements? How will such possible changes be reflected in the ultimate cost to consumers – or the availability of more energy efficient biomass-boilers in the northeast market?

This report examines the variation among northeast state air regulations and safety standards, and explores whether these variations may deter the import of lower-emitting European biomass technology or the investment by U.S. manufacturers in similar new advanced technology. The report:

- reviews current U.S. federal and northeast states, and EU air emission regulations applicable to residential and commercial biomass combustion devices;
- examines current studies of actual emissions performance of biomass boilers manufactured in the U.S. and Europe, and compares the measured performance to current and possible future U.S. emissions standards;

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- assesses the likely impact of proposed federal area source, new source, and hazardous air pollutant regulations on expanded use of biomass technology;
 - reviews the safety standards and certifications required for the sale, installation, and use of biomass room heaters, furnaces, and boilers in the U.S., compared to similar EU requirements;
 - analyzes the similarities and differences between the U.S. and EU safety requirements and whether greater compatibility might be possible; and
 - identifies several options that can be taken by the northeast states to encourage an expanded market for higher efficiency, lower emitting biomass heaters and boilers.

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AIR EMISSIONS & WOOD HEATERS AND BOILERS: REGULATIONS AND MEASURED PERFORMANCE

U.S. AND EUROPE

In the U.S., federal and state air emission regulations for biomass combustion devices vary in the scope of what is covered and how the devices are regulated. While U.S. air emission standards typically regulate by type of device, fuel and heat outputs, the EU emission standards regulate by heat output and feeding device. The performance based approach in Europe results in no loopholes and a leveling of the regulatory playing field.

As tests of U.S. and EU biomass technologies demonstrate, the differing U.S. and EU approaches to air emission requirements, particularly for particulate matter (PM), result in significantly different efficiency and emissions performance that can be attributable to differing design characteristics.

Air Emission Regulations: U.S. and Europe

Overview: U.S. Federal and State Requirements

Federal and state air emission regulations vary significantly for biomass combustion units, whether residential or commercial. At the federal level, only indoor woodstoves and large industrial boilers larger than 30 MMBtu are subject to federal New Source Performance Standards (NSPS) regulations. Outdoor wood boilers/furnaces and low mass fireplaces can obtain labeling on their emissions via EPA's voluntary labeling program. At the state and local level, air pollution control regulations vary significantly. Nationwide, twenty-six states have state legislation that either completely or partially precludes them from applying emissions standards that are more stringent than federal requirements.⁵ Table 1 provides a summary of federal and northeast state regulations for biomass fired devices. While the state and regulatory schema may be uneven, this study did not empirically address the issue of variation in air pollution control regulations acting as a barrier to market demand. However, some manufacturers of the lower emitting devices have stated that the lack of stringent regulations means they must compete on a cost basis with higher emitting, less efficient technologies.

⁵ Exceptions have been made when a state agency had more stringent restrictions or programs in place prior to the federal program (e.g., air toxics controls); the agency can demonstrate significant benefits or need, or can provide a strong justification for specific situations; the agency must adopt more stringent requirements in a State Implementation Plan (SIP) necessary to meet a National Ambient Air Quality Standards (NAAQS) in certain areas; or the agency has a more stringent program limited to certain types of sources or pollutants.

Table 1: Summary: Federal and Northeast State Regulations for Biomass Devices

Device Type	Federal	Northeast States
<i>Fireplace</i>	<ul style="list-style-type: none"> • Exempt from residential wood heater NSPS • EPA voluntary program under development 	<ul style="list-style-type: none"> • No applicable state regulations
<i>Indoor woodstove</i>	<ul style="list-style-type: none"> • Subject to residential wood heater NSPS • Standard set in 1988 (CAA requires review of standard every 5 years) • EPA working on review 	<ul style="list-style-type: none"> • No applicable state regulations
<i>Pellet stoves</i>	<ul style="list-style-type: none"> • Loophole in residential wood heater NSPS exempts most units 	<ul style="list-style-type: none"> • No applicable state regulations
<i>Coal and other residential solid fuel stoves</i>	<ul style="list-style-type: none"> • No applicable federal regulations 	<ul style="list-style-type: none"> • No applicable state regulations
<i>Indoor wood furnace/boiler</i>	<ul style="list-style-type: none"> • No applicable federal regulations • May participate in EPA OWHH voluntary program 	<ul style="list-style-type: none"> • No applicable state regulations
<i>Outdoor wood boiler/furnace</i>	<ul style="list-style-type: none"> • EPA voluntary program 	<ul style="list-style-type: none"> • State emission standards in MA, ME, NH, VT • Pending action in RI, NJ, NY
<i>Other residential solid fuels – coal, grass, corn</i>	<ul style="list-style-type: none"> • No applicable federal regulations 	<ul style="list-style-type: none"> • No applicable state regulations
<i>Under 10 MMBtu</i>	<ul style="list-style-type: none"> • No applicable federal NSPS regulations • Area source rule in 2010 will impact all institutional, and industrial boilers for mercury and carbon monoxide emissions 	<ul style="list-style-type: none"> • Limited state regulations, • See Figure 1 for size triggers and emission limits
<i>10-30 MMBtu</i>	<ul style="list-style-type: none"> • Units burning liquid fuels must comply with federal boiler NSPS • Units burning solid fuels, such as biomass, exempt from federal NSPS 	<ul style="list-style-type: none"> • State regulations vary significantly • See Figure 1 for size triggers and emission limits
<i>>30 MMBtu</i>	<ul style="list-style-type: none"> • Boiler NSPS • May be subject to industrial boiler MACT 	<ul style="list-style-type: none"> • New Source Review permitting

Federal Regulations: Residential

Current federal regulations for residential biomass devices have limited applicability. EPA regulates a limited number of residential devices, primarily indoor woodstoves, under the federal New Source Performance Standard (NSPS) for residential wood heating devices. This regulation requires all new devices to meet an emission standard, but does not affect existing appliances. Detailed information on this regulation can be found in Appendix B. The Clean Air Act requires EPA to review and update NSPS limits every five years; but such a review has not been performed in the past twenty years.⁶ EPA has implemented a voluntary labeling program for some residential devices, such as outdoor wood boilers and fireplaces. These programs, which

⁶ The research team understands that EPA has begun a review of the emission standard but as of the writing of this document, EPA had made no decision about potential revision of the regulation.

do not mandate performance levels for all units, do provide emissions data that the consumer can use to identify cleaner units. Units that emit more pollution are not labeled in this program.

Federal Regulations: Industrial, Commercial and Institutional

Federal NSPS regulations for ICI biomass boilers apply only to units larger than 30 MMBtu. However, under court order, EPA is mandated to propose area source regulations by September 2009 that is likely to impact all non-residential boilers (existing and new) regardless of their size or fuel type. Under court order, EPA will propose an area source rule for ICI boilers, and a maximum achievable control technology (MACT) rule for large industrial boilers that will set federal emission standards for all new devices and also place requirements for existing units. The form and type of standard to be proposed is still under discussion.

Under the pending area source and MACT boiler rules, the standards for new and existing sources may be identical or they may differ. For new units, EPA must adopt an emission standard based on “best performance” for a boiler installed in the United States. When promulgated, it is likely that the rule will require new units to meet national standards that are significantly more stringent than current state regulations. Based on the technical information the Agency has reviewed to date, EPA has indicated that it will propose an emission standard based on performance using high efficiency fabric filters.⁷

State Regulations: Residential and Industrial, Commercial and Institutional Boilers

Residential wood-burning devices in many instances have no state regulations. In limited instances, state or local regulations mandate use patterns (e.g., no burn days), or types of devices used (e.g., removal of uncertified devices upon transfer of property ownership). State regulations may also set emission standards that are more stringent than federal regulations, or regulate devices not covered at the federal level (e.g., outdoor wood boilers). These state regulations focus primarily on woodstoves, fireplaces, and outdoor wood boilers. Typically, they do not impact residential indoor biomass furnaces or boilers.

In contrast, many states have regulations that may impact ICI boilers. These regulations vary significantly from state to state in terms of the scope and applicability. Table 2 provides an overview of state requirements for eight northeast states. Some states regulate sources not covered under federal requirements by using state minor new source permitting or state air toxics programs. Some states regulate boilers as small as 1 MMBtu up to 10 MMBtu (or may use some other measurement such as horsepower). Some states regulate the aggregate Btus,⁸ while other states base the thresholds on tons per year of emissions.

In the northeast states, the size thresholds vary from 1 to 10 MMBtu. Many of these standards were adopted in the early 1970s and need to be updated as states move forward with their PM_{2.5}, State Implementation Plans (SIPs) and other particulate matter reduction activities. NESCAUM

⁷ EPA, Update On Federal Air Pollution Regulations for Smaller Commercial/Institutional Boilers, January 29, 2009, contained in Appendix C.

⁸ “Aggregate Btus” means that if there are multiple boilers deployed at a location, the total Btus of all boilers is added together to determine regulatory status.

is developing a model rule to assist states in updating their state regulations for small to medium sized biomass boilers.

In addition, state air toxics programs typically adopt health-or risk-based standards that limit concentrations of certain pollutants from the stack or at the property line. Variations in state regulations may lead to additional testing and control requirements. To date, the most stringent state emission standard for a wood boiler smaller than 20MMBtus is 0.10 lb/MMBtu. In comparison, other fuel sources must meet significantly more stringent emission standards. For instance, a similarly sized new coal unit may need to meet an emission standard 0.015 lb/MMBtu.

Table 2: Northeast State Emissions Requirements – Industrial, Commercial and Institutional Boilers

State	Emission threshold	Limit(s)
Connecticut	Unit has the potential to emit (PTE) 15 tons per year of any air pollutant	<ul style="list-style-type: none"> Case-by-case best available control technology (BACT)
Maine	10 MMBtu (aggregated)	<ul style="list-style-type: none"> Case-by-case BACT determination
Massachusetts	1 MMBtu	<ul style="list-style-type: none"> 0.10 – 0.20 lb/MMBtu
New Hampshire	Larger than 2 MMBtu	<ul style="list-style-type: none"> 0.3 lb/MMBtu
New Jersey	1 MMBtu	<ul style="list-style-type: none"> Case-by-case BACT determination
New York	Larger than 1 MMBtu	<ul style="list-style-type: none"> 0.6 lb/MMBtu
Rhode Island	Larger than 1 MMBtu	<ul style="list-style-type: none"> Case-by-case BACT determination Recent determination 0.20 lb/MMBtu
Vermont	Larger than 90 HP	<ul style="list-style-type: none"> Case-by-case BACT determination Recent determination 0.20 lb/MMBtu

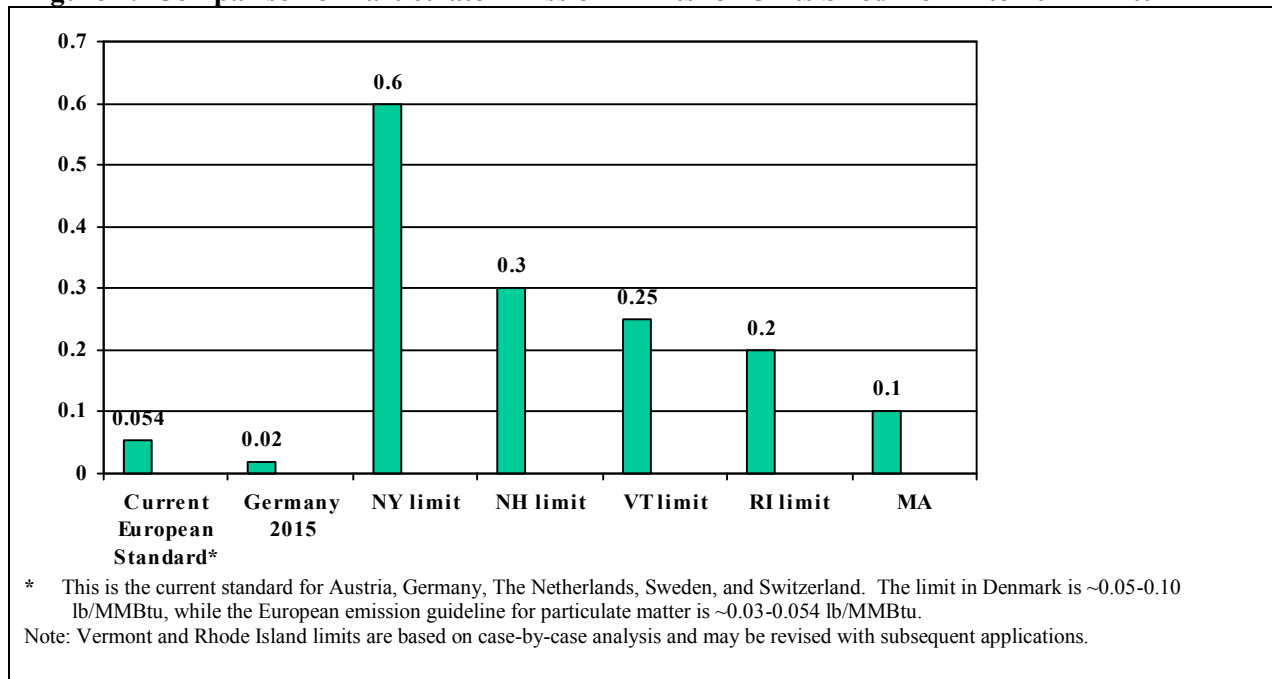
Overview: European Union Air Emission Standards

In the U.S., air emission standards typically regulate the specific type of device, the fuels, and heat outputs. Since this approach allows gaps and variation in coverage, some residential and small-to-medium-sized biomass units may not be subject to environmental regulations. In residential and small-to medium-sized applications, some biomass devices may be able to avoid environmental regulations altogether. In contrast, European emission standards regulate by heat output and feeding device (manual or automatic). This translates into no loopholes. All units, regardless of device type or fuel, must meet an emission standard, and all manufacturers must produce units that burn cleanly. The result is a leveling of the regulatory playing field. A comparison of U.S. and European emission standards indicates that the European standards are significantly more stringent (see Figure 1). When converted to U.S. metric, European requirements commonly are in the vicinity of 0.05-0.02 lb/MMBtu (heat output).

European emissions regulations tend toward lower limits based on recent national and local government activity. In Germany, for example, the maximum allowable limit for PM_{2.5} is slated to drop as low as 0.02 lb/MMBtu (heat output) by the year 2015. Such new regulations will be challenging to the manufacturing community and will force additional research and possible inter-company alliances to enable all manufacturers to achieve such best-in-class performance

capability. In comparison, the most stringent emission limit in the U.S. are state regulations with an emission limit of 0.1 lb/MMBtu heat input, almost an order of magnitude higher.

Figure 1: Comparison of Particulate Emission Limits for Units Sized from 1 to 10 MMBtu



Air Emissions Performance Characteristics: U.S. and Europe

Measured Performance: U.S.

Residential Devices

Today, the U.S. consumer can purchase a wide array of biomass burning products for home heating, including indoor woodstoves, pellet stoves, fireplaces, masonry heaters, and indoor and outdoor furnaces. EPA estimates that emissions from residential wood combustion represent one of the largest source categories for direct particulate matter (PM) emissions.⁹ However, there are limited or no emissions regulations that affect the sale of new or older units/ Units without regulatory requirements typically emit more PM than those that must meet emission standards. The lack of regulations for these devices contributes to a wide array of emission performance.

Current technologies using wood for residential heating result in greater emission impacts than associated with oil and natural gas. For example, a current NSPS woodstove has an emissions efficiency of 67-75 percent and an average PM emissions range of two grams per hour; while a natural gas boiler has 90 percent emissions efficiency and a less than one gram per hour average PM emissions range (see Appendix E). Continued or expanded use of these lightly regulated residential wood fired technologies will contribute to a decline in local and regional ambient air quality.

⁹ Based on analysis of EPA wood combustion estimates and 2002 National Emissions Inventory data.

The low change-out rate of older devices, as well as the ability to re-distribute these units via secondhand markets, compounds the air quality impact of most current residential devices. At an estimated change-out rate of one to two percent a year, it will take approximately 50-100 years to change out the existing fleet of residential biomass devices. This turnover rate may be even longer since older units continue to be sold legally in the absence of state and EPA regulation of the sale of second hand units. Without addressing and reducing emissions from the current fleet of units, this source category will continue to be a major contributor to overall particulate matter levels in the ambient air.

Commercial Wood Boilers

Current commercial wood boiler technology also has higher stack emissions for all pollutants when compared to oil and natural gas.¹⁰ For example, these commercial small and medium scale wood boilers have total PM emissions 54 times those of comparable oil-fired, and CO emissions 12.5 times those of similar oil fired boilers. The only pollutant that is reduced when switching to wood is SO₂, but that is expected to change with the implementation of low and ultra low-sulfur oil requirements. In contrast to Europe, the lack of U.S. federal and state regulations for small- and medium-sized biomass boilers has not created an incentive (or requirement) for manufacturers to reduce emissions. Advanced boiler designs and control technologies add costs, and they are typically not used unless required by regulation or permit condition.

Measured Performance: EU

Residential and Industrial-Commercial

The PM_{2.5} emissions performance of European wood-fired boilers is considerably better than those used in the United States. Even without post-combustion flue gas treatment (e.g., electrostatic precipitators - ESPs), the European units emit at levels that U.S. units can only meet with advanced emission control devices.¹¹ Residential and commercial wood-fired boilers produced in Austria have achieved PM_{2.5} emission levels representing a 90 percent or higher reduction compared to older U.S. technologies with all common types of wood fuel (logwood, pellets, and wood chips) The PM_{2.5} emissions of best-in-class, Austrian wood-fired boilers without controls emit PM_{2.5} at levels somewhat above those for U.S. oil-fired boilers.¹²

European wood-fired boilers (over a 1.8 MMBtu/hr capacity) are frequently installed with post-combustion, flue gas clean-up devices including cyclones, ESPs, or baghouse filters. ESPs for residential and small commercial size, wood-fired boilers have also been developed. Such devices have shown the capability to reduce PM_{2.5} emissions by approximately the same percentages as observed for commercial and industrial ESP systems. For additional information on EU wood boiler emissions performance, see Appendix E.

¹⁰ NESCAUM reviewed emissions results from stack testing data at 17 locations across the U.S. Specific details of this review can be found in Appendix D.

¹¹ European units emit PM_{2.5} emissions in the range of 10 to 20 mg/MJ (or 0.02 to 0.04 lb/MMBtu), representing a 90 percent or higher reduction compared to older technologies still used in the United States.

¹² European units also typically emit carbon monoxide (CO) at lower rates than U.S. units. Emissions for best-in-class products in Europe are typically under 100 ppm and thus comparable to modern gas and oil-fired boilers. See the presentation Ray Albrecht, NYSERDA, September 2007. Available at:

http://www.marama.org/calendar/events/presentations/2007_09RWC/Albrecht-UltralowEmissionsEuropeanWood-RWC07.pdf.

EU Design Characteristics

The higher emissions performance of European wood-fired boilers is attributed to their design characteristics. The boilers typically incorporate the use of staged-combustion designs that achieve high energy efficiency and very low emissions of PM_{2.5} and carbon monoxide. The boilers reduce total PM_{2.5} emissions by ensuring the complete burnout of all hydrocarbon components in wood fuel while also minimizing volatilization of ash components. The combustion designs for modern European-style wood-fired boilers include a primary gasification stage and then a secondary combustion stage. Wood fuel is stored or fed into the primary gasification chamber where initial volatilization and oxidation take place. Best-in-class wood boiler designs maintain about 1200 degrees F in the combustion chamber. Partially burned gases are then directed into the secondary combustion chamber where the combustion process is continued with sufficient temperature, time, and turbulence to ensure complete burnout of all hydrocarbon components.

European-style, staged-combustion, wood-fired boilers also generally use powered combustion air supply in the form of either forced or induced draft blowers with variable speed control. Together with the use of oxygen sensors or thermocouples in the flue gas stream, the combustion airflow is controlled to match real time fuel feed and combustion rates and thereby maximize energy efficiency while minimizing emissions. Additionally, European wood-fired boilers frequently are used together with separate, secondary water storage tanks to allow for the continued boiler operation at sufficiently high combustion rates during low load periods to ensure that highly polluting, smoldering conditions do not occur. Separate water storage systems are now required in several European countries for wood-fired (especially logwood) boiler systems either based on manufacturer guidelines or prevailing government regulations.

Test Method Differences: U.S. and Europe

Comparing emissions data from European and U.S. units requires an examination of test method procedures to determine the potential impact on emission outcomes. For residential devices, such as woodstoves and furnaces, test method protocols differ significantly. When comparing European and U.S. tests, critical differences include measurement methods, fueling protocols, burn rates, and use of different wood heating values. However, test protocols for commercial devices are similar and results between the two test methods are likely to be comparable. Table 3 highlights variations in the test method.

Residential

In the U.S., residential units are typically tested in a lab setting using U.S. EPA Test Method 28. Direct comparison between limit values achieved using U.S. EPA Test Method 28 and the European Committee for Standardization (CEN) test methods (typically used in Germany, Switzerland, and Austria) is not possible. Key differences include the particulate matter sampling (dilution tunnel in the U.S. vs. hot filter in the EU), fuel used (dimensional softwood lumber in the U.S. vs. cord hardwood in the EU), use of differing heating values, and different firing rates (four burn rates in the U.S. vs. two in the EU). Research indicates the type of wood and the moisture content of the wood can significantly influence emission outcomes. European units are not tested at the low level burn rate test, so it is not known how well they perform when the dampers are completely turned down.

U.S. and European Test Methods – Key Variations and Impacts

- The greatest impact in measurement is likely to be from the particulate matter sampling methods. U.S. EPA Test Method 28 uses dilution tunnel sampling which captures the total PM, including the filterable and condensable portion of the particulate matter. Typical European testing uses hot filter sampling techniques. This method only captures the filterable particulate matter.
- A second major difference between methods is the fuel used for the tests. Method 28 employs a test fuel called a crib, which is made up of dimensional lumber (Douglas fir for woodstoves; red oak for OWBs) with a specified moisture content configured under conditions prescribed in the test method. The European test method utilizes the use of cordwood (type of wood is specified by the manufacturer) that is randomly loaded into the device.
- A third difference between the test methods is the use of different firing rates. Method 28 requires testing at four burn rates, less than 15 percent of maximum; 15-30 percent of maximum, 30-50 percent of maximum and maximum capacity, while the European test only requires testing at nominal load and 30 percent load (50 percent for hand fired units). The most significant variation is the low load test requirement.

See Appendix E for details.

Although the Norwegian method for measuring emissions has many similarities to the U.S. standard, there are critical design differences that may impact emission outcomes. Research on the extent of variation between the two test methods, and an assessment of the impact of size of the unit, combustion temperature or combustion efficiency, would assist in determining how to best conduct lab tests for residential units.

Commercial

Commercial devices in the United States test using EPA Test Method 5, which is comparable to the European testing method. Therefore, results of testing of European units can be compared to U.S. tests conducted EPA Test Method 5.

Table 3: Comparison of Test Methods

	EPA Test Method 28	EPA Test Method 5	CEN Test Method
Fuel type	Douglas fir dimensional lumber	All solid fuels	All solid fuels
Feeding method	Hand fed	Hand and automatic feed	Hand and automatic feed
Firing rate	Four firing rates: <ul style="list-style-type: none"> ➤ <15% ➤ 15-30% ➤ 30-50% ➤ maximum load 	No firing load requirement	Two firing rates <ul style="list-style-type: none"> ➤ Nominal load ➤ 30% load (50% for hand-fired units)
Pollutants measured	Total particulate matter	Filterable particulate matter – three 60 minute samples.	Continuous emission monitoring of: <ul style="list-style-type: none"> ➤ CO₂ ➤ O₂ ➤ CO ➤ Organic carbon ➤ VOC ➤ NO_x ➤ efficiency Dust (filterable PM) four 30 minute samples
Sampling method	Dilution tunnel	Hot filter	Hot filter

Moving Toward Better Performing Technologies

The new biomass boiler technologies developed in both the U.S. and Europe are a response to government policies and regulations intended to increase energy independence, achieve economic benefits, and reduce global warming. These technologies demonstrate that it is possible to achieve low emission, high efficiency biomass boilers. System efficiencies of new boilers are now approaching the 90 percent level compared with the 70 to 80 percent range of efficiency that prevails in U.S. biomass boilers today. Many of these advanced designs incorporate improvements that reduce carbon monoxide and PM_{2.5} emissions. In Austria, active competition between manufacturers has led emission levels below those required by government regulation. Europe has demonstrated that clean burning devices can be produced. The question is how more efficient devices can be moved into the U.S. marketplace.

European Incentives for Wood Pellet and Chip-fired Boilers

Austria: In Austria, the federal government, individual provinces, and local municipalities offer several financial incentive programs for biomass boilers (including logwood, pellet and chip-fired systems). The incentives support a substantial percentage of the investment cost required for purchase and installation of biomass boilers in residential and commercial buildings. The sum total of federal, provincial, and local incentives in Austria can often amount to 50 percent (or more) of total investment costs.

A new federal incentive program implemented in April of 2009 provides support for both individual measures, such as windows, insulation, and heating system replacement, as well as incentives for whole house retrofit packages that reduce energy consumption by more than 50 percent of previous usage levels. Another federal program provides a 20 percent incentive for a variety of individual measures, including biomass heating systems. The incentive limit for individual measures is 2,500 Euros (or about \$3,500).

Provincial level incentives for biomass boilers are also offered throughout Austria. These are typically in range of 25 to 30 percent of total investment costs (including the cost of an energy audit). Most provincial incentives have limits in the range of 1,000 to 2,500 Euros (or about \$1,400 to \$3,500 per boiler). However, the province/city of Vienna offers incentives of 33 to 52 percent of investment cost, with limits of 4,500 to 7,000 Euros (about \$6,000 to just under \$10,000) depending on emissions performance. Certain provinces also offer supplemental incentives for removal of existing oil-fired and natural gas-fired boilers and corresponding fuel supply equipment (e.g., tanks and piping).

Many local municipalities in Austria also offer incentives for biomass boilers. Such local incentives range from 150 to 800 Euros (about \$200 to \$1,100).

Germany: Germany also has a federal incentive program for biomass boilers. For pellet-fired boilers up to 100 kW (about 340,000 Btu/hr) thermal capacity, the base incentive is 1,000 Euros (about \$1,400), and increases by 24 Euros for each kW of capacity over 40 kW. The incentive for chip-fired boilers is a fixed 500 Euro (about \$700) amount. Logwood-fired boilers are eligible for a fixed incentive of 750 Euros (just over \$1000.) All German biomass boiler incentives are subject to a minimum energy efficiency requirement of 90 percent based on lower heating value of the fuel.

Italy: The province of Southern Tyrol in Italy also has an incentive for biomass boilers. The incentive is 30 percent of total investment cost.

Switzerland: Several cantons (provinces) have incentives that range from about \$2,000 to \$3,000 depending on system size and expected annual wood fuel consumption.

Slovenia: Slovenia has a 40 percent incentive for biomass boilers. The incentive is limited to about \$1,600 for logwood-fired boilers, about \$2,200 for pellet-fired boilers, and about \$3,000 for chip-fired boilers.

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SAFETY STANDARDS FOR BIOMASS HEATERS AND BOILERS: U.S., CANADA AND EUROPE

Safety for heaters and boilers in the U.S., Canada and Europe, regardless of fuel type, is provided through a blend of safety standards, design and construction process codes, and testing protocols.¹³ While governments – U.S. federal and state, and EU – require adherence to standards and testing protocols, independent organizations actually set and test to technical specifications. Similar to the differing approaches to air emissions testing, the U.S. and EU also have different approaches to safety certifications, depending on the type of device, whether it is used in a residential or commercial-industrial application, and its size/heat output.

Room Heaters, Fireplace Inserts and Furnaces: Standards, Testing, and Certification Process

In the U.S., installation of any free-standing residential room heater, fireplace insert, or furnace – regardless of fuel type (e.g., biomass, oil, natural gas, coal) – requires that the equipment has a label from an accredited testing laboratory signifying that it has been tested to one or more standards for safety. Safety standards for residential heating equipment are set by the respective standard setting organizations in the U.S., Canada, and the EU. The primary safety requirements for biomass equipment are listed in Table 4.

Heaters and furnaces are required by law to be tested to ensure adherence to the standards of the respective U.S., Canadian or EU standard-setting organizations. Testing is conducted by any number of testing labs accredited by agencies that establish standards for testing labs. For example, the International Accreditation Service, Inc. (IAS) may accredit a lab as a third party product certification laboratory for fuel-burning equipment and accessories. Accreditation from the Standards Council of Canada (SCC) is recognized by all Canadian provinces and territories.

Regardless of its place of manufacture, equipment can be tested to Underwriters Laboratory (UL) standards and certified for sale in the U.S. Testing laboratories in Europe are accredited to test for U.S. and Canadian standards. However, since each country has its own standards, the testing and certification process can be expensive and may not be justified based on expected sales in that country. If this is the case, certain equipment may not be offered for sale in that market.

A U.S. manufacturer seeking to market a wood or pellet stove model must submit a stove to a certified laboratory for testing. Not every stove is tested. A single wood stove is sent to an accredited independent testing laboratory. Independent laboratories evaluate and certify that the stove meets the appropriate U.S. standard. If the testing laboratory determines that the stove meets all the appropriate requirements, a “sticker” (usually a metal plate) is affixed to the equipment indicating that models of this type have been manufactured to a specified standard, tested, and approved. In addition to initial safety certification, products intended for sale in the U.S. or Canada are required to have periodic quality control inspections performed by the test laboratory as a condition of continuing certification.

¹³ To provide a more complete picture of safety requirements likely to affect the market for biomass heaters and boilers in the Northeast, information on Canadian safety requirements is included where available.

Who Sets Safety Standards?

Standards setting organizations can be classified into four types:

- professional societies such as the American Society of Mechanical Engineers (ASME);
- trade associations such as the Hearth, Patio & Barbeque Association, which promote their members' products and conduct education and training within their industry;
- testing and certifying organizations, such as Underwriters Laboratory, which produce their own standards and test and certify their own and the standards of other organizations; and
- organizations that only develop standards, such as the American Society for Testing and Materials (ASTM).

There are formal international standards organizations such as the International Organization for Standardization (ISO). ASME considers itself a de facto international standards setting organization because its Boiler and Pressure Vessel Code is widely used worldwide.

In the U.S., safety standards for residential heating equipment are set by standards setting organizations such as Underwriters Laboratory (UL). Standards are unique to fuel type (pellet or wood) and equipment type (free-standing room heaters, fireplace heaters, or central furnaces). Separate standards have even been developed for biomass heaters in mobile homes. In Canada, the Underwriters Laboratory Canada (ULC) and the Canadian Standards Association (CSA) have standards. Standards set by an EU member state are harmonized with other EU member states under the European Committee for Standardization (CEN) standards.

In contrast to most countries which have only one standard-developing organization, the U.S. has hundreds. The American National Standards Institute (ANSI) allows developers of U.S. standards to have their standard identified as an American Standard. ANSI offers accreditation to standards-developing organizations that meet specific criteria, and accredits product certifiers.

The EU is a prime example of harmonized standards. Standards developed by EU members are submitted to the CEN and become EU standards. Harmonization of standards within a region of the U.S. would be challenging but is not unprecedented. In the U.S., states in the Northeast came together to accept the California standard for auto emissions.

Comparability and Reciprocity in Testing Heaters and Furnaces: U.S. and EU

Although a complete evaluation and comparison of the U.S. and EU standards for room heaters and residential furnaces is beyond the scope of this report, the research team found very similar testing conducted under both protocols. In general, both UL and EN standards test solid fuel room heaters (wood and pellet stoves) for materials design and construction, performance, and an array of safety tests such as draught, leak-tightness, electrical, and temperature rise of components. Safety standards also include a review of the owner's manual. The current EU standard for solid fuel room heaters also has requirements and guidelines to measure heat output, efficiency, and emissions. Unlike the U.S. where only wood stoves have EPA emissions stickers, all EU biomass heaters, furnaces, and boilers must meet a standard for efficiency and emissions. Currently, there is very little reciprocity in testing for residential solid fuel heaters and furnaces between the U.S. and EU. This may be due in part to the additional EU testing requirements for efficiency and emissions.

Northeast States: Testing and Labeling

All the northeast and mid-Atlantic states have the same testing and labeling requirements for wood and pellet stoves and inserts. While some jurisdictions do not require the homeowner to obtain a building permit to install the equipment, the commonly accepted installation practice in the hearth products industry is to obtain a building permit and complete an inspection by a local code official. Another increasingly common practice is certification of wood and pellet installations by the National Fireplace Institute (NFI). Local code officials approve plans and inspect installations to insure that the equipment is installed according to the manufacturer's specifications and local requirements. They do not inspect stoves for certification of compliance with federal or state emission requirements. Northeast state standards and exemptions for heating boilers used in residential units are discussed in the following sections.

Table 4: Primary Safety Requirements for Biomass Equipment

Equipment	United States	Canada	European Union
Wood stoves	UL 1482	ULC S627	EN 13240
Pellet stoves	UL 1482, ASTM E1509	ULC S627	CEN EN 14785
Fireplace Inserts	UL 737	ULC S628	EN 13229
Solid fuel Heating furnace	UL 391	CSA B366.1	EN 12809 pr EN 15270
Boilers	ASME BPVC Section I and Section IV*	ASME BPVC Section I and Section IV*	EN 303-5** DIN 1942 CE

* ASME BPVC Section I is "Rules for Construction of Power Boilers"; Section IV is "Rules for Construction of Heating Boilers"

** "Heating Boilers – Part 5: Heating Boilers for Solid Fuels, Hand and Automatically Stocked, Nominal Heat Output of Up to 300 kW – Terminology, Requirements, Testing and Marking."¹⁴

Boilers: Standards, Testing and Certification Process

Heating and power boilers may also be required to have a code stamp that certifies the boiler was constructed to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME BPVC). This code is not a standard but a prescription for the design and construction of a boiler. The ASME BPVC requires certification of the materials used to make the boiler, adherence to a construction strict process, certification of employees (e.g., welders) who work on boilers, and visual inspection and pressure testing of each unit. For pressure boilers, there is no distinction among fuel types under the ASME BPVC. State laws set requirements for products to be tested and meet this code. While ASME BPVC is not fuel specific, the EU does have a specific pressure test methodology for biomass boilers up to 300 kW – the EN303-5. European boilers larger than 300 kW are designed to non-fuel specific standards such as the Deutsches Institut für Normung (DIN 1942).

¹⁴ The described standard is applicable in the countries of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

U.S. and Canadian Requirements

In the U.S. and Canada, power and heating boilers – regardless of fuel type – must meet the ASME requirements. Currently, all Canadian provinces and U.S. states have adopted, by law, various sections of the ASME BPVC (see Table 4). The ASME certification process is quite extensive. Nearly 50 percent of the companies accredited by the ASME to manufacture pressure boilers in accordance with the BPVC are located outside of the United States and Canada. An ASME Code Symbol Stamp (Code) indicates that the stamped boiler equipment was manufactured by an accredited manufacturer and conforms to the Code.

Northeast States: Boiler Requirements and Exemptions

Safety Code Requirements: All northeast states require an installed power boiler (boilers designed according to ASME BPVC Section I) to have an ASME certification. All states require annual inspections for power boilers installed in public buildings or places of employment.

All northeast states require heating boilers to have an ASME Code stamp. Massachusetts requires that all biomass heating boilers meet the ASME requirements for heating boilers. However, several northeast states do allow heating boilers to be installed without an ASME Code stamp requirement under certain conditions (e.g., installed in residential dwellings of six or less units, operate at pressure less than 60 psi, and heat inputs less than 100,000 Btu/hr). For boilers in commercial facilities and regulated by state labor or safety departments, state law provides a process to allow non-ASME certified boilers to be installed and operated on a case by case basis are classified as “state specials.”¹⁵ However, the “state special” route can be costly and time consuming. See Appendix F for additional detail on northeast states’ safety regulations for biomass boiler systems.

Building Code Requirements: Regulation of boilers in residences is typically covered by state residential building codes. Many of these building codes are less clear on whether such units require the ASME Code stamp. All northeast states have adopted, at a minimum, the International Code Council (ICC) Building Code. Several states, including Massachusetts, have adopted multiple ICC codes, including the International Residential Code and the International Mechanical Code. States can adopt these codes in whole or modify the codes. Localities have also adopted building codes based on the ICC and may require more than the state code.

The local building codes may have unintended consequences for the purchase, installation, and use of solid fuel heating equipment.¹⁶ For example, in New York State, installation or replacement of a furnace or boiler requires that the owner receive a permit and have an inspection. All installed equipment must meet ANSI/UL727. All solid fuel-burning heating equipment, chimneys, and fuels must be properly labeled. The confusion can occur when a locally modified building code references the state boiler code and requires that all heating boilers meet the requirements of the ASME BPVC. Since ASME BPVC Section I (Power Boilers) and Section IV (Heating Boilers) have different requirements, state boiler codes and building codes should be clear on which section(s) of ASME BPVC is referenced. In addition, state regulations for boilers require annual inspection of boilers, particularly boilers installed in

¹⁵ "State Special" means a boiler or pressure vessel, including related appurtenances, of special construction that may not be constructed in accordance with the ASME Code.

¹⁶ <http://www.iccsafe.org/>

public buildings or buildings with employees. Simply referencing the boiler law in the state building code could have the unintended consequence of requiring annual inspections of boilers in residences.

The situation in Massachusetts is very clear and specific: the state building code requires that all biomass boilers, even boilers installed in a residence, have an ASME Code stamp. According to the code: "In general, solid fuel-burning appliances utilized within the dwelling must be: Listed as tested in accordance with National Safety Standards and labeled for the intended use. Wood boilers must be constructed and stamped in accordance with the A.S.M.E. code."¹⁷ While the state building code is clear, it prohibits the installation of European manufactured biomass boilers that do not carry an ASME Code stamp. These boilers could be installed in other northeastern states under current building codes.

EU Requirements

In the EU, a standard exists specifically for biomass heating boilers up to 300 kW – EN 303-5. All EU member countries conform to the same EN 303-5 standard. Power boilers are still certified under DIN 1942, which is a standard for fossil-fired boilers.

Many European manufactured biomass heating boilers are not manufactured to ASME BPVC requirements and do not carry the ASME Code stamp. Biomass heating boilers manufactured for sale in the EU carry stamps that indicate that they have been tested to the EN 303-5 standard. The code stamp may be a TUV or CE sticker,¹⁸ which certifies that the testing organization has tested the boiler and that the equipment complies with the European standards and directives.

Many of the boilers built to this standard are not built-in-place boilers, but are factory-built and shipped and installed at a site. Larger boilers (greater than 300 KW) are more likely to be custom-built and may be better suited to incorporate modifications needed to meet ASME Code.

Adapting Boiler Technology: Size Considerations

Large commercial and industrial biomass-fired boilers (over 500 kW thermal capacity) are frequently designed and manufactured to individual customer specifications; and have significantly higher levels of engineering and custom fabrication labor content. This contrasts with boilers produced for smaller residential and light commercial applications, which are often of fixed design and produced in mass volumes in order to achieve economies of scale.

European manufacturers may find it practical to design and produce large commercial biomass-fired boilers that meet ASME pressure vessel standards, since adjusting design differences would not necessarily negatively affect the production flow of other boilers in the manufacturing plant. Large boilers are also sometimes custom designed in order to allow shipment overseas within international shipping containers. Such custom shipping-oriented design can dominate the overall manufacturing process with the result that additional design requirements such as ASME vs. EN pressure vessel design are no longer of significant concern in regard to overall manufacturing cost.

¹⁷ Massachusetts State Building Code (780 CMR) and the State Fire Code (527 CMR).

¹⁸ Technischer Ueberwachungs Verein (TUV) is a leading European (and now international) testing organization. CE marking is an acronym for the French "Conformité Européenne."

A Comparison: U.S. and EU Safety Standards and Testing-Certification Process for Boilers

Based on field experience, there does not appear to be any appreciable difference in the level of safety afforded by the respective U.S. and European safety standards. Both U.S. and European wood-fired boiler technologies have generally performed to minimize hazards to safety. However, multiple differences between the referenced U.S. and European standards do affect the ability of manufacturers to implement common designs and manufacturing processes for wood-fired boilers that can simultaneously satisfy the code requirements of both the U.S. and EU markets.

The ASME Code is a prescriptive code that lays out a method for construction of a pressure boiler that, by its process, is deemed to be safe. The ASME Code also provides for documentation and inspection by an independent on-site authorized inspector. ASME BPVC does not cover emission standards for boilers.

The EN 303-5 is a testing procedure and certification process that subjects a constructed biomass boiler to a set of performance tests that will demonstrate its safety. The EN 303-5 requirements do not provide for an inspection by an independent inspector but most manufacturers do follow ISO standards for construction.¹⁹ EN 303-5 does take into account special conditions of biomass that are not contained in the ASME BPVC.

A major difference between the ASME Code and the European standard is the ASME BPVC requirement for an Authorized Inspector (AI). The AI's role is to monitor the manufacture of the boiler to ensure that the prescriptive ASME Code requirements are met, and that the manufacturer is working within an approved quality control program. The AI is usually an employee of the state or an insurance company that insures boilers.

With regard to materials of construction, efforts are ongoing but challenges remain to partially harmonize U.S. and European safety standards. For example, carbon steel is the most popular material for construction of biomass boiler heat exchangers, and the commonly available raw material stocks appear to meet both U.S. and European standards. The same is not true for stainless steel. The specifications for alloy component types and percentages are often so tightly prescribed that formal reciprocal acceptance between U.S. and European alloys remains elusive. One example of non-harmonized materials specifications is the German standard, where boilers (of all fuel types) marketed into the country typically must have steel raw materials that were produced in Germany.

Other technical differences in standards and testing requirements also complicate the ability to market EU equipment in the U.S., even though the actual field results may be similar.

- Materials: The EN 303-5 standard for wood-fired boilers allows the use of sheet steel that is of 5 mm (nominal 3/16 inch) thickness for walls that are in contact with both fire

¹⁹ International standards have been developed by the International Organization for Standardization (ISO). The ISO standard 16528-1:2007 defines the performance requirements for the construction of boilers and pressure vessels and is not fuel specific.

and water. The corresponding requirement of the ASME BPVC – Section IV calls for a minimum allowable thickness of 4/16 inch.

- Pressure Testing Protocols: Boiler heat exchangers are subject to pressure testing under both U.S. and European standards. Pressure testing is performed on proof specimens as well as production units during the manufacturing process. The real impact of differences in pressure testing requirements under the U.S. and European standards is not one of safety, but the process used to certify under the standard applicable in the country of product destination.

EU: EN 303-5 calls for a proof pressure test at 2.0 times the declared maximum allowable working pressure. During the proof specimen pressure test, no permanent deformation of the heat exchanger is allowed to occur. EN 303-5 calls for testing each production unit at a pressure equal to 1.30 times the declared maximum allowable working pressure. The production testing is subject to a minimum test pressure of 4 bars (about 60 psi). The minimum possible rating for allowable working pressure under the European standard is thus approximately 45 psi even when using 3/16 inch thickness sheet steel for heat exchanger manufacturing.

U.S.: ASME BPVC – Section IV requires the proof pressure test to be performed at 2.50 times the declared maximum allowable working pressure (compared to the 2.0 multiplier used under the EN 303-5 standard). However, if exact material strength testing is performed, ASME – Section IV allows the 2.0 factor to be used. Each production unit must then be tested at a pressure equal to 1.50 times the declared maximum allowable working pressure, a higher safety factor than the 1.30 multiplier used in the EN 303-5 standard. Since the proof test is conducted at a higher pressure ratio than is the production unit test (test pressure vs. maximum allowable pressure), the production unit test typically serves more as a leak detection test during manufacture than as a safety test (i.e., indicating porosity on weld joints, not a lack of physical strength). Furthermore, leaks that occur at a 1.50 pressure ratio would typically be detectable at a 1.30 pressure ratio.

- Welder Certifications: The manufacture of welded heat exchangers requires the use of certified welders under both U.S. and European standards. Today, manufacturers in the U.S. or the EU qualify their welders based on an established nationally recognized welder standard.²⁰
- Electrical Systems: The U.S. electrical testing and certification standards require greater attention to the protection of exposed inter-component wiring than do the EU standards. Electrical wiring with non-metallic sheathing typically must be replaced by metal armored cable or else protected in a separate conduit. Such wiring protection requirements can require significant modifications or re-tooling of sheet metal jacket or control box components. Manufacturing costs would therefore be increased with negative consequences for marketing in Europe.

²⁰ Personal conversation with Mark Sheehan, ASME.

In Summary

The safety testing and certification for all jurisdictions – U.S., Canada, and the EU – are readily known. There do not appear to be significant differences in safety requirements, especially for units rated at one million Btu/hr and smaller. There appear to be few technical reasons that would prevent a manufacturer located in the EU from obtaining the certification required for the U.S. market. The need to have multiple safety certifications may limit products available to consumers and could add cost, especially if the market for biomass boilers is perceived to be fairly small. In addition, the requirement for full ASME certification for boilers in residential applications, including biomass boilers, needs to be more closely evaluated, particularly since these boilers are tested for safety and do not appear to pose safety hazards. Potentially less costly safety certification options should be evaluated for biomass boilers that would be appropriate for the U.S. residential and small commercial markets.

FINDINGS AND OPTIONS FOR STATE ACTIONS

This research has focused on air emissions regulations and safety certification requirements for biomass heaters and boilers. The research team has examined the relevant air emissions and safety standards regulations and conducted interviews with key experts in the U.S. and the EU. Interviews included manufacturers and distributors of biomass heating and power devices, regulators, and representatives of certifying organizations. A summary of the key findings and options for state action is provided below.

Summary of Findings

The research and interviews focused on documenting the various safety requirements and air emission regulations that affect the sale and use of biomass heaters and boilers in the U.S., the northeast states, and the EU. It also explored the potential implications that these differing regulatory approaches and specific requirements might have on the introduction of lower emitting, higher efficiency biomass furnaces and boilers into the northeast market.

Emissions Rulemaking

Currently, state and federal air emissions regulations and voluntary programs regulate some indoor wood stoves, outdoor wood boilers, and larger industrial/commercial biomass boilers. No or limited federal and state emission performance standards exist for the smaller and medium size boilers that are a significant portion of the biomass market (i.e., under 10MMBtu and between 10-30MMBtu). This variation in regulatory coverage of biomass devices exists even though wood combustion is one of the largest sources of primary particulate matter pollution in the U.S., and emission requirements for biomass boilers tend to be less stringent than those for other fuels such as oil, natural gas or coal. The research team found that comparison of emission results for commercial biomass units in the U.S. and EU is possible; but it is difficult to compare emission results for residential units tested in Europe. To better understand the ramifications of the test method variations, further study should be conducted on European units using the U.S. and European methods.

A comparison of northeast state air emission regulations for biomass boilers found a wide variation among states in the type of devices regulated and the specific requirements. This lack of consistent regulations across state borders allows the sale and use in the Northeast of lower efficiency, higher emitting biomass boilers as well as the more advanced biomass boilers that have high efficiency and lower emissions. The more advanced biomass boiler systems tend to have higher construction costs, and cost is often the major driver in the decision-making process. Therefore, it can be uneconomic for major boiler manufacturers to commit unilaterally to manufacturing high efficiency, cleaner biomass-fired boilers if they do not perceive clear and consistent market signals that allow reasonable economies of scale. If states were to move toward more stringent and consistent emissions standards for biomass devices, the market would receive signals for new biomass units that are higher efficiency and lower emitting.

U.S. EPA is currently drafting emission rules for all industrial, commercial and institutional boilers. Once proposed, this regulation will set federal emission standards for particulate matter,

carbon monoxide, and mercury. It is anticipated that this rule will require performance standards based on the use of advanced fabric filters. If such a regulation were promulgated, it is expected to expand the market for boilers with lowest emissions since they would likely be able to meet the performance standard without the use of fabric filters. However, some of the current manufacturers will need to redesign their units or require the use of fabric filters to meet the performance standard. Additionally, NESCAUM is drafting a model rule to provide a template for states to consider that could facilitate more consistent state regulations. Additionally, EPA action to expand the scope of the residential wood heater NSPS to all residential heating devices and to lower performance requirements would expand the market for cleaner technology in residential boilers and furnaces.

Given the expected changes in air emissions requirements in the U.S. at both the federal and state level, lower emission wood combustion devices will likely be required for the northeast market. Many EU boiler manufacturers of commercial units expect to meet the pending EPA standards, based on manufacturers' testing and EU testing protocols.

Emission Testing

The Massachusetts Department of Energy Resources (DOER), NESCAUM, and other organizations, such as the New York State Energy and Research Development Authority (NYSERDA), may wish to undertake joint efforts to determine if a correction factor for emission testing can be developed to compare testing results using the U.S. and European test protocols (EPA Method 28 and EN 303-5).²¹ Furthermore, research should be undertaken to determine if any appreciable emissions differences occur using the U.S. and European field test methods.

Safety Requirements

State boiler laws and regulations require an ASME Code stamp for pressure boilers in commercial buildings. That likely will not change irrespective of the pressure (low pressure below 60 psi) or size (less than 200,000 Btu/hr input) of the boiler being installed. However, many states' residential building codes require boilers to meet ASME requirements regardless of fuel type. For some manufacturers of oil and gas boilers, the expense of ASME certification is a cost of doing business. For others, especially smaller biomass boiler manufacturers, the additional expense to meet ASME requirements for low pressure heating boilers can be high for each unit produced. For EU manufacturers whose boilers meet EN 303-5, the additional complexity of meeting the ASME requirement may be a deterrent to entry into the northeast market.

The research team conducted a side-by-side comparison of U.S. and EU safety standards and also reviewed comparisons conducted by professional engineering firms familiar with both ASME BPVC and EN 303-5. The results do not indicate any significant safety risks between

²¹ Significant differences include the EPA testing, which uses debarked, dimensional wood, and the European testing which is done with logwood with the bark on. This difference in protocol can contribute to variability in the ash content of the fuel, and thus, potential for inorganic particulate matter emissions. In addition, testing of European style boilers at part-loads of under 25 percent (or even 15 percent load), would likely motivate the manufacturers to improve the insulation design of the combustion chamber, and thus avoid high carbon monoxide and organic particulate matter at low load conditions.

biomass boilers built to the requirements of ASME Section IV and boilers tested to meet EN 303-5 for boilers up to one million BTU. The U.S. distributors of EU technologies contend that EU-manufactured boilers could fill a portion of an expanding market for cleaner, high efficiency biomass boilers in the U.S.. However, they view the requirement for ASME certification of EU technologies as adding additional costs to the devices, even though EU certification to EN 303-5 should suffice to ensure safety. Many states are concerned that opening up markets to non-ASME certified European technologies may raise liability issues for states.

Massachusetts does not exempt residential biomass boilers from ASME Code stamp requirements. It is unclear if similar sized oil and gas boilers must meet the same requirements. Other northeast states require at a minimum that residential biomass boilers meet UL 391 “Solid-Fuel and Combination-Fuel Central and Supplementary Furnaces.” Massachusetts may wish to consider working with state code officials to amend its current requirements that biomass low pressure boilers meet the ASME BPVC Section IV requirement, and require instead the UL 391 or equivalent.

For this report, the research team reviewed the requirements for certification of boilers under ASME BPVC and EN 303-5 standards. It also reviewed several reports prepared as applications to states for the “State Special” process to allow installation of boilers that have not been constructed to ASME requirements. The reviews identified several differences in the testing, but no difference in the in-service operation of boilers built to ASME Section IV vs. EN 303-5. One significant difference between the two certification standards does exist: the EN 303-5 standard only covers boilers up to 300 kW (approximately one million Btus per hr heat input).

DOER may wish to initiate a joint effort of northeast state technical and regulatory officials to undertake the following: identification and assessment of technical standards and regulatory institutional procedures that could lead to the permitting in the Northeast of those biomass boilers that are designed and constructed to accepted safety standards and that meet higher efficiency and emissions standards.²²

Options for State Action

Based on this research and analyses, the research team concludes that an expanded market for biomass furnaces and boilers in the Northeast will require higher efficiency, lower emissions biomass heaters and boilers. The availability of these systems will be significantly enhanced by:

- A region-wide discussion of the impact of addressing state safety requirements and regulatory hurdles that may limit the consumer options, or may increase manufacturing costs without providing corresponding public safety benefits; and
- Establishment of consistent, lowest-achievable air emission standards to reduce pollution and public health impacts.

²² New Hampshire has introduced legislation to study harmonizing ASME BPVC Section IV and EN 303-5 standards. The State of Oregon has adopted administrative rule changes that will allow boilers to be installed if they have been tested and meet EN 303-5 standards.

The research team offers the following options for state action:

- Participate in U.S. EPA's rulemaking to establish an area source rule and maximum achievable control technology (MACT) standard that protects public health and permits the expansion of biomass heating;
- Extend regulatory emission efforts to residential units to ensure protection of public health and to provide an even playing field among the various residential devices;
- Work with other northeast states to stimulate the market by identifying and supporting federal tax incentives to fund retrofits of existing industrial, commercial and institutional units and change-outs of residential units once appropriate emission standards are in place;
- Support additional work to allow the direct comparison of efficiency and emission testing methods between the U.S. and EU technologies, and encourage the adoption of efficiency requirements for U.S. manufactured biomass technologies;
- Work with northeast states to identify and support options to encourage research on biomass combustion technologies that can meet and exceed federal emissions requirements.
- Work with northeast states to identify and support federal and/or regional incentives for business and homeowners to purchase new cleaner, high efficiency biomass technologies;
- Work with state boiler boards and code officials to investigate an ASME standard that meets all safety requirements, while providing a cost effective process to achieve an ASME Code stamp for EU manufacturers; and
- Work with state economic development agencies and EU manufacturers to promote the production of EU technologies in the Northeast.

APPENDICES

- A. Advisory Group
- B. Federal New Source Performance Standard for Residential Wood Heating Devices
- C. Update on Federal Air Pollution Regulations For Smaller Commercial/Institutional Boilers
- D. Wood-Fired Residential Devices
- E. Air Emissions Performance Characteristics in U.S. and Europe
- F. Safety Regulations for Biomass Systems

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¹ The Advisory Group composed of state regulators, representatives of standard-setting organizations, and manufacturers reviewed the interim report for accuracy and clarity, but was not asked to endorse its findings.

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FEDERAL NEW SOURCE PERFORMANCE STANDARD FOR RESIDENTIAL WOOD HEATING DEVICES (40 CFR Part 60, Subpart AAA)

The New Source Performance Standards (NSPS) for Residential Wood Heaters was promulgated as part of a court ordered regulatory negotiation in 1988. This NSPS sets a performance standard for non-catalytic units of 7.1 grams per hour and 4.5 grams per hour for catalytic woodstoves. In addition, the NSPS granted a wide number of exemptions to this rule. Finally, this rule had no impact on existing units or the continued sale of these units in the second hand market. Recently, EPA has also developed voluntary labeling programs for outdoor wood boilers and fireplaces. These programs do not mandate performance levels for these units but rather provides emissions data to the consumer for units that emit less pollution.

Federal Requirements

Combustion devices may be regulated under Federal EPA programs based on size, device type, and emissions. The NSPS and federal New Source Review (NSR) programs have traditionally regulated steam generating units over 10 MMBtu and thermal generating units over 30 MMBtu. Additionally, hazardous air pollutant emissions may be regulated under the National Emission Standards for Hazardous Air Pollutants (NESHAP) program.

Federal NSPS Regulations

New source performance standards are authorized under Clean Air Act (CAA) § 111, and codified in 40 CFR Part 60. NSPS standards generally contain limits for criteria air pollutants, typically PM, NO_x, and SO₂. NSPS standards are supposed to be updated every five years, however, this typically does not occur.

NSPS for Small Commercial-Institutional Steam Generating Units

40 CFR Part 60 includes Subpart Dc—Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units. Subpart Dc establishes for boilers firing only wood a PM emissions standard of 0.1 lb/MMBtu, but exempts boilers with a maximum design heat input capacity less than 30 MMBtu/hr. As a result, few if any small woody biomass boilers are subject to this regulation. This standard is three years old.

Federal NESHAP Regulations

CAA § 112(b) includes a specific list of 188 hazardous air pollutants (HAPs) regulated under the NESHAP program. Typically, HAPs of concern for biomass units include acrolein, polycyclic organic matter (POM),¹ formaldehyde, naphthalene, and mercury.

The Clean Air Act requires EPA to list categories of “major sources” of HAPs and to issue national emission standards for such sources (CAA § 112(c)(1)). Under this program, devices are regulated as “major” and “area” sources. Major sources are defined as any stationary source or group of stationary sources that emits or has the potential to emit (PTE) at least 10 tons/year

¹ The CAA § 112 HAP list uses the term “polycyclic organic matter (POM).” POM is a broad term, and would include benzo(a)pyrene and other polycyclic aromatic hydrocarbons that are commonly emitted from wood combustion.

of any HAP or 25 tons/year of any combination of HAPs (CAA § 112(a)(1)). These standards shall “require the maximum degree of reduction in emissions of the hazardous air pollutants subject to this section” that the EPA Administrator determines is achievable, taking into account certain factors such as cost, energy requirements, and other impacts. These HAP standards are commonly referred to as “maximum achievable control technology” (“MACT”) standards (CAA § 112(d)(2)). Finally, NESHAP standards affect new and existing units, but often the standard for new sources is more stringent than that for existing units.

Industrial Boiler MACT

During 2004, EPA promulgated 40 CFR Part 63, Subpart DDDDD, which established national MACT emission limits and work practice standards for major sources of HAPs emitted from industrial, commercial, and institutional boilers and process heaters. This subpart also established requirements to demonstrate initial and continuous compliance with the emission limits and work practice standards. The standards in this rule required the following:

- Existing large solid fuel units larger than 10 MMBtu
 - PM – 0.07 lb/MMBtu, or TSM – 0.001 lb/MMBtu
 - HCl – 0.09 lb/MMBtu (~ 90 ppm)
 - Hg – 9 lb/trillion Btu

- New solid fuel units (no size limit)
 - Total PM – 0.025 lb/MMBtu, or TSM – 0.0003 lb/MMBtu
 - HCl – 0.02 lb/MMBtu (20 ppm)
 - Hg – 3 lb/trillion Btu
 - CO – 400 ppm @ 7% oxygen (not for small units)

On June 8, 2007, the D.C. Circuit Court of Appeals vacated and remanded the boiler MACT regulations in subpart DDDDD back to EPA. In response, EPA is revising the MACT regulations that, when promulgated, will apply only to plant sites and other facilities defined as “major sources” of HAPs under CAA § 112. It is very unlikely that emissions from a unit at a school or at a small commercial or institutional facility will exceed the “potential to emit” HAPs threshold of the revised MACT rule. Accordingly, this emissions standard will affect few if any small woody biomass boilers.

There is a provision in the Clean Air Act, contained in CAA § 112(j), that requires states to develop case-by-case MACT limits if EPA fails to promulgate MACT regulations by certain deadlines specified in the Clean Air Act. With the vacatur of the subpart DDDDD regulations, CAA § 112(j) requirements have been triggered for major industrial, commercial, and institutional boilers and process heaters. Regulations vary significantly from state to state, with some states prohibiting small solid fuel boilers while other states have virtually no requirements.

Area Source Rule for Industrial, Commercial, and Institutional Boilers

EPA has been under a court-ordered schedule to promulgate standards for area source emission standards for all industrial, commercial, and institutional boilers under CAA § 112. Under the CAA, EPA was to develop these rules within ten years of the promulgation of the 1990 Amendments, however, EPA failed to meet this deadline and was put under court ordered

deadlines in 2006.² Under the settlement order, EPA is required to propose area source boiler standards by July 15, 2009 and promulgate them by July 2010. The following highlights the requirements EPA must meet in developing the area source standard for industrial, commercial, and institutional boilers:

- EPA is required under CAA §§ 112(c)(3) and (k) to issue emissions standards for “area sources.” Area Source Rules for industrial, commercial, and institutional boilers applies to any unit in the category regardless of fuel type and applies to both new and existing units.
- Under CAA § 112(d)(5), the Administrator may, in lieu of MACT standards under § 112(d)(2), elect to promulgate standards or requirements for area sources, “which provide for the use of generally available control technologies (GACT) or management practices by such sources to reduce emissions of hazardous air pollutants (HAPs).”
- While the use of GACT standards may be an option for some pollutants emitted from this source category, EPA is also required to meet the provisions of CAA § 112(d)(2) and § 112(d)(4), which requires EPA to set MACT levels of control for area sources that are identified as emitting POM and mercury pursuant for those sources listed in CAA § 112(c)(6). Industrial, commercial, and institutional boilers are on the CAA § 112(c)(6) list for mercury and POMs, and therefore MACT control levels must be established.
- MACT requirements establish both emission limits and annual testing requirements to confirm compliance with the regulation. It is likely that the MACT requirements for industrial boilers will inform and direct the area source rule.

CAA § 129. Issue of Definition of Solid Waste

CAA § 129 contains requirements for solid waste incinerators burning “any” amount of “solid waste” materials. The same D.C. Circuit Court of Appeals decision vacating subpart DDDDD also vacated and remanded the Commercial and Industrial Solid Waste Incineration (CISWI) definitions rule, issued under CAA § 129. The court ruled that EPA erred by excluding units that combust solid waste for purposes of energy recovery from the CISWI rule and including such units in the industrial boiler MACT rule instead.

In response to the court’s decision, EPA is establishing new standards under both § 112 and § 129 for the various units subject to each section. Additionally, EPA is undertaking a review of which materials are “solid wastes” pursuant to the Resource Conservation and Recovery Act (RCRA).³ In this review, EPA’s Office of Solid Waste will determine, through notice and comment rulemaking, whether biomass or certain types of biomass are discarded, and therefore a solid waste, or alternatively are fuels for purposes of RCRA. If a small woody biomass boiler burns material that is considered “solid waste,” it will be subject to regulation under CAA § 129 as an incinerator and the costs for operating such sources would likely be higher. For example, incinerator regulations require source testing for nine pollutants, including dioxins.

² *Sierra Club v. Johnson*, http://www.epa.gov/ttn/atw/area/269439-v1-order_case_033106.pdf.

³ Under CAA § 112(g)(6), the term “solid waste” shall have the meaning established by the Administrator pursuant to RCRA.

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**UPDATE ON FEDERAL AIR POLLUTION REGULATIONS FOR SMALLER
COMMERCIAL/INSTITUTIONAL BOILERS¹**

January 29, 2009

This document provides an update concerning certain upcoming federal air pollution regulations for smaller institutional/commercial boilers, including those that burn wood. EPA is currently in the process of developing a proposed rule. Information in this document does not represent a final decision by EPA.

- EPA is under court order to propose an area source rule for boilers by July 15, 2009. The standards would set limits on the amount of hazardous air pollutants (“HAP” or “air toxics”) that may be emitted by smaller institutional/commercial boilers, including those that burn wood to provide heat or energy for schools, hospitals, prisons, manufacturing facilities, and farms.
- Wood boilers less than 20 million Btus per hour (MMBtu/hr) would most likely meet the definition of “area source” in the Clean Air Act and would therefore need to comply with the area source boilers rule. As with any rulemaking that sets emission standards, the proposed rule could change the costs of installing, operating, and/or maintaining a wood boiler.
- When the Agency establishes emission standards for a source category under Section 112 of the Clean Air Act, like the boilers category, it establishes standards for both new and existing sources. The standards for new and existing sources may be identical or they may differ, depending on the facts of the particular source category at issue. The Agency is exploring whether to include different requirements for new and existing boilers in the proposed rule. Among other things, the Agency is exploring requirements for annual tune ups, work practice standards, and operator training for both new and existing boilers. Details will be available when the proposed rule is issued.
- If you are considering installing one of these smaller wood boilers, and your boiler has not commenced construction by the date of the proposal, then you will be subject to the new source requirements after EPA issues a final rule
- If you already operate one of these smaller wood boilers, EPA recommends you continue to consider technology retrofits and other strategies to reduce air pollution from the unit.
- Boilers that meet the definition of an area source will be responsible for complying with the area source rule. New boilers, those that commence construction after the date of the proposal, will need to comply with the limits on the later of startup of the boiler or the date of the final rule. The compliance deadline for existing boilers will be established in the final

¹ Healthy Forests and Rangelands, U.S. Department of the Interior and U.S. Department of Agriculture, http://www.forestsandrangelands.gov/Woody_Biomass/documents/boiler_area_source_rule_briefing_paper.pdf (accessed August 21, 2009).

rule. The Clean Air Act requires that existing boilers comply with the area source rule as expeditiously as practicable, but no later than three years after the effective date of the standards.

- EPA will solicit public comment on the proposal after it is signed and before EPA issues a final rule. EPA is under a court order to issue a final rule by July 15, 2010.
- The area source rule proposal will address toxic air emissions from boilers. EPA remains concerned about the health effects associated with particle pollution in wood smoke.
- Smoke from wood boilers is made up of a complex mixture of gases and fine particle pollution. Scientific studies show an association between exposure to particle pollution and significant health problems, such as aggravated asthma, aggravation of lung and heart disease, and increased frequency and severity of respiratory symptoms such as difficulty breathing and coughing.
- To protect children, older adults and others from the adverse effects of particle pollution, EPA advises boiler operators to consider technology retrofits to reduce particle pollution from existing wood boilers, especially those at schools and hospitals.

More detail

- Area source rules are technology-based and designed to control emissions of hazardous air pollutants (HAPs or “air toxics”).
- EPA’s area source rules usually set emission limits for HAPs based on generally available control technology (GACT), which allows EPA to consider costs and economic impacts of the technology requirements. However, EPA has to set emission limits for area source boilers based on maximum achievable control technology (MACT) for mercury and polycyclic organic matter (POM) because institutional/commercial wood boilers are on the list of Clean Air Act Section 112(c)(6) source categories.
- MACT and GACT requirements on these boilers may differ for new and existing facilities. Details will be available when the proposed rule is published.
- Based on the technical information the Agency has reviewed to date, high efficiency fabric filters appear to be the leading technology for mercury reductions from boilers. EPA is also considering whether to use carbon monoxide (CO) as a surrogate for the organic HAP and total particulate matter (PM) as a surrogate for non-mercury metal HAP.
- The Agency is evaluating different monitoring, record keeping, and reporting requirements.
- The Agency is also exploring high efficiency boiler and fabric filter combinations as a possible component of an emission limit for new sources. Other items under consideration for both new and existing sources include energy audits, annual tune ups, and good combustion practices and boiler design.

-
- Other local, state and/or federal regulations may also apply now or in the future to institutional/commercial boilers.

Clean Air Act Definitions

Area source – Sources that emit less than 10 tons annually of a single hazardous air pollutant or less than 25 tons annually of a combination of hazardous air pollutants (HAPs). For more information about area source rules, go to <http://www.epa.gov/ttn/atw/area/arearules.html>

GACT – Generally available control technology. The standards for many area sources are based on GACT.

MACT – Maximum achievable control technology. MACT standards are based on the emission levels of the better-controlled and lower-emitting facilities in a category.

HAP – Hazardous air pollutants. HAPs are also called air toxics or toxic air pollutants.

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WOOD-FIRED RESIDENTIAL DEVICES

Fireplaces

There are 35 million fireplaces in the U.S. estimated to contribute 84,000 tons per year of direct PM emissions.

Indoor Woodstoves

Indoor woodstoves are among the most commonly used residential biomass heating devices. In 2007, EPA estimated that there were 9-14 million indoor woodstoves in use in the United States.¹ Most of the indoor woodstoves manufactured today must meet emission standards set forth in the Residential Wood Heater NSPS promulgated in 1988. In the mid 1990s, the State of Washington set an emission standard that is almost 40 percent lower than the standard set in the NSPS. It is estimated that 85 percent of the units sold today meet the Washington State standard. While significant improvements have been made to these devices in the past 20 years, indoor woodstoves continue to be a major source of direct PM emissions. EPA estimates that indoor woodstoves emit 336,000 tons per year of direct PM emissions. Due to the low replacement rates for indoor woodstoves, it is estimated that 75-80 percent of the units in use today were made prior to the NSPS requirement and emits at levels 95 percent higher than those manufactured today.

Pellet Stoves

Instead of logs, pellet stoves burn a renewable fuel made of ground, dried wood and other biomass wastes compressed into pellets. Currently, pellet stoves do not require EPA certification; some manufacturers, however, voluntarily seek this certification. While it is assumed that these devices burn cleanly since there is no requirement to conduct emission or efficiency testing, it cannot be guaranteed that all units burn cleanly.

Outdoor Furnaces/Boilers

An OWB is basically a wood-fired furnace housed within a small insulated shed that is located some distance from a house. The unit itself consists of a large firebox, which is built to accommodate large loads of either split or whole cordwood. OWBs vary in size but are typically three to five feet wide, six to nine feet deep, and six to ten feet tall (including the height of the chimney). These units are designed to burn large amounts of wood over long periods of time.²

In recent years use of these devices has become controversial. In response, states have enacted emission standards and EPA has developed a voluntary labeling program. It is estimated that there are approximately ~200,000 OWBs nationwide, with more than 90 percent of them located in the Northeast and Midwest. EPA estimates that these units emit ~176,000 tons per year of direct PM emissions.

Other Solid Fuel Residential Devices

- Exempt from federal regulations
- Not regulated at state level
- Use increasing

¹ EPA presentation available at http://www.marama.org/calendar/events/presentations/2007_09RWC/Brockman-OverviewOfSignificanceOfResWoodSmoke-RWC07.pdf.

² Schreiber, J. et al. *Smoke Gets in Your Lungs: Outdoor Wood Boilers in New York State*. Office of the Attorney General; Albany, New York, 2005. Available at <http://www.oag.state.ny.us/press/2005/aug/August%202005.pdf>

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AIR EMISSIONS PERFORMANCE CHARACTERISTICS IN U.S. AND EUROPE TECHNICAL INFORMATION

Measured Performance: U.S.

Residential Devices

With current technologies, using wood for residential heating results in greater emission impacts than those associated with fossil fuels.

Table E1: Overview: U.S. Residential Wood Combustion Devices – Emissions Efficiency¹

<i>Device Type</i>	<i>Average PM Emission Range</i>	<i>Efficiency</i>
<i>Fireplace</i>	40-60 grams per hour	10%
<i>Pellet Stove</i>	unknown	70%
<i>Current NSPS woodstove</i>	2- grams per hour	67-75%
<i>Pre-NSPS woodstove</i>	40 grams per hour	54%
<i>OWB</i>	18-390 grams per hour	30-55%
<i>Oil Boiler</i>	<1 gram per hour	90%
<i>Natural Gas Boiler</i>	<1 gram per hour	90%

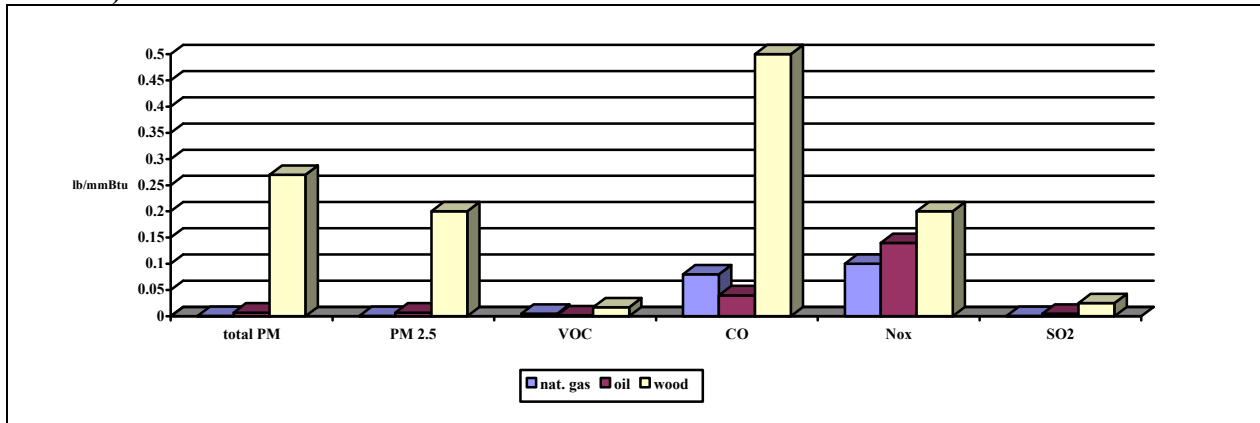
Commercial Wood Boilers

Current commercial wood boiler technology has higher stack emissions for all pollutants. Figure E1 provides an overview of emissions from these boilers and compares them to fuels commonly used in small-scale and medium-scale commercial and institutional applications in the Northeast. NESCAUM also reviewed emission results from stack testing data at 17 locations across the U.S. The units tested represent a variety of manufacturers and units ranging in size from one to 16 MMBtu. The tests were conducted between 1995 and 2008 under a variety of settings and purposes. The majority of the tests were not conducted for compliance reasons, so the results may not have undergone third party review and certification.

A summary of the stack testing results is provided in Table E3. Across all pollutants, the stack testing produced a wide range of results, often varying by an order of magnitude or more. In light of the wide range, Table E3 also displays the average result of all stack tests for each pollutant. The complete data set is available from NESCAUM in an Excel spreadsheet.

¹ EPA presentation available at http://www.marama.org/calendar/events/presentations/2007_09RWC/Brockman-OverviewOfSignificanceOfResWoodSmoke-RWC07.pdf.

Figure E1: Overview of Baseline Emissions for U.S. Boilers: Three Fuel Types (pounds per MMBtu)²



Measured Performance: EU

Residential and Industrial-Commercial

The PM_{2.5} emissions performance of European wood-fired boilers is considerably better (often representing reductions of 90 percent or more) than those used in the U.S., as shown in Figures E2 and E3. Even without post-combustion flue gas treatment (e.g., electrostatic precipitators - ESPs), the European units emit at levels that U.S. units can only meet with advanced emission control devices. European units emit PM_{2.5} in the range of 10 to 20 mg/MJ (or 0.02 to 0.04 lb/MMBtu), a reduction of 90 percent or higher compared to older technologies still used in the U.S. Such PM_{2.5} emission levels have been achieved with all common types of wood fuel (logwood, pellets and wood chips) in both residential and commercial wood-fired boilers produced in Austria. The PM_{2.5} emissions of best-in-class, Austrian wood-fired boilers without controls emit PM_{2.5} at levels somewhat above those for U.S. oil-fired boilers. European units also typically emit carbon monoxide (CO) at lower rates than U.S. units. Emissions for best-in-class products in Europe are typically under 100 ppm and thus comparable to modern gas and oil-fired boilers.³

European wood-fired boilers (over 1.8 MMBtu/hr capacity) are also frequently installed with post-combustion, flue gas clean-up devices including cyclones, ESPs, or baghouse filters. While cyclones are generally effective only for removal of smoke particles down to about 10 microns, ESPs and baghouse filters can be highly effective in reducing emissions of fine particulates as small as 0.1 microns in size. ESPs and baghouse filter systems can reduce PM_{2.5} emissions from levels in the 0.1 to 0.2 lb/MMBtu range (raw exhaust) by 80 to 90 percent or more depending on design.⁴ ESPs for residential and small commercial size wood-fired boilers have also been developed. Such devices have shown the capability to reduce PM_{2.5} emissions by approximately the same percentages as observed for commercial and industrial ESP systems. When used on

² These data were reviewed and deemed appropriate by EPA OAQPS.

³ Presentation Ray Albrecht, NYSERDA, September 2007. Available at: http://www.marama.org/calendar/events/presentations/2007_09RWC/Albrecht-UltralowEmissionsEuropeanWood-RWC07.pdf.

⁴ Amar, P., (NESCAUM). Applicability and Feasibility of NOx, SO₂, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers. November 2008.

best-in-class residential and small commercial size wood-fired boilers (which can achieve PM_{2.5} emission levels as low as 10 mg/MJ (0.02 lb/MMBtu) without any flue gas treatment), ESPs can enable final PM_{2.5} emission levels below 0.01 lb/MMBtu.⁵

Figure E2: Comparison of Particulate Matter Emissions for Residential Devices

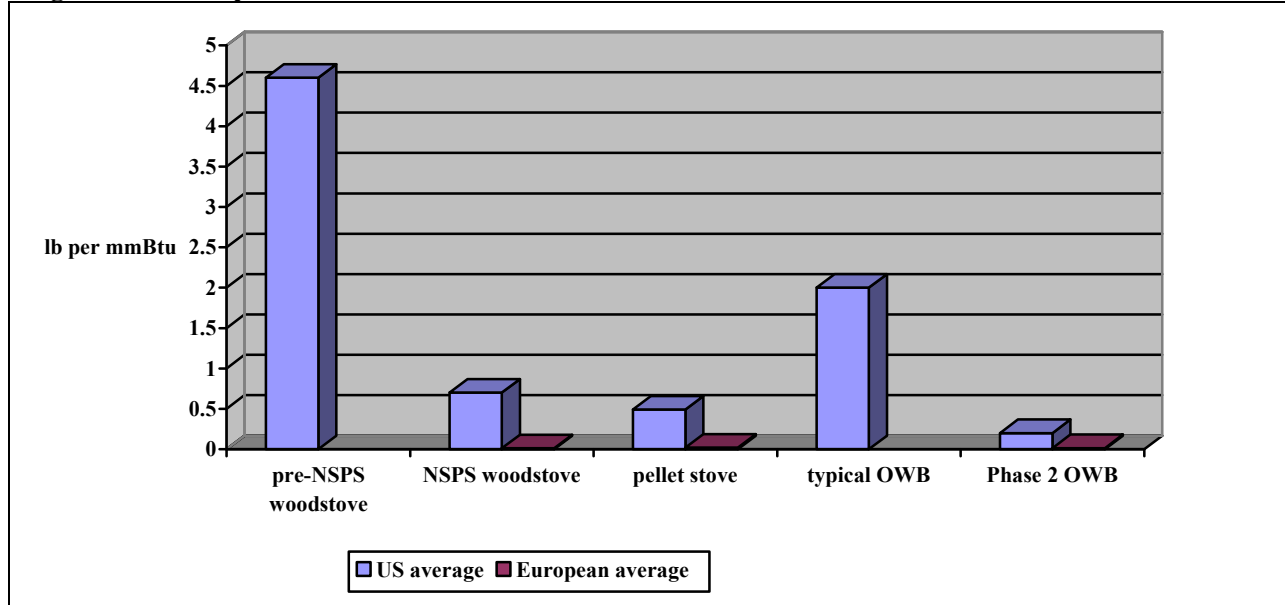
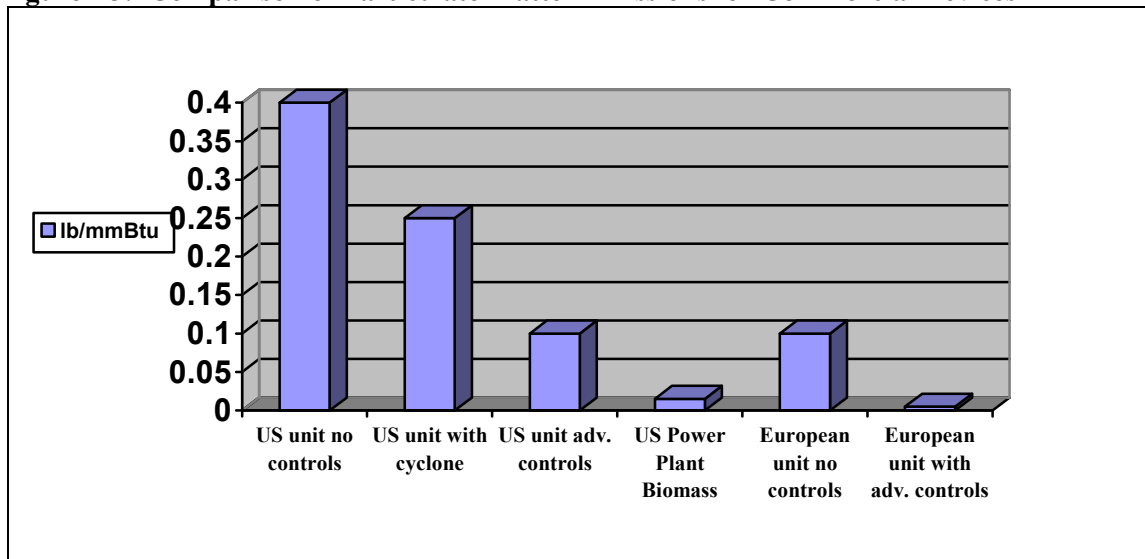


Figure E3: Comparison of Particulate Matter Emissions for Commercial Devices



⁵ Presentation Ray Albrecht, NYSERDA, September 2007. Available at: http://www.marama.org/calendar/events/presentations/2007_09RWC/Albrecht-UltralowEmissionsEuropeanWood-RWC07.pdf.

Test Method Differences – U.S. and Europe

Test methods must be carefully examined when analyzing emissions data from European and U.S. units, particularly since significant variations in test method protocols exist for residential devices, such as woodstoves and furnaces (e.g., measurement methods, fueling protocols, burn rates, and use of different wood heating values). However, test protocols for commercial devices are similar and results between the two test methods are likely to be comparable. Table E2 highlights variations in the test method.

Table E2: Comparison of Test Methods

	U.S. Test Method 28	U.S. Test Method 5	CEN Test Method
Fuel type	Douglas fir dimensional lumber	All solid fuels	All solid fuels
Feeding method	Hand fed	Hand and automatic feed	Hand and automatic feed
Firing rate	Four firing rates: <ul style="list-style-type: none"> ➤ <15% ➤ 15-30% ➤ 30-50% ➤ maximum load 	No firing load requirement	Two firing rates <ul style="list-style-type: none"> ➤ Nominal load ➤ 30% load (50% for hand-fired units)
Pollutants measured	Total particulate matter	Filterable particulate matter – three 60 minute samples.	Continuous emission monitoring of: <ul style="list-style-type: none"> ➤ CO₂ ➤ O₂ ➤ CO ➤ Organic carbon ➤ VOC ➤ NO_x ➤ efficiency Dust (filterable PM) four 30 minute samples
Sampling method	Dilution tunnel	Hot filter	Hot filter

Residential – Key Variations in Test Methods

- In the U.S., residential units are typically tested in a lab setting using U.S. EPA Test Method 28. Direct comparison between limit values achieved using U.S. EPA Test Method 28 and testing methods typically used in Germany, Switzerland, and Austria is not possible. Key differences include the particulate matter sampling (dilution tunnel in the U.S. vs. hot filter in the EU), fuel used (dimensional lumber in the U.S. vs. cordwood in the EU), and different firing rates (four burn rates in the U.S. vs. two in the EU). Research indicates that the type and moisture content of wood can significantly influence emission outcomes. European units are not tested at the low level burn rate test, so it is not known how well they perform when the dampers are completely turned town.

The greatest impact in measurement is likely to be from the particulate matter sampling methods. U.S. Test Method 28 uses dilution tunnel sampling, which capture the total PM, including the filterable and condensable portion of the particulate matter. Typical

European testing uses hot filter sampling techniques. This method only captures the filterable particulate matter.⁶

- A second major difference between methods is the fuel used for the tests. EPA Test Method 28 employs a test fuel called a crib, which is made up of dimensional lumber (Douglas fir for woodstoves, red oak for OWBs) with a specified moisture content configured under conditions prescribed in the test method. The European test method utilizes the use of cordwood (type of wood is specified by the manufacturer) that is randomly loaded into the device.
- A third difference between the test methods is the use of different firing rates. EPA Test Method 28 requires testing at four burn rates, less than 15 percent of maximum; 15-30 percent of maximum, 30-50 percent of maximum and maximum capacity, while the European test only requires testing at nominal load and 30 percent load (50 percent for hand-fired units). The most significant variation is the low load test requirement. Since European units are not tested at this low level of operation, it is not known how well they perform when dampers are completely turned down.

⁶ The hot filter test methods will not capture the condensable portion of particulate matter but it is not understood how the fraction of condensable emissions changes with more efficient, less polluting units. In larger high efficiency units, the condensable portion of total particulate matter tends to be less than 10 percent of the total PM. However, with less efficient units, the condensable fraction can be more than 50 percent of the total particulate matter.

Stack Testing

Table E3: Summary of Stack Test Results (pounds per MMBtu)

<i>Pollutant</i>	<i>Number of runs</i>	<i>Range of results</i>	<i>Average stack test result</i>
Total PM	46	0.1 – 1.15	0.27
PM filterable	39	0.06 – 0.67	0.19
PM 2.5	31	0.12 – 1.95	0.20
PM condensable	19	0.04 – 0.20	0.05
Nitrogen Dioxide	45	0.11 – 0.43	0.20
Carbon Monoxide	44	0.04 – 2.27	0.38
Formaldehyde	12	0.00000018 – 0.00357	0.000837
Acenaphthene	6	0.00000021 – 0.00000101	0.00000061
Acenaphthylene	6	0.0000247 – 0.000555	0.0001184167
Acetaldehyde	4	0.000208 – 0.0000000710	5.10E-08
Anthracene	6	0.00000131 – 0.0000376	0.0000083450
Arsenic	10	0.0000004950 – 0.000009	0.000004
Barium	6	0.000036 – 0.000125	0.000072
Benzene	6	0.000169 – 0.00000212	0.0000513
Benzo(a)anthracene	6	0.000000743 – 0.0000426	0.0000089022
Benzo(b)fluoranthene	6	0.00000259 – 0.0000572	0.0000143717
Benzo(k)fluoranthene	6	0.000000589 – 0.00000884	0.0000024645
Benzo(g,h,i)perylene	7	0.000000848 – 0.0000385	0.0000072224
Benzo(a)pyrene	6	0.000000463 – 0.0000357	0.0000072107
Benzo(e)pyrene	6	0.00000153 – 0.0000348	0.0000090450
Beryllium	6	0.0000011 – 0.000000107	
Cadmium	12	0.000000127 – 0.000078	0.000016
Chromium total	12	0.000000127 – 0.000081	0.000020
2-chloronaphthalene	6	0.0000000412 – 0.0000000039	0.0000000155
Chrysene	6	0.00000253 – 0.0000492	0.000013695
Copper	6	0.000044 – 0.000094	0.000056
Dibenz(a,h)anthracene	6	0.0000000618 – 0.0000206	0.0000035542
Dioxin/furan	6	2.16E-11 – 4.15E-12	1.06E-11
Fluoranthene	7	0.00000785 – 0.000172	0.0000464843
Fluorene	8	0.000000393 – 0.00000635	0.0000023923
Hexavalent. Chrome	6	0.000001 – 0.000002	0.000001
Indeno(1,2,3,cd)pyrene	6	0.000000638 – 0.00000457	0.0000020213
Lead	6	0.0000208 – 0.000067	0.000038
Manganese	6	0.000086 – 0.000725	0.000323
2-methylnaphthalene	6	0.000003 – 0.000027	0.000013
Naphthalene	12	0.00000132 – 0.000012	0.000007
Nickel	12	0.000000264 – 0.000082	0.000017
PAH (total)	12	0.00000132 – 0.001881	0.000287
Perylene	6	0.0000000694 – 0.00000781	0.0000015087
Phenanthrene	9	0.0000044 – 0.000547	0.0000991233
Pyrene	8	0.00000337 – 0.000147	0.0000363038
Selenium	6	0.00000055 – 0.000005	0.000002
Silver	6	0.000001 – 0.000003	0.000002
Zinc	6	0.000498 – 0.001070	0.000761

The stack testing results collected can be compared with emission factors from other traditional fuels used in similar applications.

**SAFETY REGULATIONS FOR BIOMASS SYSTEMS
NORTHEAST STATES**

State	Safety Codes	Significant Exceptions	Variations
<p>Connecticut¹ Connecticut Department of Public Safety Division of Fire, Emergency and Building Services Office of State Building Inspector Bureau of Boilers</p>	<p>The Commissioner of Public Safety shall formulate regulations for the design, construction, installation, repair, use and operation of boilers in Connecticut. Such regulations shall conform as nearly as possible to the Boiler Code of the American Society of Mechanical Engineers, and the National Board Inspection Code, both as amended, and shall prescribe requirements as to the construction, installation, repair, use and inspection of boilers in the interest of public safety.</p>	<p>Relevant exempt boilers include: (1) Boilers under federal control; (2) portable boilers used in pumping, heating, steaming and drilling in the open field; (3) portable boilers used solely for agricultural purposes; (4) steam heating boilers, hot water heaters and hot water heating boilers, when used in private homes or apartment houses of not more than five families; and (5) hot water heaters approved by a nationally recognized testing agency that are equipped with adequate safety devices including a temperature and pressure relief valve, having a nominal water capacity of not more than one hundred twenty gallons and a heat input of not more than two hundred thousand British thermal units per hour and used solely for hot water supply carrying a pressure of not more than one hundred sixty pounds per square inch and operating at temperatures of not more than two hundred ten degrees Fahrenheit, provided such heaters are not installed in schools, day care centers, public or private hospitals, nursing or boarding homes, churches or public buildings.</p>	<p>A person may apply to the State Building Inspector to grant variations or exemptions from, or approve equivalent or alternate compliance with, standards incorporated in the regulations... and the State Building Inspector or a designee may approve such variations, exemptions, or equivalent or alternate compliance where strict compliance with such provisions would cause practical difficulty or unnecessary hardship.</p>
<p>Maine² Maine Department of Professional and Financial Regulation Office of Licensing & Registration</p>	<p>Unless otherwise exempt, all new boilers and pressure vessels to be installed must be inspected during construction by an inspector authorized to inspect boilers in this State, or, if constructed outside the State, by an inspector holding a license from this State or an inspector who holds a certificate of inspection issued by the National Board of Boiler and Pressure Vessel Inspectors, or its successor or other organization approved by the board.</p>	<p>Relevant exempt boilers include: Boilers that are under federal control; Boilers used for agricultural purposes only; Steam heating boilers, hot water heating boilers and hot water supply boilers, except boilers located in schoolhouses or boilers owned by municipalities, constructed and installed in accordance with the rules adopted by the board;</p>	<p>A person who is or will be aggrieved by the application of any law, code or rule relating to the installation or alteration of boilers and pressure vessels may file a petition for a variance, if the enforcement of any law, code or rule relating to boilers or pressure vessels would do manifest injustice or cause substantial hardship, financial or otherwise, to the petitioner or would be unreasonable under the circumstances as long as desirable relief may be granted without substantial detriment to the public good and without nullifying or substantially derogating from the intent or purpose of that law, code or rule. In granting a variance under this section, the chief inspector may impose limitations both of time and of use, and a continuation of the use permitted may be conditioned upon compliance with rules made and amended from time to time.</p>

Compiled by: Rick Handley

¹ <http://www.cga.ct.gov/2008/sup/chap540.htm>

² <http://www.mainelegislature.org/legis/statutes/32/title32ch131sec0.html>

State	Safety Codes	Significant Exceptions	Variances
Massachusetts³ Department of public safety division of inspection	In accordance with the provisions of M.G.L. c. 146,s 2, the Board of Boiler Rules herewith adopts by reference the 1998 A.S.M.E. Boiler and Pressure vessel Code section I, Power Boilers with 1999 addenda	Relevant exempt boilers include: Boilers under the jurisdiction of the United State; Boilers used exclusively for horticultural or agricultural purposes; Steam Heating Boilers. Having a capacity of more than 207 pounds of steam per hour output and not in excess of 15 p.s.i.; Hot water heating Boilers, not exceeding 30 psig operating pressure; or 250°F operating temperature, or having a capacity of more than 200,000 BTU output of the boiler nozzle; Hot Water Supply Boilers and Other Liquid Heat Storage Sources Not Exceeding,160 psig operating pressure, 250°F operating temperature, provided that they not exceed, A heat input of 200,000 BTU per hour, a water temperature of 200°F, or a nominal water containing capacity of 120 gallons.	When a person or a corporation desires to manufacture a special type of boiler, the design of which is not covered by the rules formulated by the board or by the current section one, four or eight of the ASME Code, specifications and drawings shall be submitted through the chief of inspections to the board which, if it approves, shall permit the construction thereof.
New Hampshire⁴ The Department of Labor	Boilers and pressure vessels, as defined in RSA 157-A: 2, shall conform to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code.	Relevant exempt boilers include: boilers under federal control, or United States Coast Guard control; Boilers with less than 200,000 BTU/HR output in apartment houses; Pressure vessels operating at a working pressure not exceeding 15 psig; and Hot water boilers rated at less than (a) Heat input of 200,000 BTU/HR. (b) Water temperature of 210 degrees F.	Any boiler or pressure vessel that does not conform to the standards established under RSA 157-A:3 (ASME) may be operated under the following conditions: An inspection of such boiler or vessel shall be conducted annually by a person qualified under RSA 157-A:7 and in accordance with rules adopted by the commissioner, and such boiler or vessel shall conform to any conditions or restrictions established by the commissioner

³ http://www.mass.gov/Eeops/docs/dps/inf/522_cmr_1.00_14.00_board_of_boiler_rules.pdf

⁴ <http://www.gencourt.state.nh.us/rules/lab1200.html>

State	Safety Codes	Significant Exceptions	Variances
<p>New Jersey⁵ New Jersey Department of Labor & Workforce Development - Labor Standards & Safety Enforcement - Bureau of Boiler and Pressure Vessel Compliance</p>	<p>All boilers shall be constructed and installed in accordance with the applicable sections of the ASME Boiler and Pressure Vessel Code and The National Board Inspection Code</p>	<p>Relevant exempt boilers include:</p> <p>Steam boilers operating at a pressure not greater than 15 psig when such boilers serve dwellings of less than six family units or other dwellings with accommodations for less than 25 persons;</p> <p>Hot water boilers at a pressure not greater than 160 psig and hot water boilers limited to temperatures not exceeding 250 degrees Fahrenheit when such boilers serve dwellings of less than six family units or other dwellings with accommodations for less than 25 persons;</p> <p>Any steam or hot water boiler having a heat input of less than 10 kilowatts or less than 40,000 BTU per hour;</p> <p>Any steam or hot water boiler under the jurisdiction and control of the United States Government when actively regulated by a Federal agency; and Any steam or hot water boiler used solely for the propulsion of a motor vehicle regulated by the Motor Vehicle Act, Title 39 of the Revised Statutes.</p>	<p>A code of construction which is a national or international standard and is recognized by regulation and by the country of origin, when applicable, shall be acceptable as an alternate code of construction under this subchapter, provided that it has been fully and finally approved and accepted as an alternate code of construction by the NBBPVI</p>
<p>New York⁶ New York Department of Labor - Division of Safety & Health - DOSH - Boiler Safety Bureau</p>	<p>No boiler shall hereafter be installed in this State unless it has been constructed in accordance with the requirements of the American Society of Mechanical Engineers and the National Board of Boiler and Pressure Vessel inspectors and is so tamped and registered.</p>	<p>Relevant exempt boilers include: Boilers subject to inspection by DOT, boilers located on farms used solely for agriculture purposes, boilers subject to inspection by a federal agency, low-pressure boilers under 100,000 BTU/HR, steam boilers operation at 15 psi or less in dwelling occupied by fewer that 6 families</p>	<p>None found</p>

⁵ http://lwd.dol.state.nj.us/labor/lse/laws/boiler_law.html#90-4.1

⁶ <http://www.labor.state.ny.us/workerprotection/safetyhealth/sh14.shtm#14.9.41>

State	Safety Codes	Significant Exceptions	Variances
<p>Pennsylvania⁷ Pennsylvania Department of Labor & Industry - Boiler Division</p>	<p>Every boiler destined for use in this commonwealth shall be inspected during its construction by an individual who has a valid National Board commission to perform an inspection. Every boiler which has been so inspected shall, upon completion, have placed upon it a stamp bearing a symbol and number authorized by the department for this purpose. The department may accept comparable shop inspection and quality control standards which are equivalent to or exceed the ASME or National Board standards.</p>	<p>Relevant exempt boilers include: Boiler installations in a single-family residence (as long as a business is not located in the home) in apartment buildings with four (4) or fewer dwelling units, Boiler installations in agricultural buildings used for farming operations (this does not include farm buildings where sales occur or where agricultural processing may occur), Boilers or unfired pressure vessels owned and operated by the federal government, Storage water heaters and instantaneous water heaters when none of the following limitations are exceeded:</p> <ul style="list-style-type: none"> • A heat input of 200,000 BTU per hr. • A water temperature of 210° F. • A nominal water-containing capacity of 120 gallons. 	<p>Any boiler or unfired pressure vessel which has not been shop-inspected as required under subsection (a) may be installed within this Commonwealth if the following requirements are met:</p> <ol style="list-style-type: none"> (1) Submission of a request to install the equipment, in a form prescribed by the department, to the department. (2) Furnishing of mill test reports of material to show compliance with the ASME Code or another code accepted by the department. (3) Furnishing of calculations and stress analyses showing the maximum allowable working pressure under the ASME Code or another code accepted by the department. These stress analyses shall be certified by a registered professional engineer. (4) If equipment is of welded construction, all seams that are required to be X-rayed by the ASME Code or another code accepted by the department shall be X-rayed. (5) Establishment that welding meets requirements of the ASME Code or another code accepted by the department. (6) Subjection of equipment to nondestructive examination or test that verifies structural integrity. (7) All tests shall be made under the supervision of a Commonwealth-commissioned inspector or an individual holding a valid national board commission. (8) Submission of a data sheet comparable to the appropriate ASME data report form and certified by a national board-commissioned inspector. (9) If mill test reports, names of welders or other required information cannot be produced, the department may, in its discretion, accept other documentation. (10) Payment of a special equipment application fee. (11) Compliance with the requirements outlined under section 7.

⁷ <http://www.dli.state.pa.us/landi/CWP/view.asp?a=185&Q=70059>

State	Safety Codes	Significant Exceptions	Variances
<p>Rhode Island⁸ Rhode Island Department of Labor & Training - Division of Occupational Safety - Boiler Unit</p>	<p>Codes adopted and enforced shall be the standard code of rules as published and enunciated by the American Society of Mechanical Engineers and the National Board of Boiler and Pressure Vessel Inspectors and any amendments to them, as were in effect as of January 1, 2007.</p>	<p>Relevant exempt boilers include: Boilers and pressure vessels under federal control, Pressure vessels having an internal or external working pressure not exceeding fifteen (15) psig, with no limit on size, Steam boilers used for heating purposes carrying a pressure of not more than fifteen (15) pounds per square inch gauge, and which are located in private residences or in apartment houses of less than six (6) family units provided the boiler heat input does not exceed four hundred thousand (400,000) BTU per hour, Hot water heating boilers which are located in private residences or in apartment houses of less than six (6) family units provided the boiler heat input does not exceed four hundred thousand (400,000) BTU per hour, and) Hot water boilers and hot water heaters operated at pressure not exceeding one hundred sixty (160) pounds per square inch gauge, or temperatures not exceeding two hundred fifty degrees (250°) F. which are located in private residences or in apartment houses of less than six (6) family units provided the boiler or hot water heater is not in a place of public assembly.</p>	<p>Any person, who believes the rules and regulations promulgated under 28-25 of the General Laws impose an undue burden upon the owner or user, may request a variation from such rule or regulation. The request for variation shall be made to the Administrator of Occupational Safety in writing and shall specify how equivalent safety is to be maintained. The Administrator, after investigation and such hearing as it may direct, may grant such variation from the terms of any rule or regulation provided such special conditions as may be specified are maintained in order to provide equivalent safety.</p>
<p>Vermont⁹ Vermont Department of Public Safety - Division of Fire Safety - Boiler & Pressure Vessel Safety Program</p>	<p>All boilers and pressure vessels shall be manufactured, constructed and assembled in accordance with the appropriate American Society of Mechanical Engineers (ASME) standards, or equivalent standard recognized by the National Board of Boiler & Pressure Vessel Inspectors.</p>	<p>Relevant exempt boilers include: Boilers under federal control and subject to regulations under the Surface Transportation Board, Department of Transportation, Federal Railroad Administration or Nuclear Regulatory Commission. Hot water heaters and portable water storage tanks with a heat input of less than 200,000 BTU/HR, water temperature less than 210 degrees (F) and less than 120 gallons aggregate water capacity.</p>	<p>The Commissioner may grant a variance approving a different solution to compliance that meets the intent of this code, or may exempt a portion of a building, or equipment including non-standard boilers and pressure vessels, from the requirements of this Code.</p>

⁸ <http://www.dlt.ri.gov/occusafe/boilerlaws.htm>

⁹ <http://www.dps.state.vt.us/fire/05firecodeadopted.pdf>