

Task 5
Technical Memorandum 3 (Cost Benefit Analysis)

Control Analysis and Documentation for
Residential Wood Combustion in the MANE-VU Region

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1. Introduction

Task 5 of the contract for the *Control Analysis and Documentation for Residential Wood Combustion Emissions in the MANE-VU Region* is a cost benefit analysis for air pollutant reductions (Technical Memorandum 3). The costs associated with converting to improved technology and alternative fuels from traditional cordwood-burning units are provided. The cost benefit analysis is for criteria air pollutant reductions with emphasis being placed on PM_{2.5} and volatile organic compounds (VOC) due to PM_{2.5} and ozone nonattainment, as well as, regional haze being topical issues. As directed by the Mid-Atlantic Regional Air Management Association (MARAMA), Task 5 emphasis was shifted from a Reasonably Available Control Measures (RACM) analysis to a cost benefit analysis to provide air quality planners and regulators supporting information for their individual development of RACM.

However, for completeness, Section 2 of this document does provide a brief review of RACM and Best Available Control Measures (BACM) for residential wood combustion (RWC) developed for PM₁₀ control. These have been primarily implemented in the western U.S. where many PM₁₀ nonattainment areas with potential RWC impacts were/are located. State and local regulations have, in large part, reflected RACM/BACM guidance and notable state and local RWC regulations have been compiled as Appendix A in this document. As RWC emissions are primarily submicron in size, PM₁₀ RWC control measures are applicable to PM_{2.5}.

Section 3 of this document presents the key findings of Task 5 and provides the cost benefit for air pollutant reduction options for five categories of widely existing, older technology wood-burning devices. These are: (1) Freestanding cordwood stoves. (2) Cordwood-fueled fireplace inserts. (3) Cordwood fireplaces (without inserts) used for heating purposes. (4) Centralized cordwood heating systems. (5) Cordwood fireplaces used for aesthetic purposes. Table 1.1 lists these five categories with the improved technology replacement and installation scenarios, as well as, fuel alternatives that would reduce particulate and VOC emissions, that are in common use and are readily available to the public. Except for the fireplaces used for aesthetics category, the cost benefit analyses provided in Section 3 are presented by state and by Heating Degree Day (HDD) category as the heating (energy) demand varies with state and HDD category. For the fireplaces used for aesthetics, a single set of tables is provided for the MANE-VU region as the fuel usage in fireplaces used for aesthetics will not change significantly within the MANE-VU region.

Table 1.1
Improved Technologies and Fuel Alternatives

Existing Cordwood Device	High Technology Replacement, Installation or Alternative Fuel
Uncertified Freestanding Cordwood Stove	Replacement with Certified NSPS Non-Catalytic Cordwood Stove
	Replacement with Certified NSPS Catalytic Cordwood Stove
	Replacement with Pellet Stove
	Replacement with Gas Stove – natural gas (B vent, direct vent, vent free)
	Replacement with Gas Stove – LPG (B vent, direct vent, vent free)
Uncertified Cordwood Fireplace Insert	Replacement with Certified NSPS Non-Catalytic Cordwood Insert
	Replacement with Certified NSPS Replacement with Catalytic Cordwood Insert
	Replacement with Pellet Insert
	Replacement with Gas Insert – natural gas (B vent, direct vent, vent free)
	Replacement with Gas Insert – LPG (B vent, direct vent, vent free)
Cordwood Fireplace without Insert Used for Heating	Installation of Certified NSPS Non-Catalytic Cordwood Insert
	Installation of Certified NSPS Catalytic Cordwood Insert
	Installation of Pellet Insert
	Installation of Gas Insert – natural gas (B-vent, direct vent, vent free)
	Installation of Gas Insert – LPG (B-vent, direct vent, vent free)
	Installation of Vent-Free Gas Log Set – natural gas
	Installation of Vent-Free Gas Log Set – LPG (propane)
Cordwood Fireplace Used for Aesthetic Purposes	Installation of Gas Log Set – natural gas (vented and vent free)
	Installation of Vented Gas Log Set – LPG (vented and vent free)
	Wax/Fiber Firelog Fuel
Centralized Cordwood Heating System	Pellet Furnace or Boiler
	Gas Furnace or Boiler – natural gas
	Gas Furnace or Boiler – LPG

To facilitate understanding of the cost benefit analyses, descriptions of the various appliances used, as well as a brief discussion on efficiency, are provided. As noted, the cost benefit analyses focused on particles and VOC. However, the cost benefits for other relevant criteria pollutants are also included. The criteria pollutants and their treatment in these analyses are summarized in Table 1.2.

Cordwood-Fired Stoves and Fireplace Inserts

Uncertified, certified catalytic, and certified non-catalytic cordwood stoves and fireplace inserts together are considered cordwood heaters. They are designed to burn bulk cordwood and are room space heaters, i.e., they primarily rely on radiant and convection heat transfer, in contrast to centralized heating systems such as warm-air furnaces or boilers which utilized heat distribution systems to heat multiple rooms. Fireplace inserts are essentially wood stoves that are designed to be inserted into an existing fireplace cavity. Because of the heat transfer shielding effect of the fireplace cavity and the fact the majority of existing fireplace chimneys are against an outside wall, their heating efficiency is less than a similar freestanding woodstove model. Many fireplace inserts have fans to facilitate transfer of heat from the portion that is inside the fireplace cavity. Both freestanding cordwood stoves and fireplace inserts rely on a natural draft using room air for combustion, and the venting of exhaust. Though the majority of cordwood heaters use room air for combustion, some insert installations, such as in mobile homes, require the use of outside air for combustion.

Uncertified Conventional Cordwood-Fired Stoves and Fireplace Inserts

Uncertified cordwood fired stoves and fireplace inserts include units manufactured before the NSPS July 1, 1990 certification requirement, currently or recently manufactured exempt units which operate similarly to some old pre-EPA certification units, and low-technology units sold outside the United States.

NSPS Certified Catalytic Cordwood-Fired Stoves and Fireplace Inserts

Certified catalytic units pass the exhaust through a catalyst to achieve emission reductions. Generally, a coated ceramic honeycomb catalyst is located inside the stove where the incompletely combusted gases and particles ignite and are combusted further, thus reducing air emissions and increasing overall efficiency.

NSPS Certified Non-Catalytic Cordwood-Fired Stoves and Fireplace Inserts

Certified non-catalytic stoves and fireplace insets rely on design features to reduce air emission and increase efficiency. They generally rely on the introduction of heated secondary air to improve combustion, as well as firebox insulation, and baffles to produce a longer, hotter gas flow path, as well as other design features to achieve low emissions and higher efficiency.

Pellet Stoves and Fireplace Inserts

Analogous to cordwood stoves and fireplace inserts, pellet stoves and fireplace inserts are considered room heaters. They burn pellets generally made from wood sawdust, although there has been, and continues to be, research into utilizing other biomass fuels to make pellets. Combustion air is drawn from the room for most models, and exhaust is vented outdoors. Some pellet appliances must utilize outside air for combustion if warranted (i.e., they draw too much

room air). Pellet stoves and inserts require the use of electric motors to power the combustion air and heat transfer fans and the pellet-feeding auger. Modern pellet units utilize electronic sensors and controls. Pellets are introduced into the hopper, and the auger continuously feeds a consistent amount of pellets into the firebox. The feed rate is controlled electronically by a feed rate setting selected by the user. There are two basic designs, bottom-feed and top-feed models. Pellet units have a high efficiency and low emissions due to the use of the electric auger and fan that produce uniform and controlled combustion conditions. Some units are certified by the NSPS process and some are not. The performance of the certified and uncertified models are similar. What is considered by most as a “loop-hole” in the NSPS regulations essentially allows certification to be bypassed.

Fireplaces without Inserts

Fireplaces without inserts include manufactured units (often referred to as “zero-clearance” fireplaces) and site-built masonry units operated both with and without glass doors. Combustion air is drawn from the natural draft created by fire, and that same draft vents the exhaust through the chimney. Fireplaces without inserts have low efficiency due to the large amount of heated room air that is exhausted out of the chimney from the draft. Many fireplaces without inserts are not used in a given year, some are used for aesthetic purposes and some are used for heating. Those that are used for heating are almost always used for secondary heating purposes and not primary heating due to their low efficiency and lack of heat transfer capabilities. Manufactured wax/fiber firelogs are often used as a fuel in them with about 30% of fireplace users nationwide claiming that they use wax/fiber firelogs some of the time. Most fireplaces are wall-mounted, however, this category also includes some freestanding models.

Direct Vent Gas Stoves and Fireplace Inserts (LPG and Natural Gas)

Direct vent gas stoves and inserts are sealed units that draw their combustion air from, and vent their exhaust to, the outside air. Venting can be extended vertically or horizontally out of the home. A common type of venting is coaxial, which has the exhaust pipe contained within the air inlet pipe, so the temperature of the combustion air is raised, and the temperature of the exhaust is lowered, creating more efficient combustion.

Vent-Free Gas Stoves and Fireplace Inserts (LPG and Natural Gas)

Vent-free gas stoves and inserts receive their combustion air from the room in which the unit is placed, and all of the products of combustion are exhausted into the room as well. The high efficiency of vent free units is due to the fact that the heat produced is kept in the room. Vent free gas stoves and inserts have a maximum heat input in order to avoid emitting excess CO, CO₂, or NO_x into the room, and the units also have an O₂ depletion sensor to shut the unit down when oxygen levels get too low. It is important to note that vent-free natural gas and LPG stoves, inserts and log sets should not be considered options for primary or even significant secondary heating use. There is considerable concern regarding indoor air quality and damage to homes by moisture created from their use, as combustion gases are not vented. It may be possible to minimize such problems if the device is used prudently, but there is still cause for concern. Their appropriate role is for aesthetics and minor secondary heating.

B-Vent Gas Stoves and Fireplace Inserts (LPG and Natural Gas)

B-vent gas stoves and inserts draw their combustion air from the room, and exhaust is vented outdoors. These units use a draft hood for the proper venting of exhaust. B-vent gas stoves and inserts have lower efficiency than direct vent due to the fact that already heated room air is used as combustion air, which is then exhausted to the outdoors, taking heat away from the room.

Vent-Free Gas Log Sets (LPG and Natural Gas)

Vent-free gas log sets can be used in a fireplace with the damper closed, or can be in its own enclosure placed in a fireplace. As with vent free gas stoves and inserts, all of the products of combustion are exhausted into the room, causing the unit to have a high efficiency. Also, the same concerns of air quality and home damage as vent-free stoves and inserts apply.

Vented Gas Log Sets (LPG and Natural Gas)

Vented gas log sets are used in fireplaces with the damper open. They are primarily used for aesthetics because all products of combustion (including the vast majority of the heat produced) are vented up and out of the chimney, causing the unit to have a low efficiency.

Centralized Cordwood Heating Systems

The centralized cordwood heating system category consist of both cordwood fired furnaces and boilers. Furnaces rely on the transfer of warmed air through ductwork to heat multiple rooms. Boilers rely on pumps to transfer warm water to multiple rooms and radiators to provide heat. Cordwood boilers are commonly either located inside or outside of the home. Boilers are often referred to as hydronic heaters, as the water is generally not “boiled.”

Pellet-Fired Furnaces and Boilers

Pellet-fired furnaces and boilers use the same technology as pellet stove and fireplace insert room heaters, except that they use either a warmed air heat transfer system (furnaces) or water heat transfer system (boilers) to heat multiple rooms.

Gas-Fired Furnaces and Boilers (LPG and Natural Gas)

Gas-fired furnace and boilers can either be natural gas or liquid propane gas (LPG) fueled. Natural gas-fueled furnaces are the single most commonly used home heating appliance category in the United States. Newer technology units with more efficient heat exchangers exhaust systems allowing for the condensation of water, and technologies that minimize the use of pilot lights have caused an improvement in efficiency.

Efficiency

There are different standards and methods used to measure efficiency, but in general efficiency is the percentage of available heat that is put into the home divided by the available heat content of the fuel. With the exception of some modern “condensing” gas furnaces, it is assumed that water leaves the stack in the vapor phase, and thus the energy associated with state change of any water, either in the fuel or created by combustion, is not available for heating. The vast majority of the available heat that is not used for heating the room during combustion is exhausted out of the stack with the heated stack gases, water vapor, and particles created from combustion. A small amount of unutilized energy is associated with the incomplete combustion of fuel, which also reduces efficiency. Therefore, the more available heat that is kept in the room during

combustion and the more complete the combustion, the higher the efficiency of the device, and visa versa.

Table 1.2
Criteria Pollutants

Criteria Pollutant	Treatment/Rationale
PM _{2.5}	Total PM evaluated, majority of RWC particles submicron
PM ₁₀	Total PM evaluated, majority of RWC particles submicron
O ₃	NMVOC evaluated (simply listed as VOC), VOC are ozone precursors
NO ₂	NO _x reported as NO ₂ evaluated, NO and NO ₂ emitted from RWC, NO converted to NO ₂ in atmosphere
CO	Evaluated
SO ₂	Evaluated
Pb	Not relevant, not evaluated, extremely low levels emitted, little data available

Section 4 is a summary of the cost benefit analysis. It provides the cost benefits for the pollutant reduction options (for each pollutant) for the five categories of widely existing, older technology wood-burning devices averaged across the all eleven MANE-VU states and the District of Columbia. The “typical” or average MANE-VU cost benefit may be of more value to many readers rather than the detailed tabulations by state and by HDD category.

2. Residential Wood Combustion Control Measures

The U.S. Environmental Protection Agency was required under Section 190 of the 1990 Amendments to the Clean Air Act (CAA) to issue RACM and BACM technical guidance for PM₁₀ for the RWC source category. The September 1989 publication, “Guidance Document for Residential Wood Combustion Emission Control Measures” (EPA-450/2-89-015)¹ was considered as fulfilling the RACM technical guidance requirement. A subsequent document published in 1992, “Technical Information Document for Residential Wood Combustion, Best Available Control Measures,” (EPA-450/2-92-002)² fulfilled the BACM requirement. Because the majority of particles emitted by RWC are submicron, the PM₁₀ control measures that have been developed for RWC are applicable for the control of PM_{2.5}.

Table 2.1 summarizes measures for RWC RACM developed by the U.S. EPA in EPA-450/2-89-015. The RACM fall in three primary categories: (1) Improvement of performance, (2) Reducing the use of RWC devices, and (3) Episodic curtailment. The effectiveness in reducing RWC emissions and a related discussion of each of the various activities are provided in Table 2.1. In addition to the three primary categories for RWC RACM, the RACM document emphasizes the importance of public awareness in any RWC emission control program and provides considerable narrative on the subject. The importance of tailoring a public awareness program to a community’s particular attitudes and values is discussed and the various media

options are provided (Table 2.2). Clearly, web-based public awareness options can now be added to the list developed in 1989 and as provided in Table 2.2.

Table 2.1
Summary of Measures Available for RWC RACM – PM₁₀

Program Elements	Effectiveness (%)	Discussion
1. IMPROVEMENT OF PERFORMANCE		
State implementation of NSPS	0	States are not expected to adopt this program element at levels that would affect program effectiveness significantly.
Ban on resale of uncertified devices	0	No credit recognized because requirement is largely unenforceable: other elements will be required to include disabling of retired used devices.
Installer Training Certification or Inspection Program	=5	Reduction in emissions from each new certified RWC device where either the installer is trained/certified or the installation is inspected.
Pellet stoves	90	Reduction in emissions from each new or existing conventional, uncertified RWC device replaced with a pellet stove.
	75	Reduction in emissions from each new or existing Phase II EPA certified RWC device replaced with a pellet stove.
EPA Phase II certified RWC devices	~50	Reduction in emissions from each new or existing conventional, uncertified RWC device replaced with an EPA Phase II certified RWC device.
Retrofit requirement	<5	Reduction in emissions from each existing conventional, uncertified RWC device equipped with a retrofit catalyst or pellet hopper (to maximum when all existing uncertified RWC devices have retrofit devices installed).
Accelerated changeover requirement	~50	Reduction in emissions from each existing conventional, uncertified RWC device replaced with Phase II certified device.
	100	Reduction in emissions from each existing conventional, uncertified RWC device removed and not replaced: requires existing device to be disabled and not resold.
Accelerated changeover inducement	~50	Reduction in emissions from each existing conventional, uncertified RWC device replaced with Phase II certified device.
	100	Reduction in emissions from each existing conventional, uncertified RWC device removed and not replaced: requires existing device to be disabled and not resold.

Table 2.1 continued
Summary of Measures for RWC RACM – PM₁₀

Program Elements	Effectiveness (%)	Discussion
Require fireplace inserts	0	No credit recognized for fireplace inserts, since inserts change use of fireplace from aesthetic to primary heat source, resulting in an increase in amount of wood combusted and higher overall emissions
Wood moisture	<5	Reduction in total emissions from all RWC devices in the community/airshed.
Trash burning prohibition	0	No credit recognized for eliminating trash burning in RWC devices.
Weatherization of residences	<5	Reduction in total emissions from all RWC devices in the community/airshed.
Opacity limits	<5	Reduction in total emissions from all RWC devices in the community/airshed.
2. REDUCING USE OF RWC DEVICES		
Availability of alternative fuels	100	Reduction in emissions from each RWC device removed from service and replaced with device using natural gas: recognize no more than 10% or RWC devices replaced under program with no additional incentives.
Emission trading	Computation required	For a 2:1 trading ratio, the reduction in emissions from each new stove would be calculated as the difference between emissions of a new RWC device and 2 times the average emissions per stove in the community: multiplier would change for other trading ratios.
Taxes on RWC devices	Variable	Emission reduction credit would vary with utility or tax rate structure adopted and extent to which this structure resulted in reduction in number of RWC devices in the community versus reduction in use of RWC devices.
Regulatory ban on RWC devices in new dwellings	100	Reduction in emissions from new RWC devices purchased for installation in new dwellings.
Regulatory ban on existing RWC devices	100	Reduction in emissions from each RWC device removed.
3. EPISODIC CURTAILMENT		
Voluntary	10	Reduction in emissions for all RWC devices not exempted.
Mandatory	60% fireplace 50% woodstoves	Reduction in emissions for all RWC devices not exempted.

Reference 1

Table 2.2
Media Options for RWC Control Programs

Media Category	Specific Media Vehicle
Direct Public Contact/Public Education Medium	Seminars and Workshops
	Community Group Programs
	Stove Fairs
	Speakers Bureaus
	Public School Programs
Broadcast Medium	Radio-TV Spots
	Telephone Hotlines
Print Medium	Newspapers
	Brochures

Table 2.3 summarizes measures for RWC BACM developed by the U.S. EPA in EPA-450/2-92-002. As shown in Table 2.3, the BACM fall into two primary categories: (1) Integral measures which are necessary for the success of a long-term RWC pollutant reduction programs but, by themselves, are not adequate to provide long-term reductions. (2) Flexible (long-term) measures to reduce, eliminate, or prevent increases in pollutant emissions for existing and/or new installations. With the exceptions of the device and upgrade offsets, the specific elements of the BACM are essentially those described in the RACM document with the various efficiencies listed in Table 2.1 being applicable. The methods for calculating device and offset ratios are provided as Appendix B to EPA 450/2-92-002.

Table 2.3
Summary of Measures Available for RWC BACM – PM₁₀¹

Integral Measures ²	Flexible Measures that Reduce or Eliminate Emissions from Existing Installations ³	Flexible Measures that Reduce Emissions or Prevent Emission Increases from New Installations ³	Flexible Measures that Reduce Emissions from New and Existing Installations ³
1. Public awareness and education.	1. Conversion of existing wood-burning fireplaces to gas logs.	1. Gas fireplaces or gas logs in new wood burning fireplace installations.	1. Device offset. ⁵
2. Mandatory curtailment during predicted periods of high PM ₁₀ concentrations.	2. Changeover to EPA-certified, Phase II stoves or equivalent.	2. Upgrade offset. ⁵	2. Upgrade offset. ⁵
3. All new stove installations EPA-certified, Phase II stoves or equivalent.	3. Changeover to low emitting device. ⁴	3. Restriction on number and density of new wood-burning stove and/or fireplace installations.	
4. Measures to improve wood burning performance: -control of wood moisture content -weatherization of homes with wood stoves -educational opacity program		4. Requirement that new stove installations be low emitting.	

1. Reference 2
2. Integral measures are regarded as critical for the success of a RWC control program, but by themselves are not intended to result in long-term attainment of the PM₁₀ NAAQS for serious PM₁₀ nonattainment areas.
3. Flexible measures are designed for permanent control of RWC emissions and thus long-term attainment of the PM₁₀ NAAQS
4. This measure is virtually identical to item 2, except that the changeover is recommended to a “low-emitting” device that can document “in-home” field test emissions less than the emission factor averages of “in-home” field test emissions data for EPA-certified stoves. This can include classes of devices that are demonstrated to be capable as a class of producing lower field emissions, as well as, specific model units that perform better in the field than the class collectively. (An example might include masonry heaters, uncertified pellet-fueled devices, and wood fired gasification centralized heating systems)
5. Offsets are intended to achieve emission reductions, when retiring (device offset) or changing-out (upgrade offset) conventional stoves, greater than the emissions increase resulting from new stove installations.

The RWC RACM and BACM have been the basis for PM₁₀ innovative strategies implemented in various western states and in their local jurisdictions³ and have also been, in large part, the basis for a number of western state and their local RWC regulations. Table 2.4 lists notable RWC

regulations. These regulations have been provided as Appendix A for the convenience of MANE-VU state air quality planners and regulators.

Table 2.4
RWC Regulations

State	Jurisdiction/Agency
Arizona	Maricopa County
Bi-State (California and Nevada)	Tahoe Regional Planning Agency
California	Bay Area Air Quality Management District
	Butte County Air Quality Management District
	Feather River Air Quality Management District
	Glenn County Air Pollution Control District
	Great Basin Unified Pollution Control District
	Kern County Air Pollution Control District
	Placer County
	San Joaquin Valley Unified Air Pollution Control District
	San Luis Obispo County Air Pollution Control District
	Shasta County Air Quality Management District
	Yolo-Solano Air Quality Management District
Colorado	State of Colorado
	City of Aspen and Pitkin County
	City of Fort Collins ¹
Montana	Lincoln County
	Missoula County
Nevada	Clark County
	Washoe County
Oregon	State of Oregon
Washington	State of Washington

1. The regulation contains information on RWC regulations for the State of Colorado, Larimer County, Poudre Fire Authority, City and County of Denver, Weld County/Greeley, Loveland, Boulder, El Paso County/Colorado Springs, Mesa County, Grand Junction, Fruita, and Telluride.

3. Pollutant Reduction Cost Benefits of Improved Technologies and Alternative Fuels

There are five categories of existing cordwood fueled appliance types to be considered for the pollution reduction cost benefit analyses. These appliance types are listed in Table 1.1, along with their respective improved technology and alternative fuel replacement or installation options. The cost of pollutant reduction, in \$/g, was calculated by dividing the difference in cost by the difference in total emissions, both resulting from the installation or replacement of the existing wood burning device with an improved technology/alternative fuel. Total pollutant emissions were calculated by multiplying the emission factor for each of the five pollutants by the total annual fuel input for each appliance and fuel type. Emission factors were calculated directly using the best available research data for the improved technology appliances and alternative fuels, except for the improved cordwood stoves and inserts, and pellet stoves and inserts, for which the emission factors were developed in Technical Memorandum 2. The

emission factors for the existing appliances were also developed in Technical Memorandum 2. Annual fuel inputs were calculated in a way that ensures the amount of fuel input for each appliance type would end up delivering equal amounts of heat to a home, as determined by the annual fuel input of the existing appliance. This was calculated by multiplying the existing appliance annual fuel input by the ratio of the existing device's efficiency to the replacement/installation device's efficiency. Therefore, the higher the efficiency of the improved technology and alternative fuel replacement/installation, the less input fuel is needed to reach the same level of heat output.

Each of the cost benefit sections takes into account the costs associated with the use and maintenance of each appliance category, and installation/replacement of each newer technology/alternative fuel category. Installation/replacement costs are based on the typical or average costs and lifetimes, as estimated by hearth products retailers from PA, NY, and MA, including appliance costs, labor (carpentry and masonry work), auxiliary hardware (chimney and chimney connector pipe), disposal of old appliance, and gas plumbing (for gas appliances assumed home has natural gas or LPG). The estimates are attached in Appendix B. Ancillary costs per year include three components (where applicable): chimney sweeping, electricity, and catalyst replacement. (1) Chimney sweeping costs (only necessary for wood burning appliances) were determined through personal communication with the Chimney Safety Institute of America (CSIA). The CSIA estimates are attached in Appendix B. (2) Electricity costs are relevant for stoves that have electrical components. For example, pellet stoves require electricity to run their fan, auger, and other control components, and inserts, as well as gas stoves, often use an electric fan to circulate hot air into the room. (3) Catalyst replacement cost, relevant only to the certified catalytic cordwood stoves and inserts, was annualized from the data provided by the hearth products retailers.

The assumptions and calculations used for each category are provided as a general outline as follows, and in detail before each subsequent section. Following the calculations and assumptions are supplemental information tables and pollutant reduction cost benefit tables organized by the 11 MANE-VU states and District of Columbia, and the three Heating Degree Day categories. Supporting tables contain information about the annual cost difference and annual fuel input values, which are used in the pollutant reduction cost benefit tables.

Since Section 3.5 contains the pollution reduction cost benefit analysis for appliances used for aesthetic purposes, some of the calculations and assumptions presented here are not relevant. Therefore, a full calculations and assumptions outline is presented at the beginning of that section, and the Section 3.5 narrative further explains the differences of use for aesthetics and use for heating. Section 3.5 only contains two tables, one supporting information table followed by the pollutant reduction cost benefit table, which are representative of the entire MANE-VU region, because aesthetic fuel usage does not vary significantly within the climate range and characteristics of the MANE-VU region.

In addition to the major improved technologies and alternative fuel options listed in the detailed cost benefit tables, four other options can offer lower air emissions, either through replacement of older technology devices, or through their use with the existing older devices. These options were not included in the detailed tables for one or more reasons: (1) they did not represent a

large potential for use in the MANE-VU region, (2) there is currently little data documenting the level of emission reduction they offer, (3) the emission reductions they produce are relatively small. However, for completeness, they are discussed here.

The four other options are: (1) Masonry heaters (not to be confused with masonry fireplaces) – It has been well documented that masonry heaters have lower particulate and carbon monoxide emissions than conventional woodstoves^{4.01-4.06}, and their emission factors are listed in AP-42⁴. However, as of 2002, there were only an estimated 5000 units in the entire Northeast⁵. Because their cost is typically in the \$10,000 to \$20,000 range and considerable structural modification in a home is required to accommodate them, masonry heaters should be considered a specialty item and do not represent a significant airshed-wide emission reduction opportunity. (2) Manufactured densified firelogs (not to be confused with manufactured wax/fiber firelogs) – Manufactured densified firelogs have been demonstrated to offer small reductions in particulate and carbon monoxide emissions when used in a fireplace or wood heater in lieu of cordwood^{6,7}. Their use is primarily a Pacific Northwest phenomenon, which is where the majority of the manufacturing facilities are located⁸. They were not included in the detailed tables due to the small reductions their use offers and the lack of a large-scale distribution and sales network currently in the Northeast. (3) Fireplace accessories – There are several categories of fireplace accessories that improve the efficiency slightly for a typical fireplace. By improving efficiency, the amount of wood consumed for a given heat demand is reduced, and there is an effective small emission reduction. These accessories include the addition of glass doors, tube convector systems, and shell-within-shell with blower designs. Notably, forced air fireplace grates have also been shown to reduce emissions modestly⁹, but their cost (\$500 to \$1000) is prohibitive for their widespread application. Similarly, masonry fireplaces with shaped fireboxes have been shown to produce small reductions in emissions^{4.01} but, of course, require the removal and replacement of a built-in fireplace with the associated masonry, carpentry and disposal costs. (4) Modern centralized heating systems – Modern centralized heating systems can have significantly lower emissions than systems with more traditional designs. It has been well documented that boilers with heat storage systems¹⁰ and with a gasification design¹¹ produce lower emissions. Combustion technology developed for wood heaters in response to the NSPS certification process can also be applied to centralized wood heating systems and, in fact, one small wood-fired furnace has been certified as a wood heater under the NSPS process. The replacement of existing wood-fired centralized heating systems with low-emitting high-technology units was not included as a major emission reduction option as there is currently no standard as to what constitutes a low-emitting device (other than very small units that can be certified as a wood heater) or any third party unbiased listing as to what brands and models are low-emitting. There is a mechanism in the RWC BACM guidelines for establishing if a given uncertified model or class of devices is/are low-emitting² and there is an ASTM program, at the time of this writing, to develop a standardized test method for outside boilers. The former has never been done and the latter is not yet available.

Several other notes should be made in regards to the cost benefit tables. (1) Vent free natural gas and LPG stoves, inserts and log sets should not be considered options for primary or even significant secondary heating use. There is considerable concern regarding indoor air quality and damage to homes by moisture created from their use, as combustion gases are not vented. Their appropriate role is for aesthetics and minor secondary heating. (2) Electrical devices, such as,

electric fireplaces, were not evaluated, as the complexity and role of energy trajectory for electricity makes the pollutant cost-benefit analysis outside the scope of work for this project. For example, coal is the primary ultimate source of electrical energy in the United States. Coal exploration, coal transport, coal processing and desulphurization, coal-fired power plant inefficiency and emissions, and transmission line losses all need to be taken into consideration for a cost-benefit analysis of electric space heating. (3) The term “LPG” as used here is synonymous with “propane.”

General calculations and assumptions (except Section 3.5)

Calculations and assumptions that are specific to each category will be explained further before their respective sections.

Old unit: Existing unit to be replaced/modified

New unit: Unit installed in or replacing old unit

1. Annual fuel input for old unit: input MJ/yr (old)

$$\text{Cords burned by old unit (cord/yr by state and HDD – Table 3.0)} \times \text{average mass per cord by state and HDD (kg/cord – Table 3.0)} \times \text{average LHV of fuel (19.36 MJ/kg for cordwood}^{45})$$
2. Annual fuel input for new unit: input MJ/yr (new)

$$\text{MJ/yr (old)} \times (\text{efficiency (old)} / \text{efficiency (new)})$$
3. Annual fuel cost: \$/yr

$$\text{Cost of fuel (\$/MJ)} \times \text{Annual fuel input per appliance (MJ/yr)}$$

Cost of fuel:

 - Wood (avg.): \$0.008/MJ ($\$0.15/\text{kg}$ (average of cost/cord by state⁴⁶ / average of mass/cord by state⁵⁴⁻⁶⁰) / 19.36 MJ/kg^{45})
 - Pellets: \$0.016/MJ ($\$0.30/\text{kg}^{46}$ / 19.19 MJ/kg^{47})
 - LPG: \$0.024/MJ ($\$2.32/\text{gal}^{49}$ / $9.63 \times 10^4 \text{ KJ/gal}^{47}$)
 - Natural Gas: \$0.016/MJ ($\$17.13/1000\text{ft}^3$ ⁵⁰ / $1.09 \times 10^6 \text{ KJ/1000ft}^3$ ⁴⁸)
4. Annualized installation/replacement cost: \$/yr⁴²⁻⁴³

$$\text{Install/replace, plumbing, old unit removal cost all divided by the unit lifetime}$$
5. Ancillary costs: Sum of a b and c per appliance: \$/yr
 - a) Chimney cleaning – cost per cleaning X cleanings per year = \$/yr
 - b) Electricity costs - kw usage X \$0.13/kw-h⁵¹ X hours use per year
 - c) Annualized catalyst replacement - \$180 per catalyst / 4 year lifetime = \$45/yr⁴²
6. Total annual costs: Sum of annual fuel costs, ancillary costs, and annualized installation/replacement costs: \$/yr
7. Cost difference: Total annual cost (new unit) – Total annual cost (old unit)

8. Total annual emissions for each category: g/yr
 Total annual emissions = emission factor (g/MJ) X annual fuel input (MJ/yr)
 Emission factors in g/input MJ
 VOC from LPG appliances is a calculation from the AP-42 reference³⁷ for natural gas VOC corrected for VOC content of propane
9. Emissions reduction: g/yr
 Total emissions (old unit) – Total emissions (new unit)
10. Annual pollutant reduction cost benefit: \$/g, \$/ton
 Cost difference (\$/yr) / emissions reduction (g/yr) = \$/g
 \$/g X 454 g/lb X 2000 lb/ton = \$/ton

Table 3.0
 Average Mass and Number of Cords Burned per Appliance by State

State	Average Dry Mass per Cord (kg)	Cords Burned by Fireplaces without Inserts Annually	Cords Burned by Wood Heaters Annually	Cords Burned by Cordwood Furnaces and Boilers Annually
Connecticut	1335.0	0.74	2.15	3.41
Delaware	1207.3	0.51	0.95	0.75
Maine	1112.7	1.68	2.56	5.38
Maryland	1213.5	0.53	1.05	1.26
Massachusetts	1275.1	1.28	2.34	4.38
New Hampshire	1212.8	1.68	2.56	5.38
New Jersey	1203.4	0.51	1.40	1.22
New York	1285.0	1.51	2.41	5.30
Pennsylvania	1303.6	0.75	1.87	2.93
Rhode Island	1248.6	0.54	2.17	1.96
District of Columbia	1213.5	0.46	0.86	0.68
Vermont	1249.6	1.68	2.56	5.38
Average MANE-VU	1238.3	1.06	2.03	4.15
High HDD Category	1238.3	1.68	2.56	5.38
Med HDD Category	1238.3	0.50	2.03	1.83
Low HDD Category	1238.3	0.51	0.95	0.75

References 54-60

3.1. Uncertified Freestanding Cordwood Stove Replacement

The most likely replacements for an uncertified freestanding cordwood stove include certified catalytic and non-catalytic cordwood stoves, pellet stoves, direct vent gas stoves, b-vent gas stoves, and vent free gas stoves (gas includes both LPG and natural gas). Replacement of the uncertified freestanding cordwood stove requires the proper disposal of the old unit, which adds approximately \$100 to the total installation cost of the replacement unit. Calculations and assumptions for uncertified freestanding cordwood stove replacement include further explanation of calculations already listed in Section 3.

Calculations and Assumptions

Annual fuel input for new unit: input MJ/yr (new)
MJ/yr (old) X (efficiency (old) / efficiency (new))

Efficiency References:

Cordwood and Pellet Stoves: 4, 23, 32
Gas Stoves: Based on OMNI-Test Laboratories Testing

Annualized installation/replacement cost: \$/yr⁴²

Install/replace, gas plumbing, and old unit removal cost; all divided by the device lifetime

- Certified non-cat. cordwood stove: \$3,367 / 19.3 yrs = \$174.10/yr
- Certified cat. cordwood stove: \$4,150 / 19.3 yrs = \$214.70/yr
- Pellet stove: \$3,850 / 13 yrs = \$256.70/yr
- Gas stoves – natural gas (direct vent, b-vent, vent free):
\$3,400 / 17.7 yrs = \$192.50/yr
- Gas stoves – LPG (direct vent, b-vent, vent free):
\$3,367 / 17.7 yrs = \$190.60/yr

Ancillary costs: sum of a b and c per appliance: \$/yr

a) Chimney cleaning⁴⁴:

- Uncertified freestanding cordwood stove: \$150 X 1.5 cleanings/yr = \$225/yr
- Certified non-cat. and cat. cordwood stoves: \$150 X 1 cleaning/yr = \$150/yr
- Pellet stove: \$125 X 1 cleaning/yr = \$125/yr

b) Electricity costs:

Hours of use per year⁶¹ (for 6 month heating season, Oct-March) assumed to be:

60 days @ 14 hrs/day = 840 hrs

60 days @ 8 hrs/day = 280 hrs

62 days @ 4 hrs/day = 248 hrs

Total = 1,368 hrs/yr

- Pellet stove:
0.380 kw X 1,368 hrs/yr X \$0.13/kw-h = \$66.28/yr
- Gas stoves:
0.144 kw X 1,368 hrs/yr X \$0.13/kw-h = \$25.12/yr

c) Annualized catalyst replacement - \$45/yr

Total annual emissions for each category: g/yr

Total annual emissions = emission factor (g/MJ) X annual fuel input (MJ/yr)

Emission factors in g/input MJ

Wood burning stove emission factors converted from g/kg^{4.07-4.19,10,22-27} to g/MJ by
dividing the g/kg emission factor by the average wood heat content⁴⁵ (MJ/kg)

Pellet stove emission factors converted from g/kg^{4.07,4.11,4.18-4.19,10,24,26-27} to g/MJ by
dividing the g/kg emission factor by the average pellet heat content⁴⁷ (MJ/kg)

Natural Gas stove emission factors converted to g/MJ³⁶⁻⁴⁰

LPG Gas stove emission factors converted to g/MJ³⁴⁻³⁵

Table 3.1.01a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in Connecticut, Supporting Information
2.15 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Connecticut

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	55,496	46,104	42,811	39,957	46,104	39,957	30,579	46,104	39,957	30,579
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	433.00	359.72	334.03	626.24	726.22	629.39	481.68	1,109.10	961.22	735.63
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	658.00	683.86	741.68	1,074.19	943.79	846.96	699.25	1,324.78	1,176.90	951.31
Cost Difference (\$/yr)	-	25.86	83.68	416.19	285.79	188.96	41.25	666.78	518.90	293.31

Table 3.1.01b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Connecticut

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.84E+04	1.79E+04	1.85E+04	3.19E+03	1.72E+02	1.49E+02	1.14E+02	3.87E+02	3.36E+02	2.57E+02
PM Reduction (g/yr)	-	3.06E+04	2.99E+04	4.53E+04	4.83E+04	4.83E+04	4.83E+04	4.81E+04	4.81E+04	4.82E+04
Annual PM Cost Benefit (\$/g)	-	8.46E-04	2.80E-03	9.20E-03	5.92E-03	3.91E-03	8.54E-04	1.39E-02	1.08E-02	6.09E-03
Annual PM Cost Benefit (\$/ton)	-	7.68E+02	2.54E+03	8.34E+03	5.37E+03	3.55E+03	7.74E+02	1.26E+04	9.79E+03	5.52E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.25E+04	2.40E+04	1.90E+04	4.16E+01	1.06E+02	9.19E+01	3.58E+01	1.15E+03	9.99E+02	7.64E+02
VOC Reduction (g/yr)	-	2.84E+04	3.34E+04	5.24E+04	5.23E+04	5.24E+04	5.24E+04	5.13E+04	5.15E+04	5.17E+04
Annual VOC Cost Benefit (\$/g)	-	9.11E-04	2.50E-03	7.94E-03	5.46E-03	3.61E-03	7.87E-04	1.30E-02	1.01E-02	5.67E-03
Annual VOC Cost Benefit (\$/ton)	-	8.26E+02	2.27E+03	7.20E+03	4.95E+03	3.27E+03	7.14E+02	1.18E+04	9.15E+03	5.15E+03

Table 3.1.01b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Connecticut

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.25E+05	1.68E+05	1.18E+05	1.67E+04	8.94E+02	7.75E+02	9.20E+02	2.69E+02	2.33E+02	1.79E+02
CO Reduction (g/yr)	-	5.71E+04	1.06E+05	2.08E+05	2.24E+05	2.24E+05	2.24E+05	2.24E+05	2.24E+05	2.25E+05
Annual CO Cost Benefit (\$/g)	-	4.53E-04	7.86E-04	2.00E-03	1.28E-03	8.44E-04	1.84E-04	2.97E-03	2.31E-03	1.31E-03
Annual CO Cost Benefit (\$/ton)	-	4.11E+02	7.13E+02	1.81E+03	1.16E+03	7.66E+02	1.67E+02	2.70E+03	2.10E+03	1.19E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.67E+03	2.71E+03	1.55E+04	3.96E+03	2.43E+03	2.11E+03	1.28E+03	2.51E+03	2.18E+03	1.67E+03
NO _x Reduction (g/yr)	-	9.54E+02	<1.18E+04>	<2.87E+02>	1.23E+03	1.56E+03	2.39E+03	1.16E+03	1.49E+03	2.00E+03
Annual NO _x Cost Benefit (\$/g)	-	2.71E-02	NA	NA	2.32E-01	1.21E-01	1.72E-02	5.77E-01	3.48E-01	1.47E-01
Annual NO _x Cost Benefit (\$/ton)	-	2.46E+04	NA	NA	2.10E+05	1.10E+05	1.56E+04	5.23E+05	3.16E+05	1.33E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.87E+02	4.76E+02	4.42E+02	3.33E+02	1.07E+01	9.23E+00	7.06E+00	1.68E+02	1.46E+02	1.12E+02
SO ₂ Reduction (g/yr)	-	<1.90E+02>	<1.56E+02>	<4.65E+01>	2.76E+02	2.77E+02	2.80E+02	1.18E+02	1.41E+02	1.75E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.04E+00	6.81E-01	1.48E-01	5.63E+00	3.69E+00	1.68E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.40E+05	6.18E+05	1.34E+05	5.11E+06	3.34E+06	1.52E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.02a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in Delaware, Supporting Information
0.95 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Delaware

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	22,203	18,446	17,128	15,986	18,446	15,986	12,234	18,446	15,986	12,234
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	173.24	143.92	133.64	250.55	290.55	251.81	192.71	443.74	384.57	294.32
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	398.24	468.06	541.30	698.50	508.12	469.38	410.28	659.42	600.25	510.00
Cost Difference (\$/yr)	-	69.82	143.06	300.26	109.88	71.14	12.05	261.18	202.02	111.76

Table 3.1.02b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Delaware

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	1.94E+04	7.15E+03	7.40E+03	1.27E+03	6.90E+01	5.98E+01	4.58E+01	1.55E+02	1.34E+02	1.03E+02
PM Reduction (g/yr)	-	1.22E+04	1.20E+04	1.81E+04	1.93E+04	1.93E+04	1.93E+04	1.92E+04	1.92E+04	1.93E+04
Annual PM Cost Benefit (\$/g)	-	5.71E-03	1.19E-02	1.66E-02	5.69E-03	3.68E-03	6.23E-04	1.36E-02	1.05E-02	5.80E-03
Annual PM Cost Benefit (\$/ton)	-	5.18E+03	1.08E+04	1.50E+04	5.16E+03	3.34E+03	5.65E+02	1.23E+04	9.52E+03	5.26E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	2.10E+04	9.62E+03	7.61E+03	1.67E+01	4.24E+01	3.68E+01	1.43E+01	4.61E+02	4.00E+02	3.06E+02
VOC Reduction (g/yr)	-	1.14E+04	1.34E+04	2.10E+04	2.09E+04	2.09E+04	2.10E+04	2.05E+04	2.06E+04	2.07E+04
Annual VOC Cost Benefit (\$/g)	-	6.14E-03	1.07E-02	1.43E-02	5.25E-03	3.40E-03	5.74E-04	1.27E-02	9.81E-03	5.40E-03
Annual VOC Cost Benefit (\$/ton)	-	5.57E+03	9.70E+03	1.30E+04	4.76E+03	3.08E+03	5.21E+02	1.15E+04	8.90E+03	4.90E+03

Table 3.1.02b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Delaware

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	8.99E+04	6.71E+04	4.73E+04	6.66E+03	3.58E+02	3.10E+02	3.68E+02	1.08E+02	9.34E+01	7.14E+01
CO Reduction (g/yr)	-	2.28E+04	4.26E+04	8.32E+04	8.95E+04	8.96E+04	8.95E+04	8.98E+04	8.98E+04	8.98E+04
Annual CO Cost Benefit (\$/g)	-	3.06E-03	3.36E-03	3.61E-03	1.23E-03	7.94E-04	1.35E-04	2.91E-03	2.25E-03	1.24E-03
Annual CO Cost Benefit (\$/ton)	-	2.77E+03	3.05E+03	3.27E+03	1.11E+03	7.20E+02	1.22E+02	2.64E+03	2.04E+03	1.13E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	1.47E+03	1.09E+03	6.19E+03	1.58E+03	9.74E+02	8.44E+02	5.10E+02	1.01E+03	8.71E+02	6.67E+02
NO _x Reduction (g/yr)	-	3.82E+02	<4.72E+03>	<1.15E+02>	4.94E+02	6.24E+02	9.58E+02	4.62E+02	5.97E+02	8.01E+02
Annual NO _x Cost Benefit (\$/g)	-	1.83E-01	NA	NA	2.23E-01	1.14E-01	1.26E-02	5.65E-01	3.39E-01	1.40E-01
Annual NO _x Cost Benefit (\$/ton)	-	1.66E+05	NA	NA	2.02E+05	1.03E+05	1.14E+04	5.12E+05	3.07E+05	1.27E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.15E+02	1.91E+02	1.77E+02	1.33E+02	4.26E+00	3.69E+00	2.83E+00	6.73E+01	5.83E+01	4.47E+01
SO ₂ Reduction (g/yr)	-	<7.59E+01>	<6.22E+01>	<1.86E+01>	1.10E+02	1.11E+02	1.12E+02	4.73E+01	5.63E+01	7.00E+01
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	9.95E-01	6.41E-01	1.08E-01	5.52E+00	3.59E+00	1.60E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.03E+05	5.82E+05	9.77E+04	5.00E+06	3.25E+06	1.45E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.03a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in Maine, Supporting Information
2.56 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Maine

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	55,181	45,843	42,568	39,731	45,843	39,731	30,406	45,843	39,731	30,406
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	430.55	357.68	332.14	622.70	722.11	625.83	478.95	1,102.82	955.78	731.46
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	655.55	681.82	739.79	1,070.64	939.68	843.40	696.52	1,318.50	1,171.46	947.14
Cost Difference (\$/yr)	-	26.28	84.24	415.09	284.13	187.85	40.97	662.96	515.91	291.60

Table 3.1.03b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Maine

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.82E+04	1.78E+04	1.84E+04	3.17E+03	1.71E+02	1.49E+02	1.14E+02	3.85E+02	3.34E+02	2.55E+02
PM Reduction (g/yr)	-	3.04E+04	2.98E+04	4.50E+04	4.80E+04	4.80E+04	4.80E+04	4.78E+04	4.78E+04	4.79E+04
Annual PM Cost Benefit (\$/g)	-	8.65E-04	2.83E-03	9.23E-03	5.92E-03	3.91E-03	8.53E-04	1.39E-02	1.08E-02	6.09E-03
Annual PM Cost Benefit (\$/ton)	-	7.85E+02	2.57E+03	8.37E+03	5.37E+03	3.55E+03	7.74E+02	1.26E+04	9.79E+03	5.52E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.22E+04	2.39E+04	1.89E+04	4.14E+01	1.05E+02	9.14E+01	3.56E+01	1.15E+03	9.93E+02	7.60E+02
VOC Reduction (g/yr)	-	2.82E+04	3.32E+04	5.21E+04	5.20E+04	5.21E+04	5.21E+04	5.10E+04	5.12E+04	5.14E+04
Annual VOC Cost Benefit (\$/g)	-	9.30E-04	2.53E-03	7.97E-03	5.46E-03	3.61E-03	7.86E-04	1.30E-02	1.01E-02	5.67E-03
Annual VOC Cost Benefit (\$/ton)	-	8.44E+02	2.30E+03	7.23E+03	4.95E+03	3.27E+03	7.13E+02	1.18E+04	9.15E+03	5.15E+03

Table 3.1.03b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Maine

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.23E+05	1.67E+05	1.18E+05	1.66E+04	8.89E+02	7.71E+02	9.15E+02	2.68E+02	2.32E+02	1.78E+02
CO Reduction (g/yr)	-	5.68E+04	1.06E+05	2.07E+05	2.23E+05	2.23E+05	2.23E+05	2.23E+05	2.23E+05	2.23E+05
Annual CO Cost Benefit (\$/g)	-	4.63E-04	7.96E-04	2.01E-03	1.28E-03	8.44E-04	1.84E-04	2.97E-03	2.31E-03	1.31E-03
Annual CO Cost Benefit (\$/ton)	-	4.20E+02	7.22E+02	1.82E+03	1.16E+03	7.65E+02	1.67E+02	2.70E+03	2.10E+03	1.18E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.65E+03	2.70E+03	1.54E+04	3.93E+03	2.42E+03	2.10E+03	1.27E+03	2.50E+03	2.17E+03	1.66E+03
NO _x Reduction (g/yr)	-	9.49E+02	<1.17E+04>	<2.85E+02>	1.23E+03	1.55E+03	2.38E+03	1.15E+03	1.48E+03	1.99E+03
Annual NO _x Cost Benefit (\$/g)	-	2.77E-02	NA	NA	2.31E-01	1.21E-01	1.72E-02	5.77E-01	3.48E-01	1.46E-01
Annual NO _x Cost Benefit (\$/ton)	-	2.51E+04	NA	NA	2.10E+05	1.10E+05	1.56E+04	5.23E+05	3.16E+05	1.33E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.85E+02	4.74E+02	4.40E+02	3.31E+02	1.06E+01	9.18E+00	7.02E+00	1.67E+02	1.45E+02	1.11E+02
SO ₂ Reduction (g/yr)	-	<1.89E+02>	<1.55E+02>	<4.62E+01>	2.74E+02	2.76E+02	2.78E+02	1.18E+02	1.40E+02	1.74E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.04E+00	6.81E-01	1.47E-01	5.63E+00	3.69E+00	1.68E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.39E+05	6.18E+05	1.34E+05	5.11E+06	3.34E+06	1.52E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.04a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in Maryland, Supporting Information
1.05 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Maryland

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove-Natural Gas, B Vent	Gas Stove-Natural Gas, Direct Vent	Gas Stove-Natural Gas, Vent Free	Gas Stove-LPG, B Vent	Gas Stove-LPG, Direct Vent	Gas Stove-LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	24,739	20,552	19,084	17,812	20,552	17,812	13,632	20,552	17,812	13,632
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	193.02	160.36	148.90	279.17	323.74	280.57	214.72	494.41	428.49	327.93
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	418.02	484.49	556.56	727.11	541.30	498.14	432.29	710.10	644.17	543.61
Cost Difference (\$/yr)	-	66.47	138.54	309.09	123.28	80.12	14.27	292.07	226.15	125.59

Table 3.1.04b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Maryland

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove-Natural Gas, B Vent	Gas Stove-Natural Gas, Direct Vent	Gas Stove-Natural Gas, Vent Free	Gas Stove-LPG, B Vent	Gas Stove-LPG, Direct Vent	Gas Stove-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	2.16E+04	7.97E+03	8.25E+03	1.42E+03	7.69E+01	6.66E+01	5.10E+01	1.73E+02	1.50E+02	1.15E+02
PM Reduction (g/yr)	-	1.36E+04	1.33E+04	2.02E+04	2.15E+04	2.15E+04	2.15E+04	2.14E+04	2.14E+04	2.15E+04
Annual PM Cost Benefit (\$/g)	-	4.88E-03	1.04E-02	1.53E-02	5.73E-03	3.72E-03	6.62E-04	1.36E-02	1.05E-02	5.85E-03
Annual PM Cost Benefit (\$/ton)	-	4.43E+03	9.42E+03	1.39E+04	5.20E+03	3.38E+03	6.01E+02	1.24E+04	9.57E+03	5.30E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	2.34E+04	1.07E+04	8.48E+03	1.86E+01	4.73E+01	4.10E+01	1.59E+01	5.14E+02	4.45E+02	3.41E+02
VOC Reduction (g/yr)	-	1.27E+04	1.49E+04	2.34E+04	2.33E+04	2.33E+04	2.34E+04	2.29E+04	2.29E+04	2.30E+04
Annual VOC Cost Benefit (\$/g)	-	5.25E-03	9.29E-03	1.32E-02	5.28E-03	3.43E-03	6.11E-04	1.28E-02	9.86E-03	5.45E-03
Annual VOC Cost Benefit (\$/ton)	-	4.76E+03	8.43E+03	1.20E+04	4.79E+03	3.11E+03	5.54E+02	1.16E+04	8.95E+03	4.94E+03

Table 3.1.04b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Maryland

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.00E+05	7.47E+04	5.27E+04	7.42E+03	3.99E+02	3.46E+02	4.10E+02	1.20E+02	1.04E+02	7.96E+01
CO Reduction (g/yr)	-	2.54E+04	4.74E+04	9.27E+04	9.98E+04	9.98E+04	9.98E+04	1.00E+05	1.00E+05	1.00E+05
Annual CO Cost Benefit (\$/g)	-	2.61E-03	2.92E-03	3.33E-03	1.24E-03	8.03E-04	1.43E-04	2.92E-03	2.26E-03	1.25E-03
Annual CO Cost Benefit (\$/ton)	-	2.37E+03	2.65E+03	3.02E+03	1.12E+03	7.28E+02	1.30E+02	2.65E+03	2.05E+03	1.14E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	1.64E+03	1.21E+03	6.90E+03	1.76E+03	1.09E+03	9.40E+02	5.68E+02	1.12E+03	9.71E+02	7.43E+02
NO _x Reduction (g/yr)	-	4.25E+02	<5.26E+03>	<1.28E+02>	5.50E+02	6.95E+02	1.07E+03	5.15E+02	6.65E+02	8.92E+02
Annual NO _x Cost Benefit (\$/g)	-	1.56E-01	NA	NA	2.24E-01	1.15E-01	1.34E-02	5.67E-01	3.40E-01	1.41E-01
Annual NO _x Cost Benefit (\$/ton)	-	1.42E+05	NA	NA	2.03E+05	1.05E+05	1.21E+04	5.14E+05	3.09E+05	1.28E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.28E+02	2.12E+02	1.97E+02	1.48E+02	4.75E+00	4.11E+00	3.15E+00	7.50E+01	6.50E+01	4.98E+01
SO ₂ Reduction (g/yr)	-	<8.45E+01>	<6.94E+01>	<2.07E+01>	1.23E+02	1.24E+02	1.25E+02	5.28E+01	6.28E+01	7.80E+01
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.00E+00	6.48E-01	1.15E-01	5.54E+00	3.60E+00	1.61E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.09E+05	5.88E+05	1.04E+05	5.02E+06	3.27E+06	1.46E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.05a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in Massachusetts, Supporting Information
2.34 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Massachusetts

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove-Natural Gas, B Vent	Gas Stove-Natural Gas, Direct Vent	Gas Stove-Natural Gas, Vent Free	Gas Stove-LPG, B Vent	Gas Stove-LPG, Direct Vent	Gas Stove-LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	57,673	47,913	44,491	41,525	47,913	41,525	31,779	47,913	41,525	31,779
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	449.99	373.84	347.13	650.81	754.72	654.09	500.58	1,152.62	998.94	764.49
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	674.99	697.97	754.79	1,098.76	972.29	871.66	718.15	1,368.30	1,214.62	980.17
Cost Difference (\$/yr)	-	22.99	79.80	423.77	297.30	196.67	43.16	693.31	539.63	305.19

Table 3.1.05b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Massachusetts

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove-Natural Gas, B Vent	Gas Stove-Natural Gas, Direct Vent	Gas Stove-Natural Gas, Vent Free	Gas Stove-LPG, B Vent	Gas Stove-LPG, Direct Vent	Gas Stove-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.03E+04	1.86E+04	1.92E+04	3.31E+03	1.79E+02	1.55E+02	1.19E+02	4.02E+02	3.49E+02	2.67E+02
PM Reduction (g/yr)	-	3.18E+04	3.11E+04	4.70E+04	5.02E+04	5.02E+04	5.02E+04	4.99E+04	5.00E+04	5.01E+04
Annual PM Cost Benefit (\$/g)	-	7.24E-04	2.57E-03	9.01E-03	5.93E-03	3.92E-03	8.59E-04	1.39E-02	1.08E-02	6.10E-03
Annual PM Cost Benefit (\$/ton)	-	6.57E+02	2.33E+03	8.17E+03	5.38E+03	3.56E+03	7.80E+02	1.26E+04	9.79E+03	5.53E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.45E+04	2.50E+04	1.98E+04	4.33E+01	1.10E+02	9.55E+01	3.72E+01	1.20E+03	1.04E+03	7.94E+02
VOC Reduction (g/yr)	-	2.95E+04	3.47E+04	5.45E+04	5.44E+04	5.44E+04	5.45E+04	5.33E+04	5.35E+04	5.37E+04
Annual VOC Cost Benefit (\$/g)	-	7.79E-04	2.30E-03	7.78E-03	5.47E-03	3.61E-03	7.92E-04	1.30E-02	1.01E-02	5.68E-03
Annual VOC Cost Benefit (\$/ton)	-	7.07E+02	2.08E+03	7.06E+03	4.96E+03	3.28E+03	7.19E+02	1.18E+04	9.16E+03	5.15E+03

Table 3.1.05b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Massachusetts

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.34E+05	1.74E+05	1.23E+05	1.73E+04	9.30E+02	8.06E+02	9.57E+02	2.80E+02	2.43E+02	1.86E+02
CO Reduction (g/yr)	-	5.93E+04	1.11E+05	2.16E+05	2.33E+05	2.33E+05	2.33E+05	2.33E+05	2.33E+05	2.33E+05
Annual CO Cost Benefit (\$/g)	-	3.88E-04	7.22E-04	1.96E-03	1.28E-03	8.45E-04	1.86E-04	2.97E-03	2.31E-03	1.31E-03
Annual CO Cost Benefit (\$/ton)	-	3.52E+02	6.55E+02	1.78E+03	1.16E+03	7.67E+02	1.68E+02	2.70E+03	2.10E+03	1.19E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.81E+03	2.82E+03	1.61E+04	4.11E+03	2.53E+03	2.19E+03	1.33E+03	2.61E+03	2.26E+03	1.73E+03
NO _x Reduction (g/yr)	-	9.92E+02	<1.23E+04>	<2.98E+02>	1.28E+03	1.62E+03	2.49E+03	1.20E+03	1.55E+03	2.08E+03
Annual NO _x Cost Benefit (\$/g)	-	2.32E-02	NA	NA	2.32E-01	1.21E-01	1.74E-02	5.77E-01	3.48E-01	1.47E-01
Annual NO _x Cost Benefit (\$/ton)	-	2.10E+04	NA	NA	2.10E+05	1.10E+05	1.57E+04	5.24E+05	3.16E+05	1.33E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.98E+02	4.95E+02	4.60E+02	3.46E+02	1.11E+01	9.59E+00	7.34E+00	1.75E+02	1.52E+02	1.16E+02
SO ₂ Reduction (g/yr)	-	<1.97E+02>	<1.62E+02>	<4.83E+01>	2.87E+02	2.88E+02	2.91E+02	1.23E+02	1.46E+02	1.82E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.04E+00	6.82E-01	1.49E-01	5.64E+00	3.69E+00	1.68E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.40E+05	6.19E+05	1.35E+05	5.11E+06	3.35E+06	1.52E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.06a
 Replacement of an Existing Uncertified Freestanding Cordwood Stove in New Hampshire, Supporting Information
 2.56 cords/yr Burned per Uncertified Freestanding Cordwood Stove in New Hampshire

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	60,143	49,965	46,396	43,303	49,965	43,303	33,140	49,965	43,303	33,140
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	469.26	389.85	362.00	678.69	787.04	682.10	522.02	1,201.98	1,041.72	797.23
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	694.26	713.99	769.66	1,126.63	1,004.61	899.67	739.59	1,417.67	1,257.40	1,012.92
Cost Difference (\$/yr)	-	19.72	75.40	432.37	310.35	205.41	45.33	723.41	563.14	318.66

Table 3.1.06b
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in New Hampshire

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.25E+04	1.94E+04	2.01E+04	3.45E+03	1.87E+02	1.62E+02	1.24E+02	4.20E+02	3.64E+02	2.78E+02
PM Reduction (g/yr)	-	3.31E+04	3.24E+04	4.90E+04	5.23E+04	5.23E+04	5.24E+04	5.21E+04	5.21E+04	5.22E+04
Annual PM Cost Benefit (\$/g)	-	5.96E-04	2.32E-03	8.82E-03	5.93E-03	3.93E-03	8.65E-04	1.39E-02	1.08E-02	6.10E-03
Annual PM Cost Benefit (\$/ton)	-	5.40E+02	2.11E+03	8.00E+03	5.38E+03	3.56E+03	7.85E+02	1.26E+04	9.80E+03	5.54E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.68E+04	2.61E+04	2.06E+04	4.51E+01	1.15E+02	9.96E+01	3.88E+01	1.25E+03	1.08E+03	8.29E+02
VOC Reduction (g/yr)	-	3.08E+04	3.62E+04	5.68E+04	5.67E+04	5.67E+04	5.68E+04	5.56E+04	5.58E+04	5.60E+04
Annual VOC Cost Benefit (\$/g)	-	6.41E-04	2.08E-03	7.61E-03	5.47E-03	3.62E-03	7.98E-04	1.30E-02	1.01E-02	5.69E-03
Annual VOC Cost Benefit (\$/ton)	-	5.81E+02	1.89E+03	6.91E+03	4.96E+03	3.28E+03	7.24E+02	1.18E+04	9.16E+03	5.16E+03

Table 3.1.06b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in New Hampshire

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.44E+05	1.82E+05	1.28E+05	1.81E+04	9.69E+02	8.40E+02	9.98E+02	2.92E+02	2.53E+02	1.94E+02
CO Reduction (g/yr)	-	6.19E+04	1.15E+05	2.25E+05	2.43E+05	2.43E+05	2.43E+05	2.43E+05	2.43E+05	2.43E+05
Annual CO Cost Benefit (\$/g)	-	3.19E-04	6.54E-04	1.92E-03	1.28E-03	8.46E-04	1.87E-04	2.97E-03	2.31E-03	1.31E-03
Annual CO Cost Benefit (\$/ton)	-	2.89E+02	5.93E+02	1.74E+03	1.16E+03	7.68E+02	1.70E+02	2.70E+03	2.10E+03	1.19E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.98E+03	2.94E+03	1.68E+04	4.29E+03	2.64E+03	2.29E+03	1.38E+03	2.72E+03	2.36E+03	1.81E+03
NO _x Reduction (g/yr)	-	1.03E+03	<1.28E+04>	<3.11E+02>	1.34E+03	1.69E+03	2.59E+03	1.25E+03	1.62E+03	2.17E+03
Annual NO _x Cost Benefit (\$/g)	-	1.91E-02	NA	NA	2.32E-01	1.22E-01	1.75E-02	5.77E-01	3.49E-01	1.47E-01
Annual NO _x Cost Benefit (\$/ton)	-	1.73E+04	NA	NA	2.10E+05	1.10E+05	1.59E+04	5.24E+05	3.16E+05	1.33E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	3.11E+02	5.16E+02	4.79E+02	3.61E+02	1.15E+01	1.00E+01	7.66E+00	1.82E+02	1.58E+02	1.21E+02
SO ₂ Reduction (g/yr)	-	<2.05E+02>	<1.69E+02>	<5.04E+01>	2.99E+02	3.01E+02	3.03E+02	1.28E+02	1.53E+02	1.90E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.04E+00	6.83E-01	1.50E-01	5.64E+00	3.69E+00	1.68E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.41E+05	6.20E+05	1.36E+05	5.12E+06	3.35E+06	1.52E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.07a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in New Jersey, Supporting Information
1.40 cords/yr Burned per Uncertified Freestanding Cordwood Stove in New Jersey

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove-Natural Gas, B Vent	Gas Stove-Natural Gas, Direct Vent	Gas Stove-Natural Gas, Vent Free	Gas Stove-LPG, B Vent	Gas Stove-LPG, Direct Vent	Gas Stove-LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	32,646	27,121	25,184	23,505	27,121	23,505	17,988	27,121	23,505	17,988
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	254.71	211.61	196.49	368.39	427.20	370.24	283.35	652.43	565.44	432.74
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	479.71	535.75	604.15	816.34	644.77	587.81	500.92	868.12	781.13	648.42
Cost Difference (\$/yr)	-	56.03	124.43	336.62	165.06	108.10	21.21	388.40	301.41	168.71

Table 3.1.07b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in New Jersey

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove-Natural Gas, B Vent	Gas Stove-Natural Gas, Direct Vent	Gas Stove-Natural Gas, Vent Free	Gas Stove-LPG, B Vent	Gas Stove-LPG, Direct Vent	Gas Stove-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	2.85E+04	1.05E+04	1.09E+04	1.87E+03	1.01E+02	8.79E+01	6.73E+01	2.28E+02	1.97E+02	1.51E+02
PM Reduction (g/yr)	-	1.80E+04	1.76E+04	2.66E+04	2.84E+04	2.84E+04	2.84E+04	2.83E+04	2.83E+04	2.83E+04
Annual PM Cost Benefit (\$/g)	-	3.12E-03	7.07E-03	1.26E-02	5.81E-03	3.81E-03	7.46E-04	1.37E-02	1.07E-02	5.95E-03
Annual PM Cost Benefit (\$/ton)	-	2.83E+03	6.41E+03	1.15E+04	5.27E+03	3.45E+03	6.77E+02	1.25E+04	9.66E+03	5.40E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	3.09E+04	1.41E+04	1.12E+04	2.45E+01	6.24E+01	5.41E+01	2.10E+01	6.78E+02	5.88E+02	4.50E+02
VOC Reduction (g/yr)	-	1.67E+04	1.97E+04	3.08E+04	3.08E+04	3.08E+04	3.08E+04	3.02E+04	3.03E+04	3.04E+04
Annual VOC Cost Benefit (\$/g)	-	3.35E-03	6.33E-03	1.09E-02	5.36E-03	3.51E-03	6.88E-04	1.29E-02	9.96E-03	5.55E-03
Annual VOC Cost Benefit (\$/ton)	-	3.04E+03	5.74E+03	9.91E+03	4.86E+03	3.18E+03	6.24E+02	1.17E+04	9.03E+03	5.03E+03

Table 3.1.07b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in New Jersey

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.32E+05	9.86E+04	6.96E+04	9.80E+03	5.26E+02	4.56E+02	5.41E+02	1.58E+02	1.37E+02	1.05E+02
CO Reduction (g/yr)	-	3.36E+04	6.26E+04	1.22E+05	1.32E+05	1.32E+05	1.32E+05	1.32E+05	1.32E+05	1.32E+05
Annual CO Cost Benefit (\$/g)	-	1.67E-03	1.99E-03	2.75E-03	1.25E-03	8.21E-04	1.61E-04	2.94E-03	2.28E-03	1.28E-03
Annual CO Cost Benefit (\$/ton)	-	1.51E+03	1.80E+03	2.50E+03	1.14E+03	7.44E+02	1.46E+02	2.67E+03	2.07E+03	1.16E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	2.16E+03	1.60E+03	9.10E+03	2.33E+03	1.43E+03	1.24E+03	7.50E+02	1.48E+03	1.28E+03	9.80E+02
NO _x Reduction (g/yr)	-	5.61E+02	<6.95E+03>	<1.69E+02>	7.26E+02	9.17E+02	1.41E+03	6.80E+02	8.77E+02	1.18E+03
Annual NO _x Cost Benefit (\$/g)	-	9.98E-02	NA	NA	2.27E-01	1.18E-01	1.51E-02	5.71E-01	3.44E-01	1.43E-01
Annual NO _x Cost Benefit (\$/ton)	-	9.06E+04	NA	NA	2.06E+05	1.07E+05	1.37E+04	5.18E+05	3.12E+05	1.30E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.69E+02	2.80E+02	2.60E+02	1.96E+02	6.26E+00	5.43E+00	4.16E+00	9.90E+01	8.58E+01	6.57E+01
SO ₂ Reduction (g/yr)	-	<1.12E+02>	<9.15E+01>	<2.74E+01>	1.62E+02	1.63E+02	1.64E+02	6.96E+01	8.28E+01	1.03E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.02E+00	6.62E-01	1.29E-01	5.58E+00	3.64E+00	1.64E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.22E+05	6.01E+05	1.17E+05	5.06E+06	3.30E+06	1.49E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.08a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in New York, Supporting Information
2.41 cords/yr Burned per Uncertified Freestanding Cordwood Stove in New York

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	59,932	49,789	46,233	43,151	49,789	43,151	33,024	49,789	43,151	33,024
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	467.61	388.48	360.73	676.30	784.27	679.70	520.18	1,197.76	1,038.06	794.43
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	692.61	712.61	768.38	1,124.25	1,001.84	897.27	737.75	1,413.44	1,253.74	1,010.11
Cost Difference (\$/yr)	-	20.00	75.77	431.64	309.23	204.66	45.14	720.83	561.13	317.50

Table 3.1.08b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in New York

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.23E+04	1.93E+04	2.00E+04	3.44E+03	1.86E+02	1.61E+02	1.24E+02	4.18E+02	3.62E+02	2.77E+02
PM Reduction (g/yr)	-	3.30E+04	3.23E+04	4.89E+04	5.21E+04	5.21E+04	5.22E+04	5.19E+04	5.19E+04	5.20E+04
Annual PM Cost Benefit (\$/g)	-	6.06E-04	2.34E-03	8.83E-03	5.93E-03	3.92E-03	8.65E-04	1.39E-02	1.08E-02	6.10E-03
Annual PM Cost Benefit (\$/ton)	-	5.50E+02	2.13E+03	8.01E+03	5.38E+03	3.56E+03	7.85E+02	1.26E+04	9.80E+03	5.54E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.66E+04	2.60E+04	2.05E+04	4.50E+01	1.15E+02	9.92E+01	3.86E+01	1.24E+03	1.08E+03	8.26E+02
VOC Reduction (g/yr)	-	3.07E+04	3.61E+04	5.66E+04	5.65E+04	5.65E+04	5.66E+04	5.54E+04	5.56E+04	5.58E+04
Annual VOC Cost Benefit (\$/g)	-	6.52E-04	2.10E-03	7.63E-03	5.47E-03	3.62E-03	7.97E-04	1.30E-02	1.01E-02	5.69E-03
Annual VOC Cost Benefit (\$/ton)	-	5.92E+02	1.90E+03	6.92E+03	4.96E+03	3.28E+03	7.23E+02	1.18E+04	9.16E+03	5.16E+03

Table 3.1.08b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in New York

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.43E+05	1.81E+05	1.28E+05	1.80E+04	9.66E+02	8.37E+02	9.94E+02	2.91E+02	2.52E+02	1.93E+02
CO Reduction (g/yr)	-	6.16E+04	1.15E+05	2.25E+05	2.42E+05	2.42E+05	2.42E+05	2.42E+05	2.42E+05	2.42E+05
Annual CO Cost Benefit (\$/g)	-	3.25E-04	6.59E-04	1.92E-03	1.28E-03	8.46E-04	1.87E-04	2.97E-03	2.31E-03	1.31E-03
Annual CO Cost Benefit (\$/ton)	-	2.94E+02	5.98E+02	1.74E+03	1.16E+03	7.68E+02	1.69E+02	2.70E+03	2.10E+03	1.19E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.96E+03	2.93E+03	1.67E+04	4.27E+03	2.63E+03	2.28E+03	1.38E+03	2.71E+03	2.35E+03	1.80E+03
NO _x Reduction (g/yr)	-	1.03E+03	<1.28E+04>	<3.10E+02>	1.33E+03	1.68E+03	2.58E+03	1.25E+03	1.61E+03	2.16E+03
Annual NO _x Cost Benefit (\$/g)	-	1.94E-02	NA	NA	2.32E-01	1.22E-01	1.75E-02	5.77E-01	3.48E-01	1.47E-01
Annual NO _x Cost Benefit (\$/ton)	-	1.76E+04	NA	NA	2.10E+05	1.10E+05	1.58E+04	5.24E+05	3.16E+05	1.33E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	3.10E+02	5.14E+02	4.78E+02	3.60E+02	1.15E+01	9.97E+00	7.63E+00	1.82E+02	1.58E+02	1.21E+02
SO ₂ Reduction (g/yr)	-	<2.05E+02>	<1.68E+02>	<5.02E+01>	2.98E+02	3.00E+02	3.02E+02	1.28E+02	1.52E+02	1.89E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.04E+00	6.83E-01	1.50E-01	5.64E+00	3.69E+00	1.68E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.41E+05	6.20E+05	1.36E+05	5.12E+06	3.35E+06	1.52E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.09a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in Pennsylvania, Supporting Information
1.87 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Pennsylvania

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	47,114	39,141	36,345	33,922	39,141	33,922	25,961	39,141	33,922	25,961
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	367.60	305.39	283.58	531.66	616.54	534.34	408.93	941.60	816.05	624.53
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	592.60	629.53	691.24	979.61	834.11	751.91	626.50	1,157.28	1,031.73	840.21
Cost Difference (\$/yr)	-	36.93	98.63	387.00	241.51	159.30	33.90	564.68	439.13	247.61

Table 3.1.09b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Pennsylvania

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.11E+04	1.52E+04	1.57E+04	2.70E+03	1.46E+02	1.27E+02	9.71E+01	3.29E+02	2.85E+02	2.18E+02
PM Reduction (g/yr)	-	2.59E+04	2.54E+04	3.84E+04	4.10E+04	4.10E+04	4.10E+04	4.08E+04	4.08E+04	4.09E+04
Annual PM Cost Benefit (\$/g)	-	1.42E-03	3.88E-03	1.01E-02	5.89E-03	3.89E-03	8.26E-04	1.38E-02	1.08E-02	6.05E-03
Annual PM Cost Benefit (\$/ton)	-	1.29E+03	3.52E+03	9.14E+03	5.35E+03	3.53E+03	7.50E+02	1.26E+04	9.76E+03	5.49E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	4.45E+04	2.04E+04	1.61E+04	3.54E+01	9.00E+01	7.80E+01	3.04E+01	9.79E+02	8.48E+02	6.49E+02
VOC Reduction (g/yr)	-	2.41E+04	2.84E+04	4.45E+04	4.44E+04	4.45E+04	4.45E+04	4.36E+04	4.37E+04	4.39E+04
Annual VOC Cost Benefit (\$/g)	-	1.53E-03	3.47E-03	8.70E-03	5.43E-03	3.58E-03	7.62E-04	1.30E-02	1.01E-02	5.64E-03
Annual VOC Cost Benefit (\$/ton)	-	1.39E+03	3.15E+03	7.89E+03	4.93E+03	3.25E+03	6.91E+02	1.18E+04	9.12E+03	5.12E+03

Table 3.1.09b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Pennsylvania

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.91E+05	1.42E+05	1.00E+05	1.41E+04	7.59E+02	6.58E+02	7.81E+02	2.29E+02	1.98E+02	1.52E+02
CO Reduction (g/yr)	-	4.85E+04	9.03E+04	1.77E+05	1.90E+05	1.90E+05	1.90E+05	1.91E+05	1.91E+05	1.91E+05
Annual CO Cost Benefit (\$/g)	-	7.62E-04	1.09E-03	2.19E-03	1.27E-03	8.38E-04	1.78E-04	2.96E-03	2.30E-03	1.30E-03
Annual CO Cost Benefit (\$/ton)	-	6.91E+02	9.90E+02	1.99E+03	1.15E+03	7.60E+02	1.62E+02	2.69E+03	2.09E+03	1.18E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.11E+03	2.30E+03	1.31E+04	3.36E+03	2.07E+03	1.79E+03	1.08E+03	2.13E+03	1.85E+03	1.41E+03
NO _x Reduction (g/yr)	-	8.10E+02	<1.00E+04>	<2.44E+02>	1.05E+03	1.32E+03	2.03E+03	9.81E+02	1.27E+03	1.70E+03
Annual NO _x Cost Benefit (\$/g)	-	4.56E-02	NA	NA	2.30E-01	1.20E-01	1.67E-02	5.75E-01	3.47E-01	1.46E-01
Annual NO _x Cost Benefit (\$/ton)	-	4.14E+04	NA	NA	2.09E+05	1.09E+05	1.51E+04	5.22E+05	3.15E+05	1.32E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.43E+02	4.04E+02	3.75E+02	2.83E+02	9.04E+00	7.84E+00	6.00E+00	1.43E+02	1.24E+02	9.48E+01
SO ₂ Reduction (g/yr)	-	<1.61E+02>	<1.32E+02>	<3.95E+01>	2.34E+02	2.35E+02	2.37E+02	1.00E+02	1.20E+02	1.49E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.03E+00	6.76E-01	1.43E-01	5.62E+00	3.67E+00	1.67E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.35E+05	6.14E+05	1.30E+05	5.10E+06	3.33E+06	1.51E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.10a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in Rhode Island, Supporting Information
2.17 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Rhode Island

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	52,464	43,586	40,472	37,774	43,586	37,774	28,909	43,586	37,774	28,909
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	409.34	340.07	315.78	592.03	686.55	595.01	455.37	1,048.51	908.71	695.44
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	634.34	664.21	723.44	1,039.98	904.12	812.58	672.93	1,264.19	1,124.39	911.12
Cost Difference (\$/yr)	-	29.86	89.09	405.63	269.78	178.24	38.59	629.85	490.05	276.78

Table 3.1.10b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Rhode Island

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.58E+04	1.69E+04	1.75E+04	3.01E+03	1.63E+02	1.41E+02	1.08E+02	3.66E+02	3.17E+02	2.43E+02
PM Reduction (g/yr)	-	2.89E+04	2.83E+04	4.28E+04	4.56E+04	4.57E+04	4.57E+04	4.54E+04	4.55E+04	4.55E+04
Annual PM Cost Benefit (\$/g)	-	1.03E-03	3.15E-03	9.48E-03	5.91E-03	3.90E-03	8.45E-04	1.39E-02	1.08E-02	6.08E-03
Annual PM Cost Benefit (\$/ton)	-	9.38E+02	2.86E+03	8.60E+03	5.36E+03	3.54E+03	7.66E+02	1.26E+04	9.78E+03	5.51E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	4.96E+04	2.27E+04	1.80E+04	3.94E+01	1.00E+02	8.69E+01	3.38E+01	1.09E+03	9.44E+02	7.23E+02
VOC Reduction (g/yr)	-	2.68E+04	3.16E+04	4.95E+04	4.95E+04	4.95E+04	4.96E+04	4.85E+04	4.86E+04	4.89E+04
Annual VOC Cost Benefit (\$/g)	-	1.11E-03	2.82E-03	8.19E-03	5.45E-03	3.60E-03	7.79E-04	1.30E-02	1.01E-02	5.66E-03
Annual VOC Cost Benefit (\$/ton)	-	1.01E+03	2.56E+03	7.43E+03	4.95E+03	3.27E+03	7.07E+02	1.18E+04	9.14E+03	5.14E+03

Table 3.1.10b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Rhode Island

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.12E+05	1.58E+05	1.12E+05	1.57E+04	8.46E+02	7.33E+02	8.70E+02	2.55E+02	2.21E+02	1.69E+02
CO Reduction (g/yr)	-	5.40E+04	1.01E+05	1.97E+05	2.12E+05	2.12E+05	2.12E+05	2.12E+05	2.12E+05	2.12E+05
Annual CO Cost Benefit (\$/g)	-	5.53E-04	8.86E-04	2.06E-03	1.28E-03	8.42E-04	1.82E-04	2.97E-03	2.31E-03	1.30E-03
Annual CO Cost Benefit (\$/ton)	-	5.02E+02	8.03E+02	1.87E+03	1.16E+03	7.64E+02	1.65E+02	2.69E+03	2.09E+03	1.18E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.47E+03	2.57E+03	1.46E+04	3.74E+03	2.30E+03	1.99E+03	1.21E+03	2.38E+03	2.06E+03	1.58E+03
NO _x Reduction (g/yr)	-	9.02E+02	<1.12E+04>	<2.71E+02>	1.17E+03	1.47E+03	2.26E+03	1.09E+03	1.41E+03	1.89E+03
Annual NO _x Cost Benefit (\$/g)	-	3.31E-02	NA	NA	2.31E-01	1.21E-01	1.71E-02	5.76E-01	3.48E-01	1.46E-01
Annual NO _x Cost Benefit (\$/ton)	-	3.00E+04	NA	NA	2.10E+05	1.10E+05	1.55E+04	5.23E+05	3.15E+05	1.33E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.71E+02	4.50E+02	4.18E+02	3.15E+02	1.01E+01	8.73E+00	6.68E+00	1.59E+02	1.38E+02	1.06E+02
SO ₂ Reduction (g/yr)	-	<1.79E+02>	<1.47E+02>	<4.40E+01>	2.61E+02	2.62E+02	2.64E+02	1.12E+02	1.33E+02	1.65E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.03E+00	6.80E-01	1.46E-01	5.63E+00	3.68E+00	1.67E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.38E+05	6.17E+05	1.32E+05	5.11E+06	3.34E+06	1.52E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.11a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in District of Columbia, Supporting Information
0.86 cords/yr Burned per Uncertified Freestanding Cordwood Stove in District of Columbia

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	20,266	16,837	15,634	14,592	16,837	14,592	11,167	16,837	14,592	11,167
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	158.13	131.37	121.98	228.70	265.21	229.85	175.90	405.03	351.03	268.64
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	383.13	455.50	529.64	676.64	482.78	447.42	393.47	620.71	566.71	484.32
Cost Difference (\$/yr)	-	72.38	146.51	293.52	99.65	64.29	10.35	237.59	183.58	101.20

Table 3.1.11b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in District of Columbia

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	1.77E+04	6.53E+03	6.76E+03	1.16E+03	6.30E+01	5.46E+01	4.18E+01	1.41E+02	1.23E+02	9.38E+01
PM Reduction (g/yr)	-	1.12E+04	1.09E+04	1.65E+04	1.76E+04	1.76E+04	1.76E+04	1.75E+04	1.76E+04	1.76E+04
Annual PM Cost Benefit (\$/g)	-	6.49E-03	1.34E-02	1.78E-02	5.65E-03	3.65E-03	5.86E-04	1.35E-02	1.05E-02	5.75E-03
Annual PM Cost Benefit (\$/ton)	-	5.88E+03	1.22E+04	1.61E+04	5.13E+03	3.31E+03	5.32E+02	1.23E+04	9.48E+03	5.22E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	1.92E+04	8.78E+03	6.94E+03	1.52E+01	3.87E+01	3.36E+01	1.31E+01	4.21E+02	3.65E+02	2.79E+02
VOC Reduction (g/yr)	-	1.04E+04	1.22E+04	1.91E+04	1.91E+04	1.91E+04	1.91E+04	1.87E+04	1.88E+04	1.89E+04
Annual VOC Cost Benefit (\$/g)	-	6.98E-03	1.20E-02	1.53E-02	5.21E-03	3.36E-03	5.41E-04	1.27E-02	9.77E-03	5.36E-03
Annual VOC Cost Benefit (\$/ton)	-	6.33E+03	1.09E+04	1.39E+04	4.73E+03	3.05E+03	4.90E+02	1.15E+04	8.86E+03	4.86E+03

Table 3.1.11b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in District of Columbia

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	8.21E+04	6.12E+04	4.32E+04	6.08E+03	3.27E+02	2.83E+02	3.36E+02	9.83E+01	8.52E+01	6.52E+01
CO Reduction (g/yr)	-	2.08E+04	3.89E+04	7.60E+04	8.17E+04	8.18E+04	8.17E+04	8.20E+04	8.20E+04	8.20E+04
Annual CO Cost Benefit (\$/g)	-	3.47E-03	3.77E-03	3.86E-03	1.22E-03	7.86E-04	1.27E-04	2.90E-03	2.24E-03	1.23E-03
Annual CO Cost Benefit (\$/ton)	-	3.15E+03	3.42E+03	3.50E+03	1.11E+03	7.13E+02	1.15E+02	2.63E+03	2.03E+03	1.12E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	1.34E+03	9.91E+02	5.65E+03	1.44E+03	8.89E+02	7.70E+02	4.66E+02	9.18E+02	7.95E+02	6.09E+02
NO _x Reduction (g/yr)	-	3.48E+02	<4.31E+03>	<1.05E+02>	4.51E+02	5.69E+02	8.74E+02	4.22E+02	5.44E+02	7.31E+02
Annual NO _x Cost Benefit (\$/g)	-	2.08E-01	NA	NA	2.21E-01	1.13E-01	1.18E-02	5.63E-01	3.37E-01	1.38E-01
Annual NO _x Cost Benefit (\$/ton)	-	1.88E+05	NA	NA	2.01E+05	1.02E+05	1.07E+04	5.11E+05	3.06E+05	1.26E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.05E+02	1.74E+02	1.61E+02	1.22E+02	3.89E+00	3.37E+00	2.58E+00	6.15E+01	5.33E+01	4.08E+01
SO ₂ Reduction (g/yr)	-	<6.92E+01>	<5.68E+01>	<1.70E+01>	1.01E+02	1.01E+02	1.02E+02	4.32E+01	5.14E+01	6.39E+01
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	9.89E-01	6.35E-01	1.01E-01	5.50E+00	3.57E+00	1.58E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	8.97E+05	5.76E+05	9.19E+04	4.99E+06	3.24E+06	1.44E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.12a
 Replacement of an Existing Uncertified Freestanding Cordwood Stove in Vermont, Supporting Information
 2.56 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Vermont

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove-Natural Gas, B Vent	Gas Stove-Natural Gas, Direct Vent	Gas Stove-Natural Gas, Vent Free	Gas Stove-LPG, B Vent	Gas Stove-LPG, Direct Vent	Gas Stove-LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	61,971	51,483	47,806	44,619	51,483	44,619	34,147	51,483	44,619	34,147
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	483.52	401.69	373.00	699.31	810.96	702.83	537.88	1,238.51	1,073.37	821.46
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	708.52	725.83	780.66	1,147.25	1,028.52	920.40	755.45	1,454.19	1,289.05	1,037.14
Cost Difference (\$/yr)	-	17.31	72.14	438.74	320.01	211.88	46.93	745.67	580.53	328.62

Table 3.1.12b
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Vermont

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove-Natural Gas, B Vent	Gas Stove-Natural Gas, Direct Vent	Gas Stove-Natural Gas, Vent Free	Gas Stove-LPG, B Vent	Gas Stove-LPG, Direct Vent	Gas Stove-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.41E+04	2.00E+04	2.07E+04	3.56E+03	1.93E+02	1.67E+02	1.28E+02	4.32E+02	3.75E+02	2.87E+02
PM Reduction (g/yr)	-	3.41E+04	3.34E+04	5.05E+04	5.39E+04	5.39E+04	5.40E+04	5.37E+04	5.37E+04	5.38E+04
Annual PM Cost Benefit (\$/g)	-	5.07E-04	2.16E-03	8.68E-03	5.94E-03	3.93E-03	8.70E-04	1.39E-02	1.08E-02	6.11E-03
Annual PM Cost Benefit (\$/ton)	-	4.60E+02	1.96E+03	7.88E+03	5.39E+03	3.56E+03	7.89E+02	1.26E+04	9.80E+03	5.54E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.86E+04	2.69E+04	2.12E+04	4.65E+01	1.18E+02	1.03E+02	4.00E+01	1.29E+03	1.12E+03	8.54E+02
VOC Reduction (g/yr)	-	3.17E+04	3.73E+04	5.85E+04	5.85E+04	5.85E+04	5.85E+04	5.73E+04	5.75E+04	5.77E+04
Annual VOC Cost Benefit (\$/g)	-	5.46E-04	1.93E-03	7.50E-03	5.47E-03	3.62E-03	8.02E-04	1.30E-02	1.01E-02	5.69E-03
Annual VOC Cost Benefit (\$/ton)	-	4.95E+02	1.75E+03	6.80E+03	4.97E+03	3.29E+03	7.27E+02	1.18E+04	9.17E+03	5.17E+03

Table 3.1.12b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Vermont

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.51E+05	1.87E+05	1.32E+05	1.86E+04	9.99E+02	8.66E+02	1.03E+03	3.01E+02	2.61E+02	1.99E+02
CO Reduction (g/yr)	-	6.37E+04	1.19E+05	2.32E+05	2.50E+05	2.50E+05	2.50E+05	2.51E+05	2.51E+05	2.51E+05
Annual CO Cost Benefit (\$/g)	-	2.72E-04	6.07E-04	1.89E-03	1.28E-03	8.47E-04	1.88E-04	2.98E-03	2.32E-03	1.31E-03
Annual CO Cost Benefit (\$/ton)	-	2.46E+02	5.51E+02	1.71E+03	1.16E+03	7.69E+02	1.70E+02	2.70E+03	2.10E+03	1.19E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	4.10E+03	3.03E+03	1.73E+04	4.42E+03	2.72E+03	2.36E+03	1.42E+03	2.81E+03	2.43E+03	1.86E+03
NO _x Reduction (g/yr)	-	1.07E+03	<1.32E+04>	<3.21E+02>	1.38E+03	1.74E+03	2.67E+03	1.29E+03	1.66E+03	2.24E+03
Annual NO _x Cost Benefit (\$/g)	-	1.62E-02	NA	NA	2.32E-01	1.22E-01	1.76E-02	5.78E-01	3.49E-01	1.47E-01
Annual NO _x Cost Benefit (\$/ton)	-	1.47E+04	NA	NA	2.11E+05	1.10E+05	1.59E+04	5.24E+05	3.16E+05	1.33E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	3.20E+02	5.32E+02	4.94E+02	3.72E+02	1.19E+01	1.03E+01	7.89E+00	1.88E+02	1.63E+02	1.25E+02
SO ₂ Reduction (g/yr)	-	<2.12E+02>	<1.74E+02>	<5.19E+01>	3.08E+02	3.10E+02	3.12E+02	1.32E+02	1.57E+02	1.95E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.04E+00	6.84E-01	1.50E-01	5.64E+00	3.69E+00	1.68E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.42E+05	6.21E+05	1.36E+05	5.12E+06	3.35E+06	1.53E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.13a

Replacement of an Existing Uncertified Freestanding Cordwood Stove in High HDD Category, Supporting Information
2.56 cords/yr Burned per Uncertified Freestanding Cordwood Stove in high HDD Category

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	61,382	50,995	47,352	44,195	50,995	44,195	33,823	50,995	44,195	33,823
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	478.93	397.88	369.46	692.67	803.26	696.16	532.77	1,226.75	1,063.18	813.66
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	703.93	722.02	777.11	1,140.62	1,020.83	913.72	750.34	1,442.43	1,278.86	1,029.34
Cost Difference (\$/yr)	-	18.09	73.19	436.69	316.90	209.80	46.41	738.50	574.93	325.41

Table 3.1.13b

Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in High HDD Category

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.36E+04	1.98E+04	2.05E+04	3.52E+03	1.91E+02	1.65E+02	1.26E+02	4.28E+02	3.71E+02	2.84E+02
PM Reduction (g/yr)	-	3.38E+04	3.31E+04	5.01E+04	5.34E+04	5.34E+04	5.34E+04	5.31E+04	5.32E+04	5.33E+04
Annual PM Cost Benefit (\$/g)	-	5.35E-04	2.21E-03	8.72E-03	5.94E-03	3.93E-03	8.68E-04	1.39E-02	1.08E-02	6.11E-03
Annual PM Cost Benefit (\$/ton)	-	4.86E+02	2.01E+03	7.91E+03	5.39E+03	3.56E+03	7.88E+02	1.26E+04	9.80E+03	5.54E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.80E+04	2.66E+04	2.10E+04	4.61E+01	1.17E+02	1.02E+02	3.96E+01	1.27E+03	1.10E+03	8.46E+02
VOC Reduction (g/yr)	-	3.14E+04	3.70E+04	5.80E+04	5.79E+04	5.79E+04	5.80E+04	5.67E+04	5.69E+04	5.72E+04
Annual VOC Cost Benefit (\$/g)	-	5.76E-04	1.98E-03	7.53E-03	5.47E-03	3.62E-03	8.01E-04	1.30E-02	1.01E-02	5.69E-03
Annual VOC Cost Benefit (\$/ton)	-	5.22E+02	1.80E+03	6.83E+03	4.97E+03	3.29E+03	7.26E+02	1.18E+04	9.17E+03	5.16E+03

Table3.1.13b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in High HDD Category

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.49E+05	1.85E+05	1.31E+05	1.84E+04	9.89E+02	8.57E+02	1.02E+03	2.98E+02	2.58E+02	1.98E+02
CO Reduction (g/yr)	-	6.31E+04	1.18E+05	2.30E+05	2.48E+05	2.48E+05	2.48E+05	2.48E+05	2.48E+05	2.48E+05
Annual CO Cost Benefit (\$/g)	-	2.87E-04	6.22E-04	1.90E-03	1.28E-03	8.47E-04	1.88E-04	2.97E-03	2.32E-03	1.31E-03
Annual CO Cost Benefit (\$/ton)	-	2.60E+02	5.64E+02	1.72E+03	1.16E+03	7.68E+02	1.70E+02	2.70E+03	2.10E+03	1.19E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	4.06E+03	3.00E+03	1.71E+04	4.38E+03	2.69E+03	2.33E+03	1.41E+03	2.78E+03	2.41E+03	1.84E+03
NO _x Reduction (g/yr)	-	1.06E+03	<1.31E+04>	<3.18E+02>	1.37E+03	1.72E+03	2.65E+03	1.28E+03	1.65E+03	2.21E+03
Annual NO _x Cost Benefit (\$/g)	-	1.71E-02	NA	NA	2.32E-01	1.22E-01	1.75E-02	5.78E-01	3.49E-01	1.47E-01
Annual NO _x Cost Benefit (\$/ton)	-	1.55E+04	NA	NA	2.11E+05	1.10E+05	1.59E+04	5.24E+05	3.16E+05	1.33E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	3.17E+02	5.27E+02	4.89E+02	3.68E+02	1.18E+01	1.02E+01	7.81E+00	1.86E+02	1.61E+02	1.23E+02
SO ₂ Reduction (g/yr)	-	<2.10E+02>	<1.72E+02>	<5.14E+01>	3.05E+02	3.07E+02	3.09E+02	1.31E+02	1.56E+02	1.94E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.04E+00	6.84E-01	1.50E-01	5.64E+00	3.69E+00	1.68E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.42E+05	6.20E+05	1.36E+05	5.12E+06	3.35E+06	1.53E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.14a
Replacement of an Existing Uncertified Freestanding Cordwood Stove in Medium HDD Category, Supporting Information
2.03 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Medium HDD Category

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	48,674	40,437	37,549	35,045	40,437	35,045	26,821	40,437	35,045	26,821
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	379.78	315.51	292.97	549.27	636.96	552.03	422.47	972.77	843.07	645.21
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	604.78	639.64	700.62	997.21	854.53	769.60	640.04	1,188.45	1,058.75	860.89
Cost Difference (\$/yr)	-	34.87	95.85	392.44	249.75	164.82	35.27	583.68	453.98	256.11

Table 3.1.14b
Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Medium HDD Category

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.25E+04	1.57E+04	1.62E+04	2.79E+03	1.51E+02	1.31E+02	1.00E+02	3.40E+02	2.94E+02	2.25E+02
PM Reduction (g/yr)	-	2.68E+04	2.63E+04	3.97E+04	4.23E+04	4.24E+04	4.24E+04	4.21E+04	4.22E+04	4.23E+04
Annual PM Cost Benefit (\$/g)	-	1.30E-03	3.65E-03	9.89E-03	5.90E-03	3.89E-03	8.32E-04	1.38E-02	1.08E-02	6.06E-03
Annual PM Cost Benefit (\$/ton)	-	1.18E+03	3.31E+03	8.97E+03	5.35E+03	3.53E+03	7.55E+02	1.26E+04	9.76E+03	5.50E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	4.60E+04	2.11E+04	1.67E+04	3.65E+01	9.30E+01	8.06E+01	3.14E+01	1.01E+03	8.76E+02	6.71E+02
VOC Reduction (g/yr)	-	2.49E+04	2.93E+04	4.60E+04	4.59E+04	4.59E+04	4.60E+04	4.50E+04	4.51E+04	4.53E+04
Annual VOC Cost Benefit (\$/g)	-	1.40E-03	3.27E-03	8.54E-03	5.44E-03	3.59E-03	7.67E-04	1.30E-02	1.01E-02	5.65E-03
Annual VOC Cost Benefit (\$/ton)	-	1.27E+03	2.97E+03	7.75E+03	4.94E+03	3.26E+03	6.96E+02	1.18E+04	9.13E+03	5.13E+03

Table3.1.14b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Medium HDD Category

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.97E+05	1.47E+05	1.04E+05	1.46E+04	7.84E+02	6.80E+02	8.07E+02	2.36E+02	2.05E+02	1.57E+02
CO Reduction (g/yr)	-	5.01E+04	9.33E+04	1.82E+05	1.96E+05	1.96E+05	1.96E+05	1.97E+05	1.97E+05	1.97E+05
Annual CO Cost Benefit (\$/g)	-	6.97E-04	1.03E-03	2.15E-03	1.27E-03	8.39E-04	1.80E-04	2.97E-03	2.31E-03	1.30E-03
Annual CO Cost Benefit (\$/ton)	-	6.32E+02	9.32E+02	1.95E+03	1.15E+03	7.61E+02	1.63E+02	2.69E+03	2.09E+03	1.18E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.22E+03	2.38E+03	1.36E+04	3.47E+03	2.14E+03	1.85E+03	1.12E+03	2.20E+03	1.91E+03	1.46E+03
NO _x Reduction (g/yr)	-	8.37E+02	<1.04E+04>	<2.52E+02>	1.08E+03	1.37E+03	2.10E+03	1.01E+03	1.31E+03	1.76E+03
Annual NO _x Cost Benefit (\$/g)	-	4.17E-02	NA	NA	2.31E-01	1.21E-01	1.68E-02	5.76E-01	3.47E-01	1.46E-01
Annual NO _x Cost Benefit (\$/ton)	-	3.78E+04	NA	NA	2.09E+05	1.09E+05	1.52E+04	5.22E+05	3.15E+05	1.32E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.51E+02	4.18E+02	3.88E+02	2.92E+02	9.34E+00	8.10E+00	6.20E+00	1.48E+02	1.28E+02	9.79E+01
SO ₂ Reduction (g/yr)	-	<1.66E+02>	<1.36E+02>	<4.08E+01>	2.42E+02	2.43E+02	2.45E+02	1.04E+02	1.23E+02	1.53E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.03E+00	6.77E-01	1.44E-01	5.62E+00	3.68E+00	1.67E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.36E+05	6.15E+05	1.30E+05	5.10E+06	3.34E+06	1.51E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.1.15a
 Replacement of an Existing Uncertified Freestanding Cordwood Stove in Low HDD Category, Supporting Information
 0.95 cords/yr Burned per Uncertified Freestanding Cordwood Stove in Low HDD Category

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance/Fuel Type	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
Efficiency (%)	54	65	70	75	65	75	98	65	75	98
Annual Fuel Input (MJ/yr)	22,779	18,924	17,572	16,401	18,924	16,401	12,551	18,924	16,401	12,551
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	177.73	147.65	137.10	257.05	298.08	258.34	197.71	455.24	394.54	301.94
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	225.00	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	402.73	471.79	544.76	704.99	515.65	475.91	415.28	670.92	610.22	517.63
Cost Difference (\$/yr)	-	69.06	142.03	302.26	112.92	73.18	12.55	268.19	207.49	114.90

Table 3.1.15b
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Low HDD Category

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Appliance / Fuel Category	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	1.99E+04	7.34E+03	7.60E+03	1.31E+03	7.08E+01	6.13E+01	4.69E+01	1.59E+02	1.38E+02	1.05E+02
PM Reduction (g/yr)	-	1.25E+04	1.23E+04	1.86E+04	1.98E+04	1.98E+04	1.98E+04	1.97E+04	1.97E+04	1.98E+04
Annual PM Cost Benefit (\$/g)	-	5.51E-03	1.16E-02	1.63E-02	5.70E-03	3.69E-03	6.33E-04	1.36E-02	1.05E-02	5.81E-03
Annual PM Cost Benefit (\$/ton)	-	5.00E+03	1.05E+04	1.48E+04	5.17E+03	3.35E+03	5.74E+02	1.23E+04	9.53E+03	5.27E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	2.15E+04	9.87E+03	7.80E+03	1.71E+01	4.35E+01	3.77E+01	1.47E+01	4.73E+02	4.10E+02	3.14E+02
VOC Reduction (g/yr)	-	1.17E+04	1.37E+04	2.15E+04	2.15E+04	2.15E+04	2.15E+04	2.11E+04	2.11E+04	2.12E+04
Annual VOC Cost Benefit (\$/g)	-	5.92E-03	1.03E-02	1.41E-02	5.26E-03	3.41E-03	5.83E-04	1.27E-02	9.83E-03	5.42E-03
Annual VOC Cost Benefit (\$/ton)	-	5.37E+03	9.39E+03	1.27E+04	4.77E+03	3.09E+03	5.29E+02	1.16E+04	8.91E+03	4.91E+03

Table3.1.15b continued
 Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in Low HDD Category

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	9.22E+04	6.88E+04	4.86E+04	6.84E+03	3.67E+02	3.18E+02	3.78E+02	1.11E+02	9.58E+01	7.33E+01
CO Reduction (g/yr)	-	2.34E+04	4.37E+04	8.54E+04	9.19E+04	9.19E+04	9.19E+04	9.21E+04	9.21E+04	9.22E+04
Annual CO Cost Benefit (\$/g)	-	2.95E-03	3.25E-03	3.54E-03	1.23E-03	7.96E-04	1.37E-04	2.91E-03	2.25E-03	1.25E-03
Annual CO Cost Benefit (\$/ton)	-	2.67E+03	2.95E+03	3.21E+03	1.12E+03	7.22E+02	1.24E+02	2.64E+03	2.04E+03	1.13E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	1.51E+03	1.11E+03	6.35E+03	1.62E+03	9.99E+02	8.66E+02	5.23E+02	1.03E+03	8.94E+02	6.84E+02
NO _x Reduction (g/yr)	-	3.92E+02	<4.85E+03>	<1.18E+02>	5.07E+02	6.40E+02	9.82E+02	4.74E+02	6.12E+02	8.22E+02
Annual NO _x Cost Benefit (\$/g)	-	1.76E-01	NA	NA	2.23E-01	1.14E-01	1.28E-02	5.65E-01	3.39E-01	1.40E-01
Annual NO _x Cost Benefit (\$/ton)	-	1.60E+05	NA	NA	2.02E+05	1.04E+05	1.16E+04	5.13E+05	3.08E+05	1.27E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.18E+02	1.95E+02	1.82E+02	1.37E+02	4.37E+00	3.79E+00	2.90E+00	6.91E+01	5.99E+01	4.58E+01
SO ₂ Reduction (g/yr)	-	<7.78E+01>	<6.39E+01>	<1.91E+01>	1.13E+02	1.14E+02	1.15E+02	4.86E+01	5.78E+01	7.18E+01
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	9.97E-01	6.43E-01	1.09E-01	5.52E+00	3.59E+00	1.60E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.04E+05	5.83E+05	9.92E+04	5.01E+06	3.26E+06	1.45E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

3.2. Uncertified Cordwood Fireplace Insert Replacement

The most likely replacements for an uncertified cordwood fireplace insert include certified catalytic and non-catalytic cordwood inserts, pellet inserts, direct vent gas inserts, b-vent gas inserts, and vent free gas inserts (gas includes both LPG and natural gas). Replacement of the uncertified cordwood fireplace insert requires the proper disposal of the old insert, which adds approximately \$100 to the total installation cost of the replacement insert. Calculations and assumptions for uncertified cordwood fireplace insert replacement include further explanation of those already listed in Section 3.

Calculations and Assumptions

Annual fuel input for new unit: input MJ/yr (new)
MJ/yr (old) X (efficiency (old) / efficiency (new))

Insert Efficiency:

Insert efficiencies are generally 5% lower than analogous stove type efficiencies due to heat lost into firebox cavity, and the fact that inserts are generally against the outside wall of a house, which radiates heat out of the house. This is especially true for masonry chimneys, which lose heat through the un-insulated masonry material.

Annualized installation/replacement cost: \$/yr⁴²

Install/replace, gas plumbing, and old unit removal cost; all divided by the device lifetime

- Certified non-cat. cordwood insert: \$3,763 / 19.3 yrs = \$194.80/yr
- Certified cat. cordwood insert: \$3,700 / 19.3 yrs = \$191.40/yr
- Pellet insert: \$3,667 / 15 yrs = \$244.40/yr
- Gas inserts – natural gas (direct vent, B-vent, vent free): \$3,350 / 17.7 yrs = \$189.60/yr
- Gas inserts – LPG (direct vent, B-vent, vent free): \$3,300 / 17.7 yrs = \$186.80/yr

Ancillary costs: sum of a b and c per appliance: \$/yr

a) Chimney cleaning – cost per cleaning X cleanings per year = \$/yr⁴⁴

- Uncertified cordwood fireplace insert: \$175 X 2 cleanings/yr = \$350/yr
- Certified non-cat. and cat. cordwood inserts – See section 3.1 (cordwood stoves)
- Pellet insert – See section 3.1 (pellet stove)

b) Electricity costs:

- Cordwood fireplace inserts -

Hours of use per year⁶¹ (for 6 month heating season, Oct-March) assumed to be:

60 days @ 14 hrs/day = 840 hrs

60 days @ 8 hrs/day = 280 hrs

62 days @ 4 hrs/day = 248 hrs

Total = 1,368 hrs/yr

0.144 kw X 1,368 hrs/yr X \$0.13/kw-h = \$25.12/yr

- Pellet insert – See section 3.1 (pellet stove)
- Gas inserts – See section 3.1 (gas stoves)

c) Annualized catalyst replacement - \$45/yr

Total annual emissions for each category: g/yr

Total annual emissions = emission factor (g/MJ) X annual fuel input (MJ/yr)

Emission factors in g/input MJ

Wood burning insert emission factors converted from g/kg^{4,07-4,19,10,22-27} to g/MJ by
dividing the g/kg emission factor by the average wood heat content⁴⁵ (MJ/kg)

Pellet insert emission factors converted from g/kg^{4,07,4,11,4,18,4,19,10,24,26-27} to g/MJ by
dividing the g/kg emission factor by the average pellet heat content⁴⁷ (MJ/kg)

Natural Gas insert emission factors converted to g/MJ³⁶⁻⁴⁰

LPG Gas insert emission factors converted to g/MJ³⁴⁻³⁵

Table 3.2.01a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Connecticut, Supporting Information
2.15 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Connecticut

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	55,496	45,321	41,835	38,847	45,321	38,847	28,624	45,321	38,847	28,624
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	433.00	353.61	326.41	608.85	713.89	611.91	450.88	1,090.27	934.52	688.59
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	808.11	702.87	759.18	1,056.79	931.46	829.48	668.45	1,305.95	1,150.20	904.27
Cost Difference (\$/yr)	-	<105.24>	<48.93>	248.68	123.35	21.36	<139.66>	497.84	342.09	96.16

<> - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.01b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Connecticut

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.84E+04	1.76E+04	1.81E+04	3.10E+03	1.70E+02	1.45E+02	1.07E+02	3.81E+02	3.26E+02	2.40E+02
PM Reduction (g/yr)	-	3.09E+04	3.04E+04	4.53E+04	4.83E+04	4.83E+04	4.83E+04	4.81E+04	4.81E+04	4.82E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.48E-03	2.56E-03	4.42E-04	**	1.04E-02	7.11E-03	2.00E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	4.98E+03	2.32E+03	4.01E+02	**	9.40E+03	6.45E+03	1.81E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.25E+04	2.36E+04	1.86E+04	4.05E+01	1.04E+02	8.93E+01	3.35E+01	1.13E+03	9.71E+02	7.16E+02
VOC Reduction (g/yr)	-	2.88E+04	3.39E+04	5.24E+04	5.23E+04	5.24E+04	5.24E+04	5.13E+04	5.15E+04	5.17E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.74E-03	2.36E-03	4.08E-04	**	9.70E-03	6.65E-03	1.86E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.30E+03	2.14E+03	3.70E+02	**	8.80E+03	6.03E+03	1.69E+03

Table 3.2.01b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Connecticut

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.25E+05	1.65E+05	1.16E+05	1.62E+04	8.79E+02	7.54E+02	8.62E+02	2.65E+02	2.27E+02	1.67E+02
CO Reduction (g/yr)	-	5.99E+04	1.09E+05	2.09E+05	2.24E+05	2.24E+05	2.24E+05	2.24E+05	2.24E+05	2.25E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.19E-03	5.51E-04	9.54E-05	**	2.22E-03	1.52E-03	4.28E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.08E+03	5.00E+02	8.65E+01	**	2.01E+03	1.38E+03	3.89E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.67E+03	2.67E+03	1.51E+04	3.85E+03	2.39E+03	2.05E+03	1.19E+03	2.47E+03	2.12E+03	1.56E+03
NO _x Reduction (g/yr)	-	1.00E+03	<1.15E+04>	<1.77E+02>	1.28E+03	1.62E+03	2.48E+03	1.20E+03	1.55E+03	2.11E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	9.67E-02	1.32E-02	**	4.15E-01	2.20E-01	4.56E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	8.77E+04	1.20E+04	**	3.77E+05	2.00E+05	4.14E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.87E+02	4.68E+02	4.32E+02	3.24E+02	1.05E+01	8.97E+00	6.61E+00	1.65E+02	1.42E+02	1.04E+02
SO ₂ Reduction (g/yr)	-	<1.82E+02>	<1.46E+02>	<3.72E+01>	2.76E+02	2.78E+02	2.80E+02	1.21E+02	1.45E+02	1.82E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	4.47E-01	7.70E-02	**	4.11E+00	2.36E+00	5.28E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	4.05E+05	6.98E+04	**	3.73E+06	2.14E+06	4.79E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.02a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Delaware, Supporting Information
0.95 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Delaware

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	22,203	18,133	16,738	15,542	18,133	15,542	11,452	18,133	15,542	11,452
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	173.24	141.48	130.59	243.59	285.62	244.82	180.39	436.20	373.89	275.50
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	548.35	490.73	563.37	691.54	503.19	462.39	397.96	651.89	589.57	491.18
Cost Difference (\$/yr)	-	<57.62>	15.01	143.18	<45.16>	<85.97>	<150.39>	103.53	41.22	<57.17>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.02b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Delaware

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	1.94E+04	7.03E+03	7.24E+03	1.24E+03	6.78E+01	5.81E+01	4.28E+01	1.52E+02	1.31E+02	9.62E+01
PM Reduction (g/yr)	-	1.23E+04	1.21E+04	1.81E+04	1.93E+04	1.93E+04	1.93E+04	1.92E+04	1.92E+04	1.93E+04
Annual PM Cost Benefit (\$/g)	-	**	1.24E-03	7.89E-03	**	**	**	5.38E-03	2.14E-03	**
Annual PM Cost Benefit (\$/ton)	-	**	1.12E+03	7.16E+03	**	**	**	4.89E+03	1.94E+03	**
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	2.10E+04	9.46E+03	7.43E+03	1.62E+01	4.17E+01	3.57E+01	1.34E+01	4.53E+02	3.89E+02	2.86E+02
VOC Reduction (g/yr)	-	1.15E+04	1.36E+04	2.10E+04	2.09E+04	2.09E+04	2.10E+04	2.05E+04	2.06E+04	2.07E+04
Annual VOC Cost Benefit (\$/g)	-	**	1.11E-03	6.83E-03	**	**	**	5.04E-03	2.00E-03	**
Annual VOC Cost Benefit (\$/ton)	-	**	1.01E+03	6.19E+03	**	**	**	4.57E+03	1.82E+03	**

Table 3.2.02b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Delaware

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	8.99E+04	6.59E+04	4.62E+04	6.48E+03	3.52E+02	3.02E+02	3.45E+02	1.06E+02	9.08E+01	6.69E+01
CO Reduction (g/yr)	-	2.40E+04	4.37E+04	8.34E+04	8.96E+04	8.96E+04	8.96E+04	8.98E+04	8.98E+04	8.98E+04
Annual CO Cost Benefit (\$/g)	-	**	3.44E-04	1.72E-03	**	**	**	1.15E-03	4.59E-04	**
Annual CO Cost Benefit (\$/ton)	-	**	3.12E+02	1.56E+03	**	**	**	1.05E+03	4.16E+02	**
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	1.47E+03	1.07E+03	6.05E+03	1.54E+03	9.57E+02	8.21E+02	4.78E+02	9.88E+02	8.47E+02	6.24E+02
NO _x Reduction (g/yr)	-	4.00E+02	<4.58E+03>	<7.09E+01>	5.10E+02	6.47E+02	9.90E+02	4.80E+02	6.21E+02	8.44E+02
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	**	**	**	2.16E-01	6.64E-02	**
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	**	**	**	1.96E+05	6.02E+04	**
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.15E+02	1.87E+02	1.73E+02	1.30E+02	4.19E+00	3.59E+00	2.65E+00	6.62E+01	5.67E+01	4.18E+01
SO ₂ Reduction (g/yr)	-	<7.26E+01>	<5.82E+01>	<1.49E+01>	1.10E+02	1.11E+02	1.12E+02	4.85E+01	5.79E+01	7.29E+01
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	**	**	**	2.14E+00	7.11E-01	**
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	**	**	**	1.94E+06	6.45E+05	**

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.03a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Maine, Supporting Information
2.56 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Maine

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	55,181	45,065	41,598	38,627	45,065	38,627	28,462	45,065	38,627	28,462
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	430.55	351.61	324.57	605.40	709.85	608.44	448.33	1,084.10	929.23	684.69
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	805.66	700.87	757.34	1,053.34	927.42	826.01	665.90	1,299.78	1,144.91	900.38
Cost Difference (\$/yr)	-	<104.80>	<48.33>	247.68	121.76	20.35	<139.77>	494.12	339.25	94.71

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.03b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Maine

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.82E+04	1.75E+04	1.80E+04	3.08E+03	1.69E+02	1.44E+02	1.06E+02	3.79E+02	3.24E+02	2.39E+02
PM Reduction (g/yr)	-	3.07E+04	3.02E+04	4.51E+04	4.80E+04	4.80E+04	4.81E+04	4.78E+04	4.78E+04	4.79E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.49E-03	2.54E-03	4.24E-04	**	1.03E-02	7.09E-03	1.98E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	4.98E+03	2.30E+03	3.84E+02	**	9.38E+03	6.43E+03	1.79E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.22E+04	2.35E+04	1.85E+04	4.03E+01	1.04E+02	8.88E+01	3.33E+01	1.13E+03	9.66E+02	7.12E+02
VOC Reduction (g/yr)	-	2.86E+04	3.37E+04	5.21E+04	5.20E+04	5.21E+04	5.21E+04	5.10E+04	5.12E+04	5.14E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.75E-03	2.34E-03	3.91E-04	**	9.68E-03	6.63E-03	1.84E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.31E+03	2.12E+03	3.55E+02	**	8.78E+03	6.01E+03	1.67E+03

Table 3.2.03b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Maine

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.23E+05	1.64E+05	1.15E+05	1.61E+04	8.74E+02	7.49E+02	8.57E+02	2.63E+02	2.26E+02	1.66E+02
CO Reduction (g/yr)	-	5.96E+04	1.08E+05	2.07E+05	2.23E+05	2.23E+05	2.23E+05	2.23E+05	2.23E+05	2.23E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.19E-03	5.47E-04	9.14E-05	**	2.21E-03	1.52E-03	4.24E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.08E+03	4.96E+02	8.29E+01	**	2.01E+03	1.38E+03	3.85E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.65E+03	2.65E+03	1.50E+04	3.82E+03	2.38E+03	2.04E+03	1.19E+03	2.46E+03	2.11E+03	1.55E+03
NO _x Reduction (g/yr)	-	9.95E+02	<1.14E+04>	<1.76E+02>	1.27E+03	1.61E+03	2.46E+03	1.19E+03	1.54E+03	2.10E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	9.60E-02	1.27E-02	**	4.15E-01	2.20E-01	4.52E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	8.71E+04	1.15E+04	**	3.76E+05	1.99E+05	4.10E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.85E+02	4.65E+02	4.30E+02	3.22E+02	1.04E+01	8.92E+00	6.57E+00	1.64E+02	1.41E+02	1.04E+02
SO ₂ Reduction (g/yr)	-	<1.80E+02>	<1.45E+02>	<3.70E+01>	2.75E+02	2.76E+02	2.78E+02	1.21E+02	1.44E+02	1.81E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	4.43E-01	7.37E-02	**	4.10E+00	2.36E+00	5.23E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	4.02E+05	6.69E+04	**	3.72E+06	2.14E+06	4.74E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.04a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Maryland, Supporting Information
1.05 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Maryland

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	24,739	20,203	18,649	17,317	20,203	17,317	12,760	20,203	17,317	12,760
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	193.02	157.63	145.51	271.41	318.24	272.78	200.99	486.02	416.59	306.96
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	568.14	506.89	578.28	719.36	535.81	490.35	418.56	701.70	632.27	522.64
Cost Difference (\$/yr)	-	<61.25>	10.14	151.22	<32.33>	<77.79>	<149.58>	133.57	64.13	<45.49>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.04b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Maryland

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	2.16E+04	7.84E+03	8.06E+03	1.38E+03	7.56E+01	6.48E+01	4.77E+01	1.70E+02	1.45E+02	1.07E+02
PM Reduction (g/yr)	-	1.38E+04	1.35E+04	2.02E+04	2.15E+04	2.15E+04	2.15E+04	2.14E+04	2.14E+04	2.15E+04
Annual PM Cost Benefit (\$/g)	-	**	7.50E-04	7.48E-03	**	**	**	6.23E-03	2.99E-03	**
Annual PM Cost Benefit (\$/ton)	-	**	6.80E+02	6.79E+03	**	**	**	5.66E+03	2.71E+03	**
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	2.34E+04	1.05E+04	8.28E+03	1.80E+01	4.65E+01	3.98E+01	1.49E+01	5.05E+02	4.33E+02	3.19E+02
VOC Reduction (g/yr)	-	1.28E+04	1.51E+04	2.34E+04	2.33E+04	2.33E+04	2.34E+04	2.29E+04	2.29E+04	2.31E+04
Annual VOC Cost Benefit (\$/g)	-	**	6.72E-04	6.47E-03	**	**	**	5.84E-03	2.79E-03	**
Annual VOC Cost Benefit (\$/ton)	-	**	6.09E+02	5.87E+03	**	**	**	5.30E+03	2.54E+03	**

Table 3.2.04b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Maryland

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.00E+05	7.35E+04	5.15E+04	7.22E+03	3.92E+02	3.36E+02	3.84E+02	1.18E+02	1.01E+02	7.45E+01
CO Reduction (g/yr)	-	2.67E+04	4.86E+04	9.30E+04	9.98E+04	9.98E+04	9.98E+04	1.00E+05	1.00E+05	1.00E+05
Annual CO Cost Benefit (\$/g)	-	**	2.09E-04	1.63E-03	**	**	**	1.33E-03	6.41E-04	**
Annual CO Cost Benefit (\$/ton)	-	**	1.89E+02	1.48E+03	**	**	**	1.21E+03	5.81E+02	**
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	1.64E+03	1.19E+03	6.74E+03	1.71E+03	1.07E+03	9.14E+02	5.32E+02	1.10E+03	9.44E+02	6.95E+02
NO _x Reduction (g/yr)	-	4.46E+02	<5.11E+03>	<7.90E+01>	5.69E+02	7.21E+02	1.10E+03	5.34E+02	6.92E+02	9.40E+02
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	**	**	**	2.50E-01	9.27E-02	**
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	**	**	**	2.27E+05	8.41E+04	**
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.28E+02	2.09E+02	1.93E+02	1.44E+02	4.67E+00	4.00E+00	2.95E+00	7.37E+01	6.32E+01	4.66E+01
SO ₂ Reduction (g/yr)	-	<8.09E+01>	<6.49E+01>	<1.66E+01>	1.23E+02	1.24E+02	1.25E+02	5.40E+01	6.46E+01	8.12E+01
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	**	**	**	2.47E+00	9.93E-01	**
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	**	**	**	2.24E+06	9.01E+05	**

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.05a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Massachusetts, Supporting Information
2.34 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Massachusetts

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	57,673	47,100	43,477	40,371	47,100	40,371	29,747	47,100	40,371	29,747
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	449.99	367.49	339.22	632.74	741.91	635.92	468.57	1,133.05	971.19	715.61
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	825.10	716.74	771.99	1,080.68	959.47	853.49	686.14	1,348.73	1,186.87	931.29
Cost Difference (\$/yr)	-	<108.36>	<53.11>	255.58	134.37	28.38	<138.96>	523.63	361.77	106.19

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.05b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Massachusetts

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.03E+04	1.83E+04	1.88E+04	3.22E+03	1.76E+02	1.51E+02	1.11E+02	3.96E+02	3.39E+02	2.50E+02
PM Reduction (g/yr)	-	3.21E+04	3.15E+04	4.71E+04	5.02E+04	5.02E+04	5.02E+04	4.99E+04	5.00E+04	5.01E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.42E-03	2.68E-03	5.66E-04	**	1.05E-02	7.24E-03	2.12E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	4.92E+03	2.43E+03	5.13E+02	**	9.51E+03	6.56E+03	1.92E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.45E+04	2.46E+04	1.93E+04	4.21E+01	1.08E+02	9.29E+01	3.48E+01	1.18E+03	1.01E+03	7.44E+02
VOC Reduction (g/yr)	-	2.99E+04	3.52E+04	5.45E+04	5.44E+04	5.44E+04	5.45E+04	5.33E+04	5.35E+04	5.38E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.69E-03	2.47E-03	5.22E-04	**	9.82E-03	6.76E-03	1.98E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.26E+03	2.24E+03	4.73E+02	**	8.91E+03	6.13E+03	1.79E+03

Table 3.2.05b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Massachusetts

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.34E+05	1.71E+05	1.20E+05	1.68E+04	9.14E+02	7.83E+02	8.95E+02	2.75E+02	2.36E+02	1.74E+02
CO Reduction (g/yr)	-	6.23E+04	1.13E+05	2.17E+05	2.33E+05	2.33E+05	2.33E+05	2.33E+05	2.33E+05	2.33E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.18E-03	5.78E-04	1.22E-04	**	2.24E-03	1.55E-03	4.55E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.07E+03	5.24E+02	1.11E+02	**	2.04E+03	1.41E+03	4.13E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.81E+03	2.77E+03	1.57E+04	4.00E+03	2.49E+03	2.13E+03	1.24E+03	2.57E+03	2.20E+03	1.62E+03
NO _x Reduction (g/yr)	-	1.04E+03	<1.19E+04>	<1.84E+02>	1.33E+03	1.68E+03	2.57E+03	1.25E+03	1.61E+03	2.19E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	1.01E-01	1.69E-02	**	4.20E-01	2.24E-01	4.85E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	9.19E+04	1.53E+04	**	3.81E+05	2.04E+05	4.40E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.98E+02	4.87E+02	4.49E+02	3.37E+02	1.09E+01	9.33E+00	6.87E+00	1.72E+02	1.47E+02	1.09E+02
SO ₂ Reduction (g/yr)	-	<1.89E+02>	<1.51E+02>	<3.87E+01>	2.87E+02	2.89E+02	2.91E+02	1.26E+02	1.51E+02	1.89E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	4.68E-01	9.84E-02	**	4.16E+00	2.40E+00	5.61E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	4.25E+05	8.92E+04	**	3.77E+06	2.18E+06	5.09E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.06a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in New Hampshire, Supporting Information
2.56 cords/yr Burned per Uncertified Cordwood Fireplace Insert in New Hampshire

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	60,143	49,117	45,339	42,100	49,117	42,100	31,021	49,117	42,100	31,021
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	469.26	383.23	353.75	659.84	773.68	663.16	488.64	1,181.58	1,012.78	746.26
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	844.38	732.48	786.52	1,107.78	991.25	880.72	706.21	1,397.26	1,228.47	961.94
Cost Difference (\$/yr)	-	<111.89>	<57.86>	263.40	146.87	36.35	<138.17>	552.89	384.09	117.57

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.06b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in New Hampshire

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.25E+04	1.91E+04	1.96E+04	3.36E+03	1.84E+02	1.57E+02	1.16E+02	4.13E+02	3.54E+02	2.61E+02
PM Reduction (g/yr)	-	3.34E+04	3.29E+04	4.91E+04	5.23E+04	5.23E+04	5.24E+04	5.21E+04	5.21E+04	5.22E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.36E-03	2.81E-03	6.95E-04	**	1.06E-02	7.37E-03	2.25E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	4.86E+03	2.55E+03	6.30E+02	**	9.63E+03	6.68E+03	2.04E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.68E+04	2.56E+04	2.01E+04	4.39E+01	1.13E+02	9.68E+01	3.63E+01	1.23E+03	1.05E+03	7.76E+02
VOC Reduction (g/yr)	-	3.12E+04	3.67E+04	5.68E+04	5.67E+04	5.67E+04	5.68E+04	5.56E+04	5.58E+04	5.61E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.64E-03	2.59E-03	6.41E-04	**	9.94E-03	6.88E-03	2.10E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.21E+03	2.35E+03	5.81E+02	**	9.02E+03	6.25E+03	1.90E+03

Table 3.2.06b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in New Hampshire

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.44E+05	1.79E+05	1.25E+05	1.75E+04	9.53E+02	8.17E+02	9.34E+02	2.87E+02	2.46E+02	1.81E+02
CO Reduction (g/yr)	-	6.49E+04	1.18E+05	2.26E+05	2.43E+05	2.43E+05	2.43E+05	2.43E+05	2.43E+05	2.43E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.17E-03	6.05E-04	1.50E-04	**	2.27E-03	1.58E-03	4.83E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.06E+03	5.49E+02	1.36E+02	**	2.06E+03	1.43E+03	4.38E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.98E+03	2.89E+03	1.64E+04	4.17E+03	2.59E+03	2.22E+03	1.29E+03	2.68E+03	2.29E+03	1.69E+03
NO _x Reduction (g/yr)	-	1.08E+03	<1.24E+04>	<1.92E+02>	1.38E+03	1.75E+03	2.68E+03	1.30E+03	1.68E+03	2.29E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	1.06E-01	2.07E-02	**	4.26E-01	2.28E-01	5.14E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	9.64E+04	1.88E+04	**	3.86E+05	2.07E+05	4.67E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	3.11E+02	5.07E+02	4.68E+02	3.51E+02	1.13E+01	9.73E+00	7.17E+00	1.79E+02	1.54E+02	1.13E+02
SO ₂ Reduction (g/yr)	-	<1.97E+02>	<1.58E+02>	<4.04E+01>	2.99E+02	3.01E+02	3.03E+02	1.31E+02	1.57E+02	1.97E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	4.91E-01	1.21E-01	**	4.21E+00	2.45E+00	5.96E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	4.45E+05	1.10E+05	**	3.82E+06	2.22E+06	5.40E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.07a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in New Jersey, Supporting Information
1.40 cords/yr Burned per Uncertified Cordwood Fireplace Insert in New Jersey

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	32,646	26,661	24,610	22,852	26,661	22,852	16,838	26,661	22,852	16,838
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	254.71	208.02	192.01	358.16	419.95	359.96	265.23	641.36	549.74	405.07
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	629.83	557.27	624.79	806.10	637.52	577.53	482.80	857.04	765.42	620.75
Cost Difference (\$/yr)	-	<72.56>	<5.04>	176.27	7.69	<52.30>	<147.03>	227.21	135.59	<9.08>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.07b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in New Jersey

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	2.85E+04	1.03E+04	1.06E+04	1.82E+03	9.97E+01	8.55E+01	6.30E+01	2.24E+02	1.92E+02	1.41E+02
PM Reduction (g/yr)	-	1.82E+04	1.79E+04	2.67E+04	2.84E+04	2.84E+04	2.84E+04	2.83E+04	2.83E+04	2.84E+04
Annual PM Cost Benefit (\$/g)	-	**	**	6.61E-03	2.71E-04	**	**	8.04E-03	4.79E-03	**
Annual PM Cost Benefit (\$/ton)	-	**	**	6.00E+03	2.46E+02	**	**	7.29E+03	4.35E+03	**
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	3.09E+04	1.39E+04	1.09E+04	2.38E+01	6.13E+01	5.26E+01	1.97E+01	6.67E+02	5.71E+02	4.21E+02
VOC Reduction (g/yr)	-	1.69E+04	1.99E+04	3.08E+04	3.08E+04	3.08E+04	3.08E+04	3.02E+04	3.03E+04	3.04E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	5.72E-03	2.50E-04	**	**	7.53E-03	4.48E-03	**
Annual VOC Cost Benefit (\$/ton)	-	**	**	5.19E+03	2.27E+02	**	**	6.83E+03	4.06E+03	**

Table 3.2.07b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in New Jersey

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.32E+05	9.69E+04	6.80E+04	9.53E+03	5.17E+02	4.43E+02	5.07E+02	1.56E+02	1.33E+02	9.83E+01
CO Reduction (g/yr)	-	3.52E+04	6.42E+04	1.23E+05	1.32E+05	1.32E+05	1.32E+05	1.32E+05	1.32E+05	1.32E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.44E-03	5.84E-05	**	**	1.72E-03	1.03E-03	**
Annual CO Cost Benefit (\$/ton)	-	**	**	1.30E+03	5.30E+01	**	**	1.56E+03	9.32E+02	**
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	2.16E+03	1.57E+03	8.90E+03	2.26E+03	1.41E+03	1.21E+03	7.02E+02	1.45E+03	1.25E+03	9.18E+02
NO _x Reduction (g/yr)	-	5.88E+02	<6.74E+03>	<1.04E+02>	7.50E+02	9.52E+02	1.46E+03	7.05E+02	9.13E+02	1.24E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	1.03E-02	**	**	3.22E-01	1.49E-01	**
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	9.30E+03	**	**	2.92E+05	1.35E+05	**
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.69E+02	2.75E+02	2.54E+02	1.91E+02	6.16E+00	5.28E+00	3.89E+00	9.73E+01	8.34E+01	6.15E+01
SO ₂ Reduction (g/yr)	-	<1.07E+02>	<8.56E+01>	<2.19E+01>	1.62E+02	1.63E+02	1.65E+02	7.13E+01	8.52E+01	1.07E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	4.74E-02	**	**	3.19E+00	1.59E+00	**
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	4.30E+04	**	**	2.89E+06	1.44E+06	**

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.08a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in New York, Supporting Information
2.41 cords/yr Burned per Uncertified Cordwood Fireplace Insert in New York

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	59,932	48,944	45,179	41,952	48,944	41,952	30,912	48,944	41,952	30,912
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	467.61	381.88	352.51	657.52	770.96	660.82	486.92	1,177.43	1,009.22	743.64
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	842.73	731.14	785.28	1,105.46	988.53	878.39	704.49	1,393.11	1,224.90	959.32
Cost Difference (\$/yr)	-	<111.59>	<57.45>	262.73	145.80	35.67	<138.23>	550.38	382.18	116.59

<> - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.08b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in New York

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.23E+04	1.90E+04	1.95E+04	3.34E+03	1.83E+02	1.57E+02	1.16E+02	4.11E+02	3.52E+02	2.60E+02
PM Reduction (g/yr)	-	3.33E+04	3.28E+04	4.90E+04	5.21E+04	5.22E+04	5.22E+04	5.19E+04	5.20E+04	5.21E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.37E-03	2.80E-03	6.84E-04	**	1.06E-02	7.36E-03	2.24E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	4.87E+03	2.54E+03	6.20E+02	**	9.62E+03	6.67E+03	2.03E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.66E+04	2.55E+04	2.01E+04	4.37E+01	1.13E+02	9.65E+01	3.62E+01	1.22E+03	1.05E+03	7.73E+02
VOC Reduction (g/yr)	-	3.11E+04	3.66E+04	5.66E+04	5.65E+04	5.65E+04	5.66E+04	5.54E+04	5.56E+04	5.59E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.64E-03	2.58E-03	6.31E-04	**	9.93E-03	6.87E-03	2.09E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.21E+03	2.34E+03	5.72E+02	**	9.01E+03	6.24E+03	1.89E+03

Table 3.2.08b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in New York

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.43E+05	1.78E+05	1.25E+05	1.75E+04	9.50E+02	8.14E+02	9.30E+02	2.86E+02	2.45E+02	1.81E+02
CO Reduction (g/yr)	-	6.47E+04	1.18E+05	2.25E+05	2.42E+05	2.42E+05	2.42E+05	2.42E+05	2.42E+05	2.42E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.17E-03	6.03E-04	1.47E-04	**	2.27E-03	1.58E-03	4.81E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.06E+03	5.47E+02	1.34E+02	**	2.06E+03	1.43E+03	4.36E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.96E+03	2.88E+03	1.63E+04	4.15E+03	2.58E+03	2.22E+03	1.29E+03	2.67E+03	2.29E+03	1.68E+03
NO _x Reduction (g/yr)	-	1.08E+03	<1.24E+04>	<1.91E+02>	1.38E+03	1.75E+03	2.67E+03	1.29E+03	1.68E+03	2.28E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	1.06E-01	2.04E-02	**	4.25E-01	2.28E-01	5.12E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	9.60E+04	1.85E+04	**	3.86E+05	2.07E+05	4.64E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	3.10E+02	5.06E+02	4.67E+02	3.50E+02	1.13E+01	9.69E+00	7.14E+00	1.79E+02	1.53E+02	1.13E+02
SO ₂ Reduction (g/yr)	-	<1.96E+02>	<1.57E+02>	<4.02E+01>	2.98E+02	3.00E+02	3.02E+02	1.31E+02	1.56E+02	1.97E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	4.89E-01	1.19E-01	**	4.21E+00	2.44E+00	5.93E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	4.44E+05	1.08E+05	**	3.82E+06	2.22E+06	5.38E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.09a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Pennsylvania, Supporting Information
1.87 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Pennsylvania

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	47,114	38,477	35,517	32,980	38,477	32,980	24,301	38,477	32,980	24,301
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	367.60	300.21	277.12	516.90	606.08	519.50	382.79	925.61	793.38	584.60
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	742.72	649.46	709.89	964.84	823.65	737.06	600.36	1,141.30	1,009.07	800.28
Cost Difference (\$/yr)	-	<93.26>	<32.83>	222.12	80.93	<5.66>	<142.36>	398.58	266.35	57.56

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.09b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Pennsylvania

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.11E+04	1.49E+04	1.54E+04	2.63E+03	1.44E+02	1.23E+02	9.09E+01	3.23E+02	2.77E+02	2.04E+02
PM Reduction (g/yr)	-	2.62E+04	2.58E+04	3.85E+04	4.10E+04	4.10E+04	4.10E+04	4.08E+04	4.08E+04	4.09E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.77E-03	1.97E-03	**	**	9.77E-03	6.52E-03	1.41E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	5.23E+03	1.79E+03	**	**	8.86E+03	5.92E+03	1.28E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	4.45E+04	2.01E+04	1.58E+04	3.44E+01	8.85E+01	7.59E+01	2.84E+01	9.62E+02	8.25E+02	6.08E+02
VOC Reduction (g/yr)	-	2.45E+04	2.88E+04	4.45E+04	4.44E+04	4.45E+04	4.45E+04	4.36E+04	4.37E+04	4.39E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.99E-03	1.82E-03	**	**	9.15E-03	6.09E-03	1.31E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.53E+03	1.65E+03	**	**	8.30E+03	5.53E+03	1.19E+03

Table 3.2.09b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Pennsylvania

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.91E+05	1.40E+05	9.81E+04	1.37E+04	7.46E+02	6.40E+02	7.31E+02	2.25E+02	1.93E+02	1.42E+02
CO Reduction (g/yr)	-	5.09E+04	9.26E+04	1.77E+05	1.90E+05	1.90E+05	1.90E+05	1.91E+05	1.91E+05	1.91E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.25E-03	4.26E-04	**	**	2.09E-03	1.40E-03	3.02E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.14E+03	3.86E+02	**	**	1.90E+03	1.27E+03	2.74E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.11E+03	2.27E+03	1.28E+04	3.27E+03	2.03E+03	1.74E+03	1.01E+03	2.10E+03	1.80E+03	1.32E+03
NO _x Reduction (g/yr)	-	8.49E+02	<9.73E+03>	<1.50E+02>	1.08E+03	1.37E+03	2.10E+03	1.02E+03	1.32E+03	1.79E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	7.47E-02	**	**	3.92E-01	2.02E-01	3.22E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	6.78E+04	**	**	3.55E+05	1.83E+05	2.92E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.43E+02	3.97E+02	3.67E+02	2.75E+02	8.89E+00	7.62E+00	5.61E+00	1.40E+02	1.20E+02	8.87E+01
SO ₂ Reduction (g/yr)	-	<1.54E+02>	<1.24E+02>	<3.16E+01>	2.34E+02	2.36E+02	2.38E+02	1.03E+02	1.23E+02	1.55E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	3.45E-01	**	**	3.87E+00	2.17E+00	3.72E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	3.13E+05	**	**	3.51E+06	1.97E+06	3.38E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.10a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Rhode Island, Supporting Information
2.17 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Rhode Island

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	52,464	42,846	39,550	36,725	42,846	36,725	27,060	42,846	36,725	27,060
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	409.34	334.30	308.58	575.59	674.90	578.48	426.25	1,030.71	883.47	650.98
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	784.46	683.55	741.35	1,023.53	892.47	796.05	643.82	1,246.40	1,099.15	866.66
Cost Difference (\$/yr)	-	<100.91>	<43.11>	239.07	108.01	11.59	<140.64>	461.94	314.69	82.20

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.10b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Rhode Island

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.58E+04	1.66E+04	1.71E+04	2.93E+03	1.60E+02	1.37E+02	1.01E+02	3.60E+02	3.08E+02	2.27E+02
PM Reduction (g/yr)	-	2.92E+04	2.87E+04	4.29E+04	4.56E+04	4.57E+04	4.57E+04	4.54E+04	4.55E+04	4.56E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.58E-03	2.37E-03	2.54E-04	**	1.02E-02	6.92E-03	1.80E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	5.06E+03	2.15E+03	2.30E+02	**	9.22E+03	6.28E+03	1.64E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	4.96E+04	2.23E+04	1.76E+04	3.83E+01	9.85E+01	8.45E+01	3.17E+01	1.07E+03	9.18E+02	6.77E+02
VOC Reduction (g/yr)	-	2.72E+04	3.20E+04	4.95E+04	4.95E+04	4.95E+04	4.96E+04	4.85E+04	4.87E+04	4.89E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.83E-03	2.18E-03	2.34E-04	**	9.52E-03	6.47E-03	1.68E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.38E+03	1.98E+03	2.12E+02	**	8.64E+03	5.87E+03	1.52E+03

Table 3.2.10b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Rhode Island

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.12E+05	1.56E+05	1.09E+05	1.53E+04	8.31E+02	7.12E+02	8.15E+02	2.50E+02	2.14E+02	1.58E+02
CO Reduction (g/yr)	-	5.66E+04	1.03E+05	1.97E+05	2.12E+05	2.12E+05	2.12E+05	2.12E+05	2.12E+05	2.12E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.21E-03	5.10E-04	5.47E-05	**	2.18E-03	1.48E-03	3.87E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.10E+03	4.63E+02	4.97E+01	**	1.98E+03	1.35E+03	3.51E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.47E+03	2.52E+03	1.43E+04	3.64E+03	2.26E+03	1.94E+03	1.13E+03	2.34E+03	2.00E+03	1.47E+03
NO _x Reduction (g/yr)	-	9.46E+02	<1.08E+04>	<1.68E+02>	1.21E+03	1.53E+03	2.34E+03	1.13E+03	1.47E+03	1.99E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	8.96E-02	7.58E-03	**	4.08E-01	2.15E-01	4.12E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	8.12E+04	6.88E+03	**	3.70E+05	1.95E+05	3.74E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.71E+02	4.43E+02	4.09E+02	3.06E+02	9.90E+00	8.48E+00	6.25E+00	1.56E+02	1.34E+02	9.88E+01
SO ₂ Reduction (g/yr)	-	<1.72E+02>	<1.38E+02>	<3.52E+01>	2.61E+02	2.62E+02	2.65E+02	1.15E+02	1.37E+02	1.72E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	4.14E-01	4.42E-02	**	4.03E+00	2.30E+00	4.77E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	3.75E+05	4.01E+04	**	3.66E+06	2.09E+06	4.33E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.11a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in the District of Columbia, Supporting Information
0.86 cords/yr Burned per Uncertified Cordwood Fireplace Insert in the District of Columbia

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	20,266	16,551	15,278	14,186	16,551	14,186	10,453	16,551	14,186	10,453
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	158.13	129.14	119.20	222.34	260.71	223.46	164.66	398.15	341.28	251.47
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	533.24	478.39	551.97	670.29	478.27	441.03	382.22	613.84	556.96	467.15
Cost Difference (\$/yr)	-	<54.85>	18.73	137.05	<54.97>	<92.21>	<151.02>	80.59	23.72	<66.09>

<> - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.11b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in the District of Columbia

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	1.77E+04	6.42E+03	6.60E+03	1.13E+03	6.19E+01	5.31E+01	3.91E+01	1.39E+02	1.19E+02	8.78E+01
PM Reduction (g/yr)	-	1.13E+04	1.11E+04	1.66E+04	1.76E+04	1.76E+04	1.76E+04	1.75E+04	1.76E+04	1.76E+04
Annual PM Cost Benefit (\$/g)	-	**	1.69E-03	8.28E-03	**	**	**	4.59E-03	1.35E-03	**
Annual PM Cost Benefit (\$/ton)	-	**	1.53E+03	7.51E+03	**	**	**	4.17E+03	1.22E+03	**
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	1.92E+04	8.63E+03	6.79E+03	1.48E+01	3.81E+01	3.26E+01	1.22E+01	4.14E+02	3.55E+02	2.61E+02
VOC Reduction (g/yr)	-	1.05E+04	1.24E+04	1.91E+04	1.91E+04	1.91E+04	1.91E+04	1.87E+04	1.88E+04	1.89E+04
Annual VOC Cost Benefit (\$/g)	-	**	1.51E-03	7.16E-03	**	**	**	4.30E-03	1.26E-03	**
Annual VOC Cost Benefit (\$/ton)	-	**	1.37E+03	6.50E+03	**	**	**	3.90E+03	1.14E+03	**

Table 3.2.11b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in the District of Columbia

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	8.21E+04	6.02E+04	4.22E+04	5.91E+03	3.21E+02	2.75E+02	3.15E+02	9.67E+01	8.28E+01	6.10E+01
CO Reduction (g/yr)	-	2.19E+04	3.98E+04	7.61E+04	8.17E+04	8.18E+04	8.17E+04	8.20E+04	8.20E+04	8.20E+04
Annual CO Cost Benefit (\$/g)	-	**	4.70E-04	1.80E-03	**	**	**	9.83E-04	2.89E-04	**
Annual CO Cost Benefit (\$/ton)	-	**	4.26E+02	1.63E+03	**	**	**	8.92E+02	2.62E+02	**
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	1.34E+03	9.74E+02	5.52E+03	1.40E+03	8.74E+02	7.49E+02	4.36E+02	9.02E+02	7.73E+02	5.70E+02
NO _x Reduction (g/yr)	-	3.65E+02	<4.18E+03>	<6.47E+01>	4.66E+02	5.91E+02	9.04E+02	4.38E+02	5.67E+02	7.70E+02
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	**	**	**	1.84E-01	4.19E-02	**
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	**	**	**	1.67E+05	3.80E+04	**
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.05E+02	1.71E+02	1.58E+02	1.18E+02	3.82E+00	3.28E+00	2.41E+00	6.04E+01	5.18E+01	3.82E+01
SO ₂ Reduction (g/yr)	-	<6.63E+01>	<5.31E+01>	<1.36E+01>	1.01E+02	1.01E+02	1.02E+02	4.43E+01	5.29E+01	6.65E+01
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	**	**	**	1.82E+00	4.48E-01	**
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	**	**	**	1.65E+06	4.07E+05	**

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.12a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Vermont, Supporting Information
2.56 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Vermont

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	61,971	50,609	46,716	43,379	50,609	43,379	31,964	50,609	43,379	31,964
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	483.52	394.87	364.50	679.88	797.19	683.31	503.49	1,217.48	1,043.56	768.94
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	858.63	744.13	797.27	1,127.83	1,014.76	900.87	721.06	1,433.16	1,259.24	984.62
Cost Difference (\$/yr)	-	<114.51>	<61.36>	269.19	156.12	42.24	<137.58>	574.53	400.60	125.98

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.12b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Vermont

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.41E+04	1.96E+04	2.02E+04	3.46E+03	1.89E+02	1.62E+02	1.20E+02	4.25E+02	3.64E+02	2.68E+02
PM Reduction (g/yr)	-	3.45E+04	3.39E+04	5.06E+04	5.39E+04	5.39E+04	5.40E+04	5.37E+04	5.37E+04	5.38E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.32E-03	2.90E-03	7.83E-04	**	1.07E-02	7.46E-03	2.34E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	4.82E+03	2.63E+03	7.11E+02	**	9.71E+03	6.76E+03	2.12E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.86E+04	2.64E+04	2.07E+04	4.52E+01	1.16E+02	9.98E+01	3.74E+01	1.27E+03	1.08E+03	7.99E+02
VOC Reduction (g/yr)	-	3.22E+04	3.78E+04	5.85E+04	5.85E+04	5.85E+04	5.85E+04	5.73E+04	5.75E+04	5.78E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.60E-03	2.67E-03	7.22E-04	**	1.00E-02	6.97E-03	2.18E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.17E+03	2.42E+03	6.55E+02	**	9.10E+03	6.32E+03	1.98E+03

Table 3.2.12b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Vermont

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.51E+05	1.84E+05	1.29E+05	1.81E+04	9.82E+02	8.42E+02	9.62E+02	2.96E+02	2.53E+02	1.87E+02
CO Reduction (g/yr)	-	6.69E+04	1.22E+05	2.33E+05	2.50E+05	2.50E+05	2.50E+05	2.51E+05	2.51E+05	2.51E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.16E-03	6.25E-04	1.69E-04	**	2.29E-03	1.60E-03	5.02E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.05E+03	5.67E+02	1.53E+02	**	2.08E+03	1.45E+03	4.56E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	4.10E+03	2.98E+03	1.69E+04	4.29E+03	2.67E+03	2.29E+03	1.33E+03	2.76E+03	2.36E+03	1.74E+03
NO _x Reduction (g/yr)	-	1.12E+03	<1.28E+04>	<1.98E+02>	1.42E+03	1.81E+03	2.76E+03	1.34E+03	1.73E+03	2.35E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	1.10E-01	2.34E-02	**	4.29E-01	2.31E-01	5.35E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	9.94E+04	2.12E+04	**	3.89E+05	2.10E+05	4.85E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	3.20E+02	5.23E+02	4.83E+02	3.62E+02	1.17E+01	1.00E+01	7.38E+00	1.85E+02	1.58E+02	1.17E+02
SO ₂ Reduction (g/yr)	-	<2.03E+02>	<1.62E+02>	<4.16E+01>	3.08E+02	3.10E+02	3.13E+02	1.35E+02	1.62E+02	2.03E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	5.06E-01	1.36E-01	**	4.25E+00	2.48E+00	6.19E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	4.59E+05	1.24E+05	**	3.85E+06	2.25E+06	5.62E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.13a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in High HDD, Supporting Information
2.56 cords/yr Burned per Uncertified Cordwood Fireplace Insert in High HDD

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	61,382	50,129	46,273	42,968	50,129	42,968	31,660	50,129	42,968	31,660
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	478.93	391.12	361.04	673.43	789.62	676.82	498.71	1,205.92	1,033.65	761.64
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	854.04	740.38	793.81	1,121.37	1,007.19	894.39	716.28	1,421.61	1,249.33	977.32
Cost Difference (\$/yr)	-	<113.67>	<60.23>	267.33	153.15	40.34	<137.77>	567.56	395.29	123.27

<> - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.13b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in High HDD

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	5.36E+04	1.94E+04	2.00E+04	3.43E+03	1.87E+02	1.61E+02	1.18E+02	4.21E+02	3.61E+02	2.66E+02
PM Reduction (g/yr)	-	3.41E+04	3.36E+04	5.02E+04	5.34E+04	5.34E+04	5.35E+04	5.32E+04	5.32E+04	5.33E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.33E-03	2.87E-03	7.55E-04	**	1.07E-02	7.43E-03	2.31E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	4.84E+03	2.60E+03	6.85E+02	**	9.69E+03	6.74E+03	2.10E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	5.80E+04	2.61E+04	2.06E+04	4.48E+01	1.15E+02	9.88E+01	3.70E+01	1.25E+03	1.07E+03	7.92E+02
VOC Reduction (g/yr)	-	3.19E+04	3.75E+04	5.80E+04	5.79E+04	5.79E+04	5.80E+04	5.68E+04	5.69E+04	5.72E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.61E-03	2.65E-03	6.97E-04	**	1.00E-02	6.94E-03	2.15E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.18E+03	2.40E+03	6.32E+02	**	9.07E+03	6.30E+03	1.95E+03

Table 3.2.13b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in High HDD

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	2.49E+05	1.82E+05	1.28E+05	1.79E+04	9.73E+02	8.34E+02	9.53E+02	2.93E+02	2.51E+02	1.85E+02
CO Reduction (g/yr)	-	6.63E+04	1.21E+05	2.31E+05	2.48E+05	2.48E+05	2.48E+05	2.48E+05	2.48E+05	2.48E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.16E-03	6.19E-04	1.63E-04	**	2.29E-03	1.59E-03	4.96E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.05E+03	5.61E+02	1.48E+02	**	2.07E+03	1.44E+03	4.50E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	4.06E+03	2.95E+03	1.67E+04	4.25E+03	2.65E+03	2.27E+03	1.32E+03	2.73E+03	2.34E+03	1.73E+03
NO _x Reduction (g/yr)	-	1.11E+03	<1.27E+04>	<1.96E+02>	1.41E+03	1.79E+03	2.74E+03	1.33E+03	1.72E+03	2.33E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	1.09E-01	2.25E-02	**	4.28E-01	2.30E-01	5.29E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	9.85E+04	2.05E+04	**	3.88E+05	2.09E+05	4.79E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	3.17E+02	5.18E+02	4.78E+02	3.58E+02	1.16E+01	9.93E+00	7.31E+00	1.83E+02	1.57E+02	1.16E+02
SO ₂ Reduction (g/yr)	-	<2.01E+02>	<1.61E+02>	<4.12E+01>	3.05E+02	3.07E+02	3.10E+02	1.34E+02	1.60E+02	2.01E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	5.01E-01	1.31E-01	**	4.23E+00	2.47E+00	6.12E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	4.55E+05	1.19E+05	**	3.84E+06	2.24E+06	5.55E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.14a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Medium HDD, Supporting Information
2.03 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Medium HDD

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	48,674	39,751	36,693	34,072	39,751	34,072	25,106	39,751	34,072	25,106
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	379.78	310.15	286.29	534.01	626.15	536.70	395.46	956.26	819.65	603.95
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	754.89	659.40	719.06	981.95	843.71	754.26	613.03	1,171.94	1,035.33	819.64
Cost Difference (\$/yr)	-	<95.49>	<35.83>	227.06	88.82	<0.63>	<141.86>	417.05	280.44	64.74

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.14b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Medium HDD

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.25E+04	1.54E+04	1.59E+04	2.72E+03	1.49E+02	1.27E+02	9.39E+01	3.34E+02	2.86E+02	2.11E+02
PM Reduction (g/yr)	-	2.71E+04	2.66E+04	3.98E+04	4.23E+04	4.24E+04	4.24E+04	4.22E+04	4.22E+04	4.23E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.71E-03	2.10E-03	**	**	9.89E-03	6.65E-03	1.53E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	5.18E+03	1.90E+03	**	**	8.98E+03	6.03E+03	1.39E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	4.60E+04	2.07E+04	1.63E+04	3.55E+01	9.14E+01	7.84E+01	2.94E+01	9.94E+02	8.52E+02	6.28E+02
VOC Reduction (g/yr)	-	2.53E+04	2.97E+04	4.60E+04	4.59E+04	4.59E+04	4.60E+04	4.50E+04	4.52E+04	4.54E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.94E-03	1.93E-03	**	**	9.27E-03	6.21E-03	1.43E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.48E+03	1.76E+03	**	**	8.41E+03	5.63E+03	1.29E+03

Table 3.2.14b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Medium HDD

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.97E+05	1.45E+05	1.01E+05	1.42E+04	7.71E+02	6.61E+02	7.56E+02	2.32E+02	1.99E+02	1.47E+02
CO Reduction (g/yr)	-	5.26E+04	9.57E+04	1.83E+05	1.96E+05	1.96E+05	1.96E+05	1.97E+05	1.97E+05	1.97E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.24E-03	4.52E-04	**	**	2.12E-03	1.42E-03	3.29E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.13E+03	4.10E+02	**	**	1.92E+03	1.29E+03	2.98E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.22E+03	2.34E+03	1.33E+04	3.37E+03	2.10E+03	1.80E+03	1.05E+03	2.17E+03	1.86E+03	1.37E+03
NO _x Reduction (g/yr)	-	8.77E+02	<1.00E+04>	<1.55E+02>	1.12E+03	1.42E+03	2.17E+03	1.05E+03	1.36E+03	1.85E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	7.94E-02	**	**	3.97E-01	2.06E-01	3.50E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	7.20E+04	**	**	3.60E+05	1.87E+05	3.18E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.51E+02	4.11E+02	3.79E+02	2.84E+02	9.18E+00	7.87E+00	5.80E+00	1.45E+02	1.24E+02	9.16E+01
SO ₂ Reduction (g/yr)	-	<1.59E+02>	<1.28E+02>	<3.27E+01>	2.42E+02	2.44E+02	2.46E+02	1.06E+02	1.27E+02	1.60E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	3.67E-01	**	**	3.92E+00	2.21E+00	4.05E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	3.33E+05	**	**	3.56E+06	2.00E+06	3.68E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.2.15a
Replacement of an Existing Uncertified Cordwood Fireplace Insert in Low HDD, Supporting Information
0.95 cords/yr Burned per Uncertified Cordwood Fireplace Insert in Low HDD

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Appliance/Fuel Type	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Efficiency (%)	49	60	65	70	60	70	95	60	70	95
Annual Fuel Input (MJ/yr)	22,779	18,603	17,172	15,945	18,603	15,945	11,749	18,603	15,945	11,749
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241
Annual Fuel Cost (\$/yr)	177.73	145.14	133.98	249.91	293.02	251.16	185.07	447.51	383.58	282.64
Annualized Initial Cost (\$/yr)	-	174.14	214.66	256.67	192.45	192.45	192.45	190.57	190.57	190.57
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	552.84	494.40	566.75	697.85	510.59	468.73	402.64	663.19	599.26	498.32
Cost Difference (\$/yr)	-	<58.45>	13.91	145.01	<42.25>	<84.11>	<150.21>	110.35	46.42	<54.52>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.2.15b
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Low HDD

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
Appliance/Fuel Category	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	1.99E+04	7.22E+03	7.42E+03	1.27E+03	6.96E+01	5.96E+01	4.39E+01	1.56E+02	1.34E+02	9.87E+01
PM Reduction (g/yr)	-	1.27E+04	1.25E+04	1.86E+04	1.98E+04	1.98E+04	1.98E+04	1.97E+04	1.97E+04	1.98E+04
Annual PM Cost Benefit (\$/g)	-	**	1.12E-03	7.79E-03	**	**	**	5.59E-03	2.35E-03	**
Annual PM Cost Benefit (\$/ton)	-	**	1.01E+03	7.07E+03	**	**	**	5.08E+03	2.13E+03	**
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	2.15E+04	9.70E+03	7.63E+03	1.66E+01	4.28E+01	3.67E+01	1.37E+01	4.65E+02	3.99E+02	2.94E+02
VOC Reduction (g/yr)	-	1.18E+04	1.39E+04	2.15E+04	2.15E+04	2.15E+04	2.15E+04	2.11E+04	2.11E+04	2.12E+04
Annual VOC Cost Benefit (\$/g)	-	**	1.00E-03	6.74E-03	**	**	**	5.24E-03	2.20E-03	**
Annual VOC Cost Benefit (\$/ton)	-	**	9.08E+02	6.12E+03	**	**	**	4.75E+03	1.99E+03	**

Table 3.2.15b continued
 Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in Low HDD

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	9.22E+04	6.76E+04	4.74E+04	6.65E+03	3.61E+02	3.09E+02	3.54E+02	1.09E+02	9.31E+01	6.86E+01
CO Reduction (g/yr)	-	2.46E+04	4.48E+04	8.56E+04	9.19E+04	9.19E+04	9.19E+04	9.21E+04	9.21E+04	9.22E+04
Annual CO Cost Benefit (\$/g)	-	**	3.11E-04	1.69E-03	**	**	**	1.20E-03	5.04E-04	**
Annual CO Cost Benefit (\$/ton)	-	**	2.82E+02	1.54E+03	**	**	**	1.09E+03	4.57E+02	**
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	1.51E+03	1.10E+03	6.21E+03	1.58E+03	9.82E+02	8.42E+02	4.90E+02	1.01E+03	8.69E+02	6.40E+02
NO _x Reduction (g/yr)	-	4.11E+02	<4.70E+03>	<7.27E+01>	5.24E+02	6.64E+02	1.02E+03	4.92E+02	6.37E+02	8.66E+02
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	**	**	**	2.24E-01	7.29E-02	**
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	**	**	**	2.03E+05	6.61E+04	**
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	1.18E+02	1.92E+02	1.77E+02	1.33E+02	4.30E+00	3.68E+00	2.71E+00	6.79E+01	5.82E+01	4.29E+01
SO ₂ Reduction (g/yr)	-	<7.45E+01>	<5.97E+01>	<1.53E+01>	1.13E+02	1.14E+02	1.15E+02	4.97E+01	5.94E+01	7.48E+01
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	**	**	**	2.22E+00	7.81E-01	**
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	**	**	**	2.01E+06	7.08E+05	**

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

3.3. Addition of an Insert or Gas Log Set to an Existing Fireplace without Insert Used for Heating

The most likely additions to an existing fireplace without insert used for heating include certified catalytic and non-catalytic cordwood inserts, pellet inserts, direct vent gas inserts, b-vent gas inserts, vent free gas inserts, and vent free gas log sets (gas includes both LPG and natural gas). Calculations and assumptions for addition to an existing fireplace without insert used for heating include further explanation of those already listed in Section 3.

Calculations and Assumptions

Annual fuel input for new unit: input MJ/yr (new)
MJ/yr (old) X (efficiency (old) / efficiency (new))

Efficiency Reference:

Fireplace without Insert: 12

Insert Efficiency: Insert efficiencies are generally 5% lower than analogous stove type efficiencies due to heat lost into the firebox cavity, and the fact that inserts are generally against the outside wall of a house, which radiates heat out of the house. This is especially true for masonry chimneys, which lose heat through the un-insulated masonry material.

Annualized installation cost: \$/yr⁴²⁻⁴³

Installation and gas plumbing cost; all divided by the unit lifetime

- Certified non-cat. cordwood insert: \$3,600 / 19.3 yrs = \$186.20/yr
- Certified cat. cordwood insert: \$3,500 / 19.3 yrs = \$181.00/yr
- Pellet insert: \$3,500 / 15 yrs = \$233.30/yr
- Gas inserts – natural gas (direct vent, B-vent, vent free): \$3,233 / 17.7 yrs = \$183.00/yr
- Vent free log set – natural gas: \$1,493 / 12.7 yrs = \$117.90/yr
- Gas inserts – LPG (direct vent, B-vent, vent free): \$3,200 / 17.7 yrs = \$181.10/yr
- Vent free log set - LPG: \$1,477 / 12.7 yrs = \$116.60/yr

Ancillary costs: sum of a b and c per appliance: \$/yr

- a) Chimney cleaning – cost per cleaning X cleanings per year = \$/yr⁴⁴
 - Cordwood fireplace used for heating: \$150 X 1 cleaning/year = \$150/yr
 - Certified non-cat. and cat. cordwood fireplace inserts - See section 3.2
 - Pellet insert - See section 3.2
- b) Electricity costs:
 - Cordwood fireplace inserts (cat. and non-cat. only) - See section 3.2
 - Pellet insert – See section 3.2
 - Gas inserts – See section 3.2
- c) Annualized catalyst replacement - \$45/yr

8. Total annual emissions for each category: g/yr

Total annual emissions = emission factor (g/MJ) X annual fuel input (MJ/yr)

Emission factors in g/input MJ

Wood burning emission factors converted from g/kg^{4.07-4.19,7,9,10,13-27} to g/MJ by
dividing the g/kg emission factor by the average wood heat content⁴⁵ (MJ/kg).
Pellet insert emission factors converted from g/kg^{4.07,4.11,4.18-4.19,10,24,26-27} to g/MJ by
dividing the g/kg emission factor by the average pellet heat content⁴⁷ (MJ/kg)
Natural Gas insert emission factors converted to g/MJ³⁶⁻⁴⁰
LPG Gas insert emission factors converted to g/MJ³⁴⁻³⁵

Table 3.3.01a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Connecticut, Supporting Information
0.74 cords/yr Burned per Cordwood Fireplace in Connecticut

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	19,032	5,710	5,270	4,894	5,710	4,894	3,606	5,710	4,894	3,606	3,606	3,606
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	148.49	44.55	41.12	76.70	89.94	77.09	56.80	137.35	117.73	86.75	56.80	86.75
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	298.49	405.87	440.27	501.31	298.07	285.22	264.94	343.60	323.98	293.00	199.81	228.44
Cost Difference (\$/yr)	-	107.38	141.78	202.82	<0.42>	<13.27>	<33.56>	45.11	25.48	<5.50>	<98.68>	<70.05>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.01b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Connecticut

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	1.50E+04	2.21E+03	2.28E+03	3.90E+02	2.14E+01	1.83E+01	1.35E+01	4.80E+01	4.11E+01	3.03E+01	1.35E+01	3.03E+01
PM Reduction (g/yr)	-	1.28E+04	1.28E+04	1.46E+04	1.50E+04	1.50E+04	1.50E+04	1.50E+04	1.50E+04	1.50E+04	1.50E+04	1.50E+04
Annual PM Cost Benefit (\$/g)	-	8.37E-03	1.11E-02	1.38E-02	**	**	**	3.01E-03	1.70E-03	**	**	**
Annual PM Cost Benefit (\$/ton)	-	7.60E+03	1.01E+04	1.26E+04	**	**	**	2.73E+03	1.54E+03	**	**	**

Table 3.3.01b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Connecticut

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	9.27E+03	2.98E+03	2.34E+03	5.10E+00	1.31E+01	1.13E+01	4.22E+00	1.43E+02	1.22E+02	9.02E+01	9.77E+00	9.02E+01
VOC Reduction (g/yr)	-	6.29E+03	6.93E+03	9.26E+03	9.26E+03	9.26E+03	9.26E+03	9.13E+03	9.15E+03	9.18E+03	9.26E+03	9.18E+03
Annual VOC Cost Benefit (\$/g)	-	1.71E-02	2.05E-02	2.19E-02	**	**	**	4.94E-03	2.79E-03	**	**	**
Annual VOC Cost Benefit (\$/ton)	-	1.55E+04	1.86E+04	1.99E+04	**	**	**	4.48E+03	2.53E+03	**	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	7.33E+04	2.08E+04	1.46E+04	2.04E+03	1.11E+02	9.49E+01	1.09E+02	3.33E+01	2.86E+01	2.11E+01	7.57E+01	2.11E+01
CO Reduction (g/yr)	-	5.26E+04	5.88E+04	7.13E+04	7.32E+04	7.32E+04	7.32E+04	7.33E+04	7.33E+04	7.33E+04	7.33E+04	7.33E+04
Annual CO Cost Benefit (\$/g)	-	2.04E-03	2.41E-03	2.85E-03	**	**	**	6.15E-04	3.48E-04	**	**	**
Annual CO Cost Benefit (\$/ton)	-	1.85E+03	2.19E+03	2.58E+03	**	**	**	5.58E+02	3.15E+02	**	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	1.43E+03	3.36E+02	1.91E+03	4.85E+02	3.01E+02	2.58E+02	1.50E+02	3.11E+02	2.67E+02	1.97E+02	1.50E+02	1.97E+02
NO _x Reduction (g/yr)	-	1.09E+03	<4.80E+02>	9.41E+02	1.12E+03	1.17E+03	1.27E+03	1.11E+03	1.16E+03	1.23E+03	1.28E+03	1.23E+03
Annual NO _x Cost Benefit (\$/g)	-	9.86E-02	NA	2.16E-01	**	**	**	4.05E-02	2.20E-02	**	**	**
Annual NO _x Cost Benefit (\$/ton)	-	8.94E+04	NA	1.96E+05	**	**	**	3.67E+04	2.00E+04	**	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.97E+02	5.90E+01	5.44E+01	4.08E+01	1.32E+00	1.13E+00	8.33E-01	2.08E+01	1.79E+01	1.32E+01	8.33E-01	1.32E+01
SO ₂ Reduction (g/yr)	-	1.38E+02	1.42E+02	1.56E+02	1.95E+02	1.95E+02	1.96E+02	1.76E+02	1.79E+02	1.83E+02	1.96E+02	1.83E+02
Annual SO ₂ Cost Benefit (\$/g)	-	7.80E-01	9.97E-01	1.30E+00	**	**	**	2.57E-01	1.43E-01	**	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	7.08E+05	9.05E+05	1.18E+06	**	**	**	2.33E+05	1.29E+05	**	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.02a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Delaware, Supporting Information
0.51 cords/yr Burned per Cordwood Fireplace in Delaware

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	11,924	3,577	3,302	3,066	3,577	3,066	2,259	3,577	3,066	2,259	2,259	2,259
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	93.04	27.91	25.76	48.06	56.35	48.30	35.59	86.06	73.76	54.35	35.59	54.35
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	243.04	389.23	424.91	472.67	264.48	256.43	243.72	292.30	280.01	260.60	178.60	196.05
Cost Difference (\$/yr)	-	146.20	181.88	229.63	21.45	13.40	0.69	49.27	36.97	17.56	<64.44>	<46.99>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.02b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Delaware

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	9.42E+03	1.39E+03	1.43E+03	2.44E+02	1.34E+01	1.15E+01	8.45E+00	3.00E+01	2.58E+01	1.90E+01	8.45E+00	1.90E+01
PM Reduction (g/yr)	-	8.03E+03	7.99E+03	9.18E+03	9.41E+03	9.41E+03	9.41E+03	9.39E+03	9.40E+03	9.40E+03	9.41E+03	9.40E+03
Annual PM Cost Benefit (\$/g)	-	1.82E-02	2.27E-02	2.50E-02	2.28E-03	1.42E-03	7.29E-05	5.25E-03	3.93E-03	1.87E-03	**	**
Annual PM Cost Benefit (\$/ton)	-	1.65E+04	2.06E+04	2.27E+04	2.07E+03	1.29E+03	6.61E+01	4.76E+03	3.57E+03	1.69E+03	**	**

Table 3.3.02b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Delaware

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	5.81E+03	1.87E+03	1.47E+03	3.20E+00	8.23E+00	7.05E+00	2.64E+00	8.94E+01	7.67E+01	5.65E+01	6.12E+00	5.65E+01
VOC Reduction (g/yr)	-	3.94E+03	4.34E+03	5.80E+03	5.80E+03	5.80E+03	5.80E+03	5.72E+03	5.73E+03	5.75E+03	5.80E+03	5.75E+03
Annual VOC Cost Benefit (\$/g)	-	3.71E-02	4.19E-02	3.96E-02	3.70E-03	2.31E-03	1.18E-04	8.62E-03	6.45E-03	3.05E-03	**	**
Annual VOC Cost Benefit (\$/ton)	-	3.37E+04	3.80E+04	3.59E+04	3.35E+03	2.10E+03	1.07E+02	7.82E+03	5.85E+03	2.77E+03	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	4.59E+04	1.30E+04	9.12E+03	1.28E+03	6.94E+01	5.95E+01	6.80E+01	2.09E+01	1.79E+01	1.32E+01	4.74E+01	1.32E+01
CO Reduction (g/yr)	-	3.29E+04	3.68E+04	4.47E+04	4.59E+04	4.59E+04	4.59E+04	4.59E+04	4.59E+04	4.59E+04	4.59E+04	4.59E+04
Annual CO Cost Benefit (\$/g)	-	4.44E-03	4.94E-03	5.14E-03	4.68E-04	2.92E-04	1.50E-05	1.07E-03	8.05E-04	3.82E-04	**	**
Annual CO Cost Benefit (\$/ton)	-	4.03E+03	4.48E+03	4.66E+03	4.24E+02	2.65E+02	1.36E+01	9.73E+02	7.30E+02	3.47E+02	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	8.93E+02	2.11E+02	1.19E+03	3.04E+02	1.89E+02	1.62E+02	9.42E+01	1.95E+02	1.67E+02	1.23E+02	9.40E+01	1.23E+02
NO _x Reduction (g/yr)	-	6.82E+02	<3.01E+02>	5.89E+02	7.04E+02	7.31E+02	7.99E+02	6.98E+02	7.26E+02	7.70E+02	7.99E+02	7.70E+02
Annual NO _x Cost Benefit (\$/g)	-	2.14E-01	NA	3.90E-01	3.05E-02	1.83E-02	8.59E-04	7.06E-02	5.09E-02	2.28E-02	**	**
Annual NO _x Cost Benefit (\$/ton)	-	1.94E+05	NA	3.53E+05	2.76E+04	1.66E+04	7.79E+02	6.40E+04	4.62E+04	2.07E+04	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.23E+02	3.70E+01	3.41E+01	2.56E+01	8.26E-01	7.08E-01	5.22E-01	1.31E+01	1.12E+01	8.25E+00	5.22E-01	8.25E+00
SO ₂ Reduction (g/yr)	-	8.62E+01	8.91E+01	9.76E+01	1.22E+02	1.22E+02	1.23E+02	1.10E+02	1.12E+02	1.15E+02	1.23E+02	1.15E+02
Annual SO ₂ Cost Benefit (\$/g)	-	1.70E+00	2.04E+00	2.35E+00	1.75E-01	1.09E-01	5.59E-03	4.47E-01	3.30E-01	1.53E-01	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	1.54E+06	1.85E+06	2.13E+06	1.59E+05	9.92E+04	5.07E+03	4.06E+05	3.00E+05	1.39E+05	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.03a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Maine, Supporting Information
1.68 cords/yr Burned per Cordwood Fireplace in Maine

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	36,201	10,860	10,025	9,309	10,860	9,309	6,859	10,860	9,309	6,859	6,859	6,859
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	282.46	84.74	78.22	145.90	171.07	146.63	108.05	261.26	223.94	165.01	108.05	165.01
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	432.46	446.06	477.37	570.51	379.21	354.77	316.18	467.51	430.19	371.26	251.06	306.70
Cost Difference (\$/yr)	-	13.60	44.91	138.05	<53.25>	<77.69>	<116.28>	35.05	<2.27>	<61.20>	<181.40>	<125.75>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.03b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Maine

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	2.86E+04	4.21E+03	4.33E+03	7.42E+02	4.06E+01	3.48E+01	2.57E+01	9.12E+01	7.82E+01	5.76E+01	2.57E+01	5.76E+01
PM Reduction (g/yr)	-	2.44E+04	2.43E+04	2.79E+04	2.86E+04	2.86E+04	2.86E+04	2.85E+04	2.85E+04	2.85E+04	2.86E+04	2.85E+04
Annual PM Cost Benefit (\$/g)	-	5.58E-04	1.85E-03	4.95E-03	**	**	**	1.23E-03	**	**	**	**
Annual PM Cost Benefit (\$/ton)	-	5.06E+02	1.68E+03	4.49E+03	**	**	**	1.12E+03	**	**	**	**

Table 3.3.03b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Maine

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	1.76E+04	5.67E+03	4.45E+03	9.70E+00	2.50E+01	2.14E+01	8.03E+00	2.72E+02	2.33E+02	1.71E+02	1.86E+01	1.71E+02
VOC Reduction (g/yr)	-	1.20E+04	1.32E+04	1.76E+04	1.76E+04	1.76E+04	1.76E+04	1.74E+04	1.74E+04	1.75E+04	1.76E+04	1.75E+04
Annual VOC Cost Benefit (\$/g)	-	1.14E-03	3.41E-03	7.83E-03	**	**	**	2.02E-03	**	**	**	**
Annual VOC Cost Benefit (\$/ton)	-	1.03E+03	3.09E+03	7.11E+03	**	**	**	1.83E+03	**	**	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	1.39E+05	3.95E+04	2.77E+04	3.88E+03	2.11E+02	1.81E+02	2.06E+02	6.34E+01	5.44E+01	4.01E+01	1.44E+02	4.01E+01
CO Reduction (g/yr)	-	1.00E+05	1.12E+05	1.36E+05	1.39E+05	1.39E+05	1.39E+05	1.39E+05	1.39E+05	1.39E+05	1.39E+05	1.39E+05
Annual CO Cost Benefit (\$/g)	-	1.36E-04	4.02E-04	1.02E-03	**	**	**	2.51E-04	**	**	**	**
Annual CO Cost Benefit (\$/ton)	-	1.23E+02	3.65E+02	9.24E+02	**	**	**	2.28E+02	**	**	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	2.71E+03	6.39E+02	3.62E+03	9.22E+02	5.73E+02	4.92E+02	2.86E+02	5.92E+02	5.07E+02	3.74E+02	2.85E+02	3.74E+02
NO _x Reduction (g/yr)	-	2.07E+03	<9.13E+02>	1.79E+03	2.14E+03	2.22E+03	2.42E+03	2.12E+03	2.20E+03	2.34E+03	2.43E+03	2.34E+03
Annual NO _x Cost Benefit (\$/g)	-	6.57E-03	NA	7.71E-02	**	**	**	1.65E-02	**	**	**	**
Annual NO _x Cost Benefit (\$/ton)	-	5.96E+03	NA	7.00E+04	**	**	**	1.50E+04	**	**	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	3.74E+02	1.12E+02	1.04E+02	7.76E+01	2.51E+00	2.15E+00	1.58E+00	3.96E+01	3.40E+01	2.50E+01	1.58E+00	2.50E+01
SO ₂ Reduction (g/yr)	-	2.62E+02	2.70E+02	2.96E+02	3.71E+02	3.72E+02	3.72E+02	3.34E+02	3.40E+02	3.49E+02	3.72E+02	3.49E+02
Annual SO ₂ Cost Benefit (\$/g)	-	5.20E-02	1.66E-01	4.66E-01	**	**	**	1.05E-01	**	**	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	4.71E+04	1.51E+05	4.23E+05	**	**	**	9.51E+04	**	**	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.04a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Maryland, Supporting Information
0.53 cords/yr Burned per Cordwood Fireplace in Maryland

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	12,435	3,731	3,444	3,198	3,731	3,198	2,356	3,731	3,198	2,356	2,356	2,356
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	97.02	29.11	26.87	50.12	58.76	50.37	37.11	89.74	76.92	56.68	37.11	56.68
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	247.02	390.43	426.02	474.73	266.90	258.50	245.25	295.99	283.17	262.93	180.12	198.37
Cost Difference (\$/yr)	-	143.41	179.00	227.70	19.87	11.48	<1.78>	48.97	36.15	15.90	<66.90>	<48.65>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.04b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Maryland

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	9.83E+03	1.45E+03	1.49E+03	2.55E+02	1.40E+01	1.20E+01	8.81E+00	3.13E+01	2.69E+01	1.98E+01	8.81E+00	1.98E+01
PM Reduction (g/yr)	-	8.38E+03	8.34E+03	9.57E+03	9.81E+03	9.81E+03	9.82E+03	9.79E+03	9.80E+03	9.81E+03	9.82E+03	9.81E+03
Annual PM Cost Benefit (\$/g)	-	1.71E-02	2.15E-02	2.38E-02	2.03E-03	1.17E-03	**	5.00E-03	3.69E-03	1.62E-03	**	**
Annual PM Cost Benefit (\$/ton)	-	1.55E+04	1.95E+04	2.16E+04	1.84E+03	1.06E+03	**	4.54E+03	3.35E+03	1.47E+03	**	**

Table 3.3.04b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Maryland

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	6.06E+03	1.95E+03	1.53E+03	3.33E+00	8.58E+00	7.35E+00	2.76E+00	9.33E+01	7.99E+01	5.89E+01	6.39E+00	5.89E+01
VOC Reduction (g/yr)	-	4.11E+03	4.53E+03	6.05E+03	6.05E+03	6.05E+03	6.05E+03	5.96E+03	5.98E+03	6.00E+03	6.05E+03	6.00E+03
Annual VOC Cost Benefit (\$/g)	-	3.49E-02	3.95E-02	3.76E-02	3.29E-03	1.90E-03	**	8.21E-03	6.05E-03	2.65E-03	**	**
Annual VOC Cost Benefit (\$/ton)	-	3.17E+04	3.59E+04	3.41E+04	2.98E+03	1.72E+03	**	7.45E+03	5.49E+03	2.41E+03	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	4.79E+04	1.36E+04	9.51E+03	1.33E+03	7.24E+01	6.20E+01	7.09E+01	2.18E+01	1.87E+01	1.38E+01	4.95E+01	1.38E+01
CO Reduction (g/yr)	-	3.43E+04	3.84E+04	4.66E+04	4.78E+04	4.78E+04	4.78E+04	4.79E+04	4.79E+04	4.79E+04	4.79E+04	4.79E+04
Annual CO Cost Benefit (\$/g)	-	4.18E-03	4.66E-03	4.89E-03	4.15E-04	2.40E-04	**	1.02E-03	7.55E-04	3.32E-04	**	**
Annual CO Cost Benefit (\$/ton)	-	3.79E+03	4.23E+03	4.44E+03	3.77E+02	2.18E+02	**	9.28E+02	6.85E+02	3.01E+02	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	9.31E+02	2.20E+02	1.24E+03	3.17E+02	1.97E+02	1.69E+02	9.82E+01	2.03E+02	1.74E+02	1.28E+02	9.80E+01	1.28E+02
NO _x Reduction (g/yr)	-	7.12E+02	<3.14E+02>	6.15E+02	7.34E+02	7.62E+02	8.33E+02	7.28E+02	7.57E+02	8.03E+02	8.33E+02	8.03E+02
Annual NO _x Cost Benefit (\$/g)	-	2.02E-01	NA	3.70E-01	2.71E-02	1.51E-02	**	6.73E-02	4.78E-02	1.98E-02	**	**
Annual NO _x Cost Benefit (\$/ton)	-	1.83E+05	NA	3.36E+05	2.46E+04	1.37E+04	**	6.10E+04	4.33E+04	1.80E+04	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.28E+02	3.85E+01	3.56E+01	2.67E+01	8.62E-01	7.39E-01	5.44E-01	1.36E+01	1.17E+01	8.60E+00	5.44E-01	8.60E+00
SO ₂ Reduction (g/yr)	-	8.99E+01	9.29E+01	1.02E+02	1.28E+02	1.28E+02	1.28E+02	1.15E+02	1.17E+02	1.20E+02	1.28E+02	1.20E+02
Annual SO ₂ Cost Benefit (\$/g)	-	1.59E+00	1.93E+00	2.24E+00	1.56E-01	8.99E-02	**	4.26E-01	3.10E-01	1.33E-01	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	1.45E+06	1.75E+06	2.03E+06	1.41E+05	8.15E+04	**	3.87E+05	2.81E+05	1.20E+05	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.05a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Massachusetts, Supporting Information

1.28 cords/yr Burned per Cordwood Fireplace in Massachusetts

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	31,492	9,447	8,721	8,098	9,447	8,098	5,967	9,447	8,098	5,967	5,967	5,967
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	245.71	73.71	68.04	126.92	148.82	127.56	93.99	227.27	194.81	143.54	93.99	143.54
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	395.71	435.04	467.19	551.53	356.95	335.69	302.12	433.52	401.05	349.79	237.00	285.24
Cost Difference (\$/yr)	-	39.33	71.48	155.82	<38.76>	<60.02>	<93.59>	37.81	5.34	<45.92>	<158.71>	<110.47>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.05b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Massachusetts

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	2.49E+04	3.66E+03	3.77E+03	6.46E+02	3.53E+01	3.03E+01	2.23E+01	7.94E+01	6.80E+01	5.01E+01	2.23E+01	5.01E+01
PM Reduction (g/yr)	-	2.12E+04	2.11E+04	2.42E+04	2.48E+04	2.49E+04	2.49E+04	2.48E+04	2.48E+04	2.48E+04	2.49E+04	2.48E+04
Annual PM Cost Benefit (\$/g)	-	1.85E-03	3.39E-03	6.43E-03	**	**	**	1.52E-03	2.15E-04	**	**	**
Annual PM Cost Benefit (\$/ton)	-	1.68E+03	3.07E+03	5.83E+03	**	**	**	1.38E+03	1.95E+02	**	**	**

Table 3.3.05b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Massachusetts

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	1.53E+04	4.93E+03	3.87E+03	8.44E+00	2.17E+01	1.86E+01	6.98E+00	2.36E+02	2.02E+02	1.49E+02	1.62E+01	1.49E+02
VOC Reduction (g/yr)	-	1.04E+04	1.15E+04	1.53E+04	1.53E+04	1.53E+04	1.53E+04	1.51E+04	1.51E+04	1.52E+04	1.53E+04	1.52E+04
Annual VOC Cost Benefit (\$/g)	-	3.78E-03	6.24E-03	1.02E-02	**	**	**	2.50E-03	3.53E-04	**	**	**
Annual VOC Cost Benefit (\$/ton)	-	3.43E+03	5.66E+03	9.22E+03	**	**	**	2.27E+03	3.20E+02	**	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	1.21E+05	3.44E+04	2.41E+04	3.38E+03	1.83E+02	1.57E+02	1.80E+02	5.52E+01	4.73E+01	3.48E+01	1.25E+02	3.48E+01
CO Reduction (g/yr)	-	8.70E+04	9.72E+04	1.18E+05	1.21E+05	1.21E+05	1.21E+05	1.21E+05	1.21E+05	1.21E+05	1.21E+05	1.21E+05
Annual CO Cost Benefit (\$/g)	-	4.52E-04	7.35E-04	1.32E-03	**	**	**	3.12E-04	4.41E-05	**	**	**
Annual CO Cost Benefit (\$/ton)	-	4.10E+02	6.67E+02	1.20E+03	**	**	**	2.83E+02	4.00E+01	**	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	2.36E+03	5.56E+02	3.15E+03	8.02E+02	4.99E+02	4.28E+02	2.49E+02	5.15E+02	4.41E+02	3.25E+02	2.48E+02	3.25E+02
NO _x Reduction (g/yr)	-	1.80E+03	<7.94E+02>	1.56E+03	1.86E+03	1.93E+03	2.11E+03	1.84E+03	1.92E+03	2.03E+03	2.11E+03	2.03E+03
Annual NO _x Cost Benefit (\$/g)	-	2.18E-02	NA	1.00E-01	**	**	**	2.05E-02	2.79E-03	**	**	**
Annual NO _x Cost Benefit (\$/ton)	-	1.98E+04	NA	9.08E+04	**	**	**	1.86E+04	2.53E+03	**	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	3.25E+02	9.76E+01	9.01E+01	6.75E+01	2.18E+00	1.87E+00	1.38E+00	3.45E+01	2.96E+01	2.18E+01	1.38E+00	2.18E+01
SO ₂ Reduction (g/yr)	-	2.28E+02	2.35E+02	2.58E+02	3.23E+02	3.23E+02	3.24E+02	2.91E+02	2.96E+02	3.04E+02	3.24E+02	3.04E+02
Annual SO ₂ Cost Benefit (\$/g)	-	1.73E-01	3.04E-01	6.04E-01	**	**	**	1.30E-01	1.81E-02	**	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	1.57E+05	2.76E+05	5.48E+05	**	**	**	1.18E+05	1.64E+04	**	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.06a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in New Hampshire, Supporting Information

1.68 cords/yr Burned per Cordwood Fireplace in New Hampshire

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	39,457	11,837	10,926	10,146	11,837	10,146	7,476	11,837	10,146	7,476	7,476	7,476
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	307.86	92.36	85.25	159.02	186.45	159.82	117.76	284.76	244.08	179.85	117.76	179.85
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	457.86	453.68	484.40	583.63	394.59	367.95	325.90	491.00	450.32	386.09	260.77	321.54
Cost Difference (\$/yr)	-	<4.18>	26.55	125.77	<63.27>	<89.90>	<131.96>	33.15	<7.53>	<71.76>	<197.08>	<136.32>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.06b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in New Hampshire

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	3.12E+04	4.59E+03	4.72E+03	8.09E+02	4.43E+01	3.79E+01	2.80E+01	9.94E+01	8.52E+01	6.28E+01	2.80E+01	6.28E+01
PM Reduction (g/yr)	-	2.66E+04	2.65E+04	3.04E+04	3.11E+04	3.11E+04	3.12E+04	3.11E+04	3.11E+04	3.11E+04	3.12E+04	3.11E+04
Annual PM Cost Benefit (\$/g)	-	**	1.00E-03	4.14E-03	**	**	**	1.07E-03	**	**	**	**
Annual PM Cost Benefit (\$/ton)	-	**	9.10E+02	3.76E+03	**	**	**	9.68E+02	**	**	**	**

Table 3.3.06b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in New Hampshire

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	1.92E+04	6.17E+03	4.85E+03	1.06E+01	2.72E+01	2.33E+01	8.75E+00	2.96E+02	2.54E+02	1.87E+02	2.03E+01	1.87E+02
VOC Reduction (g/yr)	-	1.30E+04	1.44E+04	1.92E+04	1.92E+04	1.92E+04	1.92E+04	1.89E+04	1.90E+04	1.90E+04	1.92E+04	1.90E+04
Annual VOC Cost Benefit (\$/g)	-	**	1.85E-03	6.55E-03	**	**	**	1.75E-03	**	**	**	**
Annual VOC Cost Benefit (\$/ton)	-	**	1.68E+03	5.94E+03	**	**	**	1.59E+03	**	**	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	1.52E+05	4.30E+04	3.02E+04	4.23E+03	2.30E+02	1.97E+02	2.25E+02	6.91E+01	5.93E+01	4.37E+01	1.57E+02	4.37E+01
CO Reduction (g/yr)	-	1.09E+05	1.22E+05	1.48E+05	1.52E+05	1.52E+05	1.52E+05	1.52E+05	1.52E+05	1.52E+05	1.52E+05	1.52E+05
Annual CO Cost Benefit (\$/g)	-	**	2.18E-04	8.51E-04	**	**	**	2.18E-04	**	**	**	**
Annual CO Cost Benefit (\$/ton)	-	**	1.98E+02	7.72E+02	**	**	**	1.98E+02	**	**	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	2.95E+03	6.97E+02	3.95E+03	1.00E+03	6.25E+02	5.36E+02	3.12E+02	6.45E+02	5.53E+02	4.07E+02	3.11E+02	4.07E+02
NO _x Reduction (g/yr)	-	2.26E+03	<9.95E+02>	1.95E+03	2.33E+03	2.42E+03	2.64E+03	2.31E+03	2.40E+03	2.55E+03	2.64E+03	2.55E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	6.45E-02	**	**	**	1.44E-02	**	**	**	**
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	5.85E+04	**	**	**	1.30E+04	**	**	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	4.08E+02	1.22E+02	1.13E+02	8.46E+01	2.73E+00	2.34E+00	1.73E+00	4.32E+01	3.70E+01	2.73E+01	1.73E+00	2.73E+01
SO ₂ Reduction (g/yr)	-	2.85E+02	2.95E+02	3.23E+02	4.05E+02	4.05E+02	4.06E+02	3.64E+02	3.71E+02	3.80E+02	4.06E+02	3.80E+02
Annual SO ₂ Cost Benefit (\$/g)	-	**	9.01E-02	3.89E-01	**	**	**	9.10E-02	**	**	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	**	8.17E+04	3.53E+05	**	**	**	8.25E+04	**	**	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.07a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in New Jersey, Supporting Information
0.51 cords/yr Burned per Cordwood Fireplace in New Jersey

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	11,780	3,534	3,262	3,029	3,534	3,029	2,232	3,534	3,029	2,232	2,232	2,232
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	91.92	27.57	25.45	47.48	55.67	47.72	35.16	85.02	72.87	53.70	35.16	53.70
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	241.92	388.90	424.60	472.09	263.80	255.85	243.29	291.27	279.12	259.94	178.17	195.39
Cost Difference (\$/yr)	-	146.98	182.69	230.17	21.89	13.94	1.38	49.35	37.21	18.03	<63.75>	<46.52>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.07b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in New Jersey

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	9.31E+03	1.37E+03	1.41E+03	2.41E+02	1.32E+01	1.13E+01	8.35E+00	2.97E+01	2.54E+01	1.87E+01	8.35E+00	1.87E+01
PM Reduction (g/yr)	-	7.94E+03	7.90E+03	9.07E+03	9.30E+03	9.30E+03	9.30E+03	9.28E+03	9.28E+03	9.29E+03	9.30E+03	9.29E+03
Annual PM Cost Benefit (\$/g)	-	1.85E-02	2.31E-02	2.54E-02	2.35E-03	1.50E-03	1.48E-04	5.32E-03	4.01E-03	1.94E-03	**	**
Annual PM Cost Benefit (\$/ton)	-	1.68E+04	2.10E+04	2.30E+04	2.14E+03	1.36E+03	1.34E+02	4.83E+03	3.64E+03	1.76E+03	**	**

Table 3.3.07b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in New Jersey

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	5.74E+03	1.84E+03	1.45E+03	3.16E+00	8.13E+00	6.97E+00	2.61E+00	8.84E+01	7.57E+01	5.58E+01	6.05E+00	5.58E+01
VOC Reduction (g/yr)	-	3.89E+03	4.29E+03	5.73E+03	5.73E+03	5.73E+03	5.73E+03	5.65E+03	5.66E+03	5.68E+03	5.73E+03	5.68E+03
Annual VOC Cost Benefit (\$/g)	-	3.77E-02	4.26E-02	4.01E-02	3.82E-03	2.43E-03	2.40E-04	8.74E-03	6.57E-03	3.17E-03	**	**
Annual VOC Cost Benefit (\$/ton)	-	3.42E+04	3.86E+04	3.64E+04	3.47E+03	2.21E+03	2.18E+02	7.93E+03	5.96E+03	2.88E+03	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	4.54E+04	1.28E+04	9.01E+03	1.26E+03	6.86E+01	5.88E+01	6.72E+01	2.06E+01	1.77E+01	1.30E+01	4.69E+01	1.30E+01
CO Reduction (g/yr)	-	3.25E+04	3.64E+04	4.41E+04	4.53E+04	4.53E+04	4.53E+04	4.54E+04	4.54E+04	4.54E+04	4.53E+04	4.54E+04
Annual CO Cost Benefit (\$/g)	-	4.52E-03	5.02E-03	5.22E-03	4.83E-04	3.07E-04	3.04E-05	1.09E-03	8.20E-04	3.97E-04	**	**
Annual CO Cost Benefit (\$/ton)	-	4.10E+03	4.56E+03	4.73E+03	4.38E+02	2.79E+02	2.76E+01	9.87E+02	7.44E+02	3.60E+02	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	8.82E+02	2.08E+02	1.18E+03	3.00E+02	1.87E+02	1.60E+02	9.31E+01	1.93E+02	1.65E+02	1.22E+02	9.29E+01	1.22E+02
NO _x Reduction (g/yr)	-	6.74E+02	<2.97E+02>	5.82E+02	6.96E+02	7.22E+02	7.89E+02	6.90E+02	7.17E+02	7.61E+02	7.89E+02	7.61E+02
Annual NO _x Cost Benefit (\$/g)	-	2.18E-01	NA	3.95E-01	3.15E-02	1.93E-02	1.75E-03	7.16E-02	5.19E-02	2.37E-02	**	**
Annual NO _x Cost Benefit (\$/ton)	-	1.98E+05	NA	3.59E+05	2.85E+04	1.75E+04	1.59E+03	6.49E+04	4.71E+04	2.15E+04	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.22E+02	3.65E+01	3.37E+01	2.53E+01	8.16E-01	7.00E-01	5.16E-01	1.29E+01	1.11E+01	8.15E+00	5.16E-01	8.15E+00
SO ₂ Reduction (g/yr)	-	8.52E+01	8.80E+01	9.64E+01	1.21E+02	1.21E+02	1.21E+02	1.09E+02	1.11E+02	1.14E+02	1.21E+02	1.14E+02
Annual SO ₂ Cost Benefit (\$/g)	-	1.73E+00	2.08E+00	2.39E+00	1.81E-01	1.15E-01	1.14E-02	4.54E-01	3.36E-01	1.59E-01	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	1.57E+06	1.88E+06	2.17E+06	1.64E+05	1.04E+05	1.03E+04	4.12E+05	3.05E+05	1.44E+05	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.08a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in New York, Supporting Information
1.51 cords/yr Burned per Cordwood Fireplace in New York

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	37,660	11,298	10,429	9,684	11,298	9,684	7,136	11,298	9,684	7,136	7,136	7,136
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	293.84	88.15	81.37	151.78	177.97	152.54	112.40	271.79	232.96	171.66	112.40	171.66
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	443.84	449.47	480.52	576.39	386.10	360.68	320.53	478.04	439.21	377.91	255.41	313.35
Cost Difference (\$/yr)	-	5.63	36.68	132.55	<57.74>	<83.16>	<123.31>	34.20	<4.63>	<65.93>	<188.43>	<130.49>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.08b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in New York

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	2.98E+04	4.38E+03	4.51E+03	7.72E+02	4.23E+01	3.62E+01	2.67E+01	9.49E+01	8.13E+01	5.99E+01	2.67E+01	5.99E+01
PM Reduction (g/yr)	-	2.54E+04	2.53E+04	2.90E+04	2.97E+04	2.97E+04	2.97E+04	2.97E+04	2.97E+04	2.97E+04	2.97E+04	2.97E+04
Annual PM Cost Benefit (\$/g)	-	2.22E-04	1.45E-03	4.57E-03	**	**	**	1.15E-03	**	**	**	**
Annual PM Cost Benefit (\$/ton)	-	2.01E+02	1.32E+03	4.15E+03	**	**	**	1.05E+03	**	**	**	**

Table 3.3.08b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in New York

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	1.83E+04	5.89E+03	4.63E+03	1.01E+01	2.60E+01	2.23E+01	8.35E+00	2.82E+02	2.42E+02	1.78E+02	1.93E+01	1.78E+02
VOC Reduction (g/yr)	-	1.24E+04	1.37E+04	1.83E+04	1.83E+04	1.83E+04	1.83E+04	1.81E+04	1.81E+04	1.82E+04	1.83E+04	1.82E+04
Annual VOC Cost Benefit (\$/g)	-	4.53E-04	2.68E-03	7.23E-03	**	**	**	1.89E-03	**	**	**	**
Annual VOC Cost Benefit (\$/ton)	-	4.11E+02	2.43E+03	6.56E+03	**	**	**	1.72E+03	**	**	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	1.45E+05	4.11E+04	2.88E+04	4.04E+03	2.19E+02	1.88E+02	2.15E+02	6.60E+01	5.66E+01	4.17E+01	1.50E+02	4.17E+01
CO Reduction (g/yr)	-	1.04E+05	1.16E+05	1.41E+05	1.45E+05	1.45E+05	1.45E+05	1.45E+05	1.45E+05	1.45E+05	1.45E+05	1.45E+05
Annual CO Cost Benefit (\$/g)	-	5.42E-05	3.15E-04	9.40E-04	**	**	**	2.36E-04	**	**	**	**
Annual CO Cost Benefit (\$/ton)	-	4.91E+01	2.86E+02	8.52E+02	**	**	**	2.14E+02	**	**	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	2.82E+03	6.65E+02	3.77E+03	9.59E+02	5.97E+02	5.11E+02	2.98E+02	6.16E+02	5.28E+02	3.89E+02	2.97E+02	3.89E+02
NO _x Reduction (g/yr)	-	2.16E+03	<9.50E+02>	1.86E+03	2.22E+03	2.31E+03	2.52E+03	2.20E+03	2.29E+03	2.43E+03	2.52E+03	2.43E+03
Annual NO _x Cost Benefit (\$/g)	-	2.61E-03	NA	7.12E-02	**	**	**	1.55E-02	**	**	**	**
Annual NO _x Cost Benefit (\$/ton)	-	2.37E+03	NA	6.46E+04	**	**	**	1.41E+04	**	**	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	3.89E+02	1.17E+02	1.08E+02	8.07E+01	2.61E+00	2.24E+00	1.65E+00	4.12E+01	3.53E+01	2.60E+01	1.65E+00	2.60E+01
SO ₂ Reduction (g/yr)	-	2.72E+02	2.81E+02	3.08E+02	3.86E+02	3.87E+02	3.87E+02	3.48E+02	3.54E+02	3.63E+02	3.87E+02	3.63E+02
Annual SO ₂ Cost Benefit (\$/g)	-	2.07E-02	1.30E-01	4.30E-01	**	**	**	9.83E-02	**	**	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	1.88E+04	1.18E+05	3.90E+05	**	**	**	8.92E+04	**	**	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.09a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Pennsylvania, Supporting Information

0.75 cords/yr Burned per Cordwood Fireplace in Pennsylvania

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	18,963	5,689	5,251	4,876	5,689	4,876	3,593	5,689	4,876	3,593	3,593	3,593
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	147.96	44.39	40.97	76.42	89.61	76.81	56.60	136.86	117.30	86.43	56.60	86.43
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	297.96	405.71	440.12	501.04	297.75	284.94	264.73	343.10	323.55	292.68	199.61	228.13
Cost Difference (\$/yr)	-	107.75	142.17	203.08	<0.21>	<13.01>	<33.23>	45.15	25.60	<5.27>	<98.35>	<69.83>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.09b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Pennsylvania

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	1.50E+04	2.21E+03	2.27E+03	3.89E+02	2.13E+01	1.82E+01	1.34E+01	4.78E+01	4.10E+01	3.02E+01	1.34E+01	3.02E+01
PM Reduction (g/yr)	-	1.28E+04	1.27E+04	1.46E+04	1.50E+04	1.50E+04	1.50E+04	1.49E+04	1.49E+04	1.50E+04	1.50E+04	1.50E+04
Annual PM Cost Benefit (\$/g)	-	8.43E-03	1.12E-02	1.39E-02	**	**	**	3.02E-03	1.71E-03	**	**	**
Annual PM Cost Benefit (\$/ton)	-	7.65E+03	1.01E+04	1.26E+04	**	**	**	2.74E+03	1.55E+03	**	**	**

Table 3.3.09b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Pennsylvania

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	9.24E+03	2.97E+03	2.33E+03	5.08E+00	1.31E+01	1.12E+01	4.20E+00	1.42E+02	1.22E+02	8.98E+01	9.74E+00	8.98E+01
VOC Reduction (g/yr)	-	6.27E+03	6.90E+03	9.23E+03	9.22E+03	9.22E+03	9.23E+03	9.09E+03	9.11E+03	9.15E+03	9.23E+03	9.15E+03
Annual VOC Cost Benefit (\$/g)	-	1.72E-02	2.06E-02	2.20E-02	**	**	**	4.96E-03	2.81E-03	**	**	**
Annual VOC Cost Benefit (\$/ton)	-	1.56E+04	1.87E+04	2.00E+04	**	**	**	4.50E+03	2.55E+03	**	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	7.31E+04	2.07E+04	1.45E+04	2.03E+03	1.10E+02	9.46E+01	1.08E+02	3.32E+01	2.85E+01	2.10E+01	7.55E+01	2.10E+01
CO Reduction (g/yr)	-	5.24E+04	5.86E+04	7.10E+04	7.30E+04	7.30E+04	7.30E+04	7.30E+04	7.30E+04	7.30E+04	7.30E+04	7.30E+04
Annual CO Cost Benefit (\$/g)	-	2.06E-03	2.43E-03	2.86E-03	**	**	**	6.18E-04	3.50E-04	**	**	**
Annual CO Cost Benefit (\$/ton)	-	1.87E+03	2.20E+03	2.59E+03	**	**	**	5.61E+02	3.18E+02	**	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	1.42E+03	3.35E+02	1.90E+03	4.83E+02	3.00E+02	2.57E+02	1.50E+02	3.10E+02	2.66E+02	1.96E+02	1.49E+02	1.96E+02
NO _x Reduction (g/yr)	-	1.09E+03	<4.78E+02>	9.37E+02	1.12E+03	1.16E+03	1.27E+03	1.11E+03	1.15E+03	1.22E+03	1.27E+03	1.22E+03
Annual NO _x Cost Benefit (\$/g)	-	9.93E-02	NA	2.17E-01	**	**	**	4.07E-02	2.22E-02	**	**	**
Annual NO _x Cost Benefit (\$/ton)	-	9.01E+04	NA	1.97E+05	**	**	**	3.69E+04	2.01E+04	**	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.96E+02	5.88E+01	5.42E+01	4.07E+01	1.31E+00	1.13E+00	8.30E-01	2.08E+01	1.78E+01	1.31E+01	8.30E-01	1.31E+01
SO ₂ Reduction (g/yr)	-	1.37E+02	1.42E+02	1.55E+02	1.95E+02	1.95E+02	1.95E+02	1.75E+02	1.78E+02	1.83E+02	1.95E+02	1.83E+02
Annual SO ₂ Cost Benefit (\$/g)	-	7.86E-01	1.00E+00	1.31E+00	**	**	**	2.58E-01	1.44E-01	**	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	7.13E+05	9.11E+05	1.19E+06	**	**	**	2.34E+05	1.30E+05	**	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.10a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Rhode Island, Supporting Information

0.54 cords/yr Burned per Cordwood Fireplace in Rhode Island

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	12,939	3,882	3,583	3,327	3,882	3,327	2,452	3,882	3,327	2,452	2,452	2,452
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	100.96	30.29	27.96	52.15	61.15	52.41	38.62	93.38	80.04	58.98	38.62	58.98
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	250.96	391.61	427.11	476.76	269.28	260.55	246.75	299.63	286.29	265.23	181.63	200.67
Cost Difference (\$/yr)	-	140.65	176.15	225.80	18.32	9.59	<4.21>	48.67	35.33	14.27	<69.33>	<50.28>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.10b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Rhode Island

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	1.02E+04	1.51E+03	1.55E+03	2.65E+02	1.45E+01	1.24E+01	9.17E+00	3.26E+01	2.79E+01	2.06E+01	9.17E+00	2.06E+01
PM Reduction (g/yr)	-	8.72E+03	8.68E+03	9.96E+03	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04	1.02E+04
Annual PM Cost Benefit (\$/g)	-	1.61E-02	2.03E-02	2.27E-02	1.79E-03	9.39E-04	**	4.78E-03	3.47E-03	1.40E-03	**	**
Annual PM Cost Benefit (\$/ton)	-	1.46E+04	1.84E+04	2.06E+04	1.63E+03	8.52E+02	**	4.33E+03	3.14E+03	1.27E+03	**	**

Table 3.3.10b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Rhode Island

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	6.30E+03	2.02E+03	1.59E+03	3.47E+00	8.93E+00	7.65E+00	2.87E+00	9.70E+01	8.32E+01	6.13E+01	6.64E+00	6.13E+01
VOC Reduction (g/yr)	-	4.28E+03	4.71E+03	6.30E+03	6.29E+03	6.29E+03	6.30E+03	6.20E+03	6.22E+03	6.24E+03	6.30E+03	6.24E+03
Annual VOC Cost Benefit (\$/g)	-	3.29E-02	3.74E-02	3.59E-02	2.91E-03	1.52E-03	**	7.84E-03	5.68E-03	2.29E-03	**	**
Annual VOC Cost Benefit (\$/ton)	-	2.98E+04	3.39E+04	3.25E+04	2.64E+03	1.38E+03	**	7.12E+03	5.15E+03	2.07E+03	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	4.99E+04	1.41E+04	9.90E+03	1.39E+03	7.53E+01	6.45E+01	7.38E+01	2.27E+01	1.94E+01	1.43E+01	5.15E+01	1.43E+01
CO Reduction (g/yr)	-	3.57E+04	4.00E+04	4.85E+04	4.98E+04	4.98E+04	4.98E+04	4.98E+04	4.98E+04	4.98E+04	4.98E+04	4.98E+04
Annual CO Cost Benefit (\$/g)	-	3.94E-03	4.41E-03	4.66E-03	3.68E-04	1.93E-04	**	9.77E-04	7.09E-04	2.86E-04	**	**
Annual CO Cost Benefit (\$/ton)	-	3.57E+03	4.00E+03	4.23E+03	3.34E+02	1.75E+02	**	8.86E+02	6.43E+02	2.60E+02	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	9.69E+02	2.29E+02	1.30E+03	3.29E+02	2.05E+02	1.76E+02	1.02E+02	2.12E+02	1.81E+02	1.34E+02	1.02E+02	1.34E+02
NO _x Reduction (g/yr)	-	7.40E+02	<3.26E+02>	6.40E+02	7.64E+02	7.93E+02	8.67E+02	7.57E+02	7.88E+02	8.35E+02	8.67E+02	8.35E+02
Annual NO _x Cost Benefit (\$/g)	-	1.90E-01	NA	3.53E-01	2.40E-02	1.21E-02	**	6.43E-02	4.49E-02	1.71E-02	**	**
Annual NO _x Cost Benefit (\$/ton)	-	1.72E+05	NA	3.20E+05	2.18E+04	1.10E+04	**	5.83E+04	4.07E+04	1.55E+04	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.34E+02	4.01E+01	3.70E+01	2.77E+01	8.97E-01	7.69E-01	5.66E-01	1.42E+01	1.21E+01	8.95E+00	5.66E-01	8.95E+00
SO ₂ Reduction (g/yr)	-	9.36E+01	9.66E+01	1.06E+02	1.33E+02	1.33E+02	1.33E+02	1.19E+02	1.22E+02	1.25E+02	1.33E+02	1.25E+02
Annual SO ₂ Cost Benefit (\$/g)	-	1.50E+00	1.82E+00	2.13E+00	1.38E-01	7.21E-02	**	4.07E-01	2.91E-01	1.14E-01	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	1.36E+06	1.65E+06	1.93E+06	1.25E+05	6.55E+04	**	3.70E+05	2.64E+05	1.04E+05	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.11a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in the District of Columbia, Supporting Information

0.46 cords/yr Burned per Cordwood Fireplace in the District of Columbia

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	10,884	3,265	3,014	2,799	3,265	2,799	2,062	3,265	2,799	2,062	2,062	2,062
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	84.92	25.48	23.52	43.86	51.43	44.09	32.48	78.55	67.33	49.61	32.48	49.61
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	234.92	386.80	422.67	468.48	259.57	252.22	240.62	284.80	273.58	255.86	175.49	191.30
Cost Difference (\$/yr)	-	151.88	187.75	233.55	24.65	17.30	5.70	49.88	38.65	20.94	<59.43>	<43.62>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.11b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in the District of Columbia

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	8.60E+03	1.27E+03	1.30E+03	2.23E+02	1.22E+01	1.05E+01	7.71E+00	2.74E+01	2.35E+01	1.73E+01	7.71E+00	1.73E+01
PM Reduction (g/yr)	-	7.33E+03	7.30E+03	8.38E+03	8.59E+03	8.59E+03	8.59E+03	8.57E+03	8.58E+03	8.58E+03	8.59E+03	8.58E+03
Annual PM Cost Benefit (\$/g)	-	2.07E-02	2.57E-02	2.79E-02	2.87E-03	2.01E-03	6.63E-04	5.82E-03	4.51E-03	2.44E-03	**	**
Annual PM Cost Benefit (\$/ton)	-	1.88E+04	2.33E+04	2.53E+04	2.60E+03	1.83E+03	6.01E+02	5.28E+03	4.09E+03	2.21E+03	**	**

Table 3.3.11b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in the District of Columbia

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	5.30E+03	1.70E+03	1.34E+03	2.92E+00	7.51E+00	6.44E+00	2.41E+00	8.16E+01	7.00E+01	5.16E+01	5.59E+00	5.16E+01
VOC Reduction (g/yr)	-	3.60E+03	3.96E+03	5.30E+03	5.29E+03	5.29E+03	5.30E+03	5.22E+03	5.23E+03	5.25E+03	5.30E+03	5.25E+03
Annual VOC Cost Benefit (\$/g)	-	4.22E-02	4.74E-02	4.41E-02	4.66E-03	3.27E-03	1.08E-03	9.56E-03	7.39E-03	3.99E-03	**	**
Annual VOC Cost Benefit (\$/ton)	-	3.83E+04	4.30E+04	4.00E+04	4.22E+03	2.96E+03	9.75E+02	8.67E+03	6.70E+03	3.62E+03	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	4.19E+04	1.19E+04	8.33E+03	1.17E+03	6.33E+01	5.43E+01	6.21E+01	1.91E+01	1.63E+01	1.20E+01	4.33E+01	1.20E+01
CO Reduction (g/yr)	-	3.01E+04	3.36E+04	4.08E+04	4.19E+04	4.19E+04	4.19E+04	4.19E+04	4.19E+04	4.19E+04	4.19E+04	4.19E+04
Annual CO Cost Benefit (\$/g)	-	5.05E-03	5.59E-03	5.73E-03	5.89E-04	4.13E-04	1.36E-04	1.19E-03	9.22E-04	4.99E-04	**	**
Annual CO Cost Benefit (\$/ton)	-	4.58E+03	5.07E+03	5.20E+03	5.34E+02	3.75E+02	1.23E+02	1.08E+03	8.37E+02	4.53E+02	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	8.15E+02	1.92E+02	1.09E+03	2.77E+02	1.72E+02	1.48E+02	8.60E+01	1.78E+02	1.53E+02	1.12E+02	8.58E+01	1.12E+02
NO _x Reduction (g/yr)	-	6.23E+02	<2.75E+02>	5.38E+02	6.43E+02	6.67E+02	7.29E+02	6.37E+02	6.63E+02	7.03E+02	7.29E+02	7.03E+02
Annual NO _x Cost Benefit (\$/g)	-	2.44E-01	NA	4.34E-01	3.83E-02	2.59E-02	7.81E-03	7.83E-02	5.83E-02	2.98E-02	**	**
Annual NO _x Cost Benefit (\$/ton)	-	2.21E+05	NA	3.94E+05	3.48E+04	2.35E+04	7.09E+03	7.10E+04	5.29E+04	2.70E+04	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.12E+02	3.37E+01	3.11E+01	2.33E+01	7.54E-01	6.47E-01	4.76E-01	1.19E+01	1.02E+01	7.53E+00	4.76E-01	7.53E+00
SO ₂ Reduction (g/yr)	-	7.87E+01	8.13E+01	8.91E+01	1.12E+02	1.12E+02	1.12E+02	1.01E+02	1.02E+02	1.05E+02	1.12E+02	1.05E+02
Annual SO ₂ Cost Benefit (\$/g)	-	1.93E+00	2.31E+00	2.62E+00	2.21E-01	1.55E-01	5.09E-02	4.96E-01	3.78E-01	2.00E-01	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	1.75E+06	2.10E+06	2.38E+06	2.00E+05	1.40E+05	4.62E+04	4.50E+05	3.43E+05	1.81E+05	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.12a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Vermont, Supporting Information
1.68 cords/yr Burned per Cordwood Fireplace in Vermont

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	40,656	12,197	11,258	10,454	12,197	10,454	7,703	12,197	10,454	7,703	7,703	7,703
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	317.21	95.16	87.84	163.85	192.12	164.67	121.34	293.41	251.49	185.31	121.34	185.31
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	467.21	456.49	486.99	588.46	400.25	372.81	329.47	499.66	457.74	391.56	264.35	327.01
Cost Difference (\$/yr)	-	<10.72>	19.78	121.25	<66.96>	<94.40>	<137.74>	32.45	<9.47>	<75.65>	<202.86>	<140.20>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.12b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Vermont

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	3.21E+04	4.73E+03	4.87E+03	8.33E+02	4.56E+01	3.91E+01	2.88E+01	1.02E+02	8.78E+01	6.47E+01	2.88E+01	6.47E+01
PM Reduction (g/yr)	-	2.74E+04	2.73E+04	3.13E+04	3.21E+04	3.21E+04	3.21E+04	3.20E+04	3.20E+04	3.21E+04	3.21E+04	3.21E+04
Annual PM Cost Benefit (\$/g)	-	**	7.26E-04	3.87E-03	**	**	**	1.01E-03	**	**	**	**
Annual PM Cost Benefit (\$/ton)	-	**	6.58E+02	3.52E+03	**	**	**	9.19E+02	**	**	**	**

Table 3.3.12b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Vermont

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	1.98E+04	6.36E+03	5.00E+03	1.09E+01	2.81E+01	2.40E+01	9.01E+00	3.05E+02	2.61E+02	1.93E+02	2.09E+01	1.93E+02
VOC Reduction (g/yr)	-	1.34E+04	1.48E+04	1.98E+04	1.98E+04	1.98E+04	1.98E+04	1.95E+04	1.95E+04	1.96E+04	1.98E+04	1.96E+04
Annual VOC Cost Benefit (\$/g)	-	**	1.34E-03	6.13E-03	**	**	**	1.66E-03	**	**	**	**
Annual VOC Cost Benefit (\$/ton)	-	**	1.21E+03	5.56E+03	**	**	**	1.51E+03	**	**	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	1.57E+05	4.43E+04	3.11E+04	4.36E+03	2.37E+02	2.03E+02	2.32E+02	7.12E+01	6.11E+01	4.50E+01	1.62E+02	4.50E+01
CO Reduction (g/yr)	-	1.12E+05	1.26E+05	1.52E+05	1.56E+05	1.56E+05	1.56E+05	1.57E+05	1.57E+05	1.57E+05	1.56E+05	1.57E+05
Annual CO Cost Benefit (\$/g)	-	**	1.58E-04	7.96E-04	**	**	**	2.07E-04	**	**	**	**
Annual CO Cost Benefit (\$/ton)	-	**	1.43E+02	7.22E+02	**	**	**	1.88E+02	**	**	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	3.04E+03	7.18E+02	4.07E+03	1.03E+03	6.44E+02	5.52E+02	3.21E+02	6.65E+02	5.70E+02	4.20E+02	3.20E+02	4.20E+02
NO _x Reduction (g/yr)	-	2.33E+03	<1.03E+03>	2.01E+03	2.40E+03	2.49E+03	2.72E+03	2.38E+03	2.47E+03	2.62E+03	2.72E+03	2.62E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	6.03E-02	**	**	**	1.36E-02	**	**	**	**
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	5.47E+04	**	**	**	1.24E+04	**	**	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	4.20E+02	1.26E+02	1.16E+02	8.72E+01	2.82E+00	2.41E+00	1.78E+00	4.45E+01	3.82E+01	2.81E+01	1.78E+00	2.81E+01
SO ₂ Reduction (g/yr)	-	2.94E+02	3.04E+02	3.33E+02	4.17E+02	4.18E+02	4.18E+02	3.75E+02	3.82E+02	3.92E+02	4.18E+02	3.92E+02
Annual SO ₂ Cost Benefit (\$/g)	-	**	6.52E-02	3.64E-01	**	**	**	8.64E-02	**	**	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	**	5.91E+04	3.31E+05	**	**	**	7.84E+04	**	**	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.13a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in High HDD, Supporting Information
1.68 cords/yr Burned per Cordwood Fireplace in High HDD

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	40,282	12,085	11,155	10,358	12,085	10,358	7,632	12,085	10,358	7,632	7,632	7,632
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	314.30	94.29	87.04	162.34	190.36	163.16	120.22	290.71	249.18	183.61	120.22	183.61
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	464.30	455.61	486.19	586.96	398.49	371.30	328.36	496.96	455.43	389.86	263.23	325.30
Cost Difference (\$/yr)	-	<8.68>	21.89	122.66	<65.81>	<93.00>	<135.94>	32.66	<8.87>	<74.44>	<201.06>	<138.99>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.13b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in High HDD

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	3.18E+04	4.69E+03	4.82E+03	8.26E+02	4.52E+01	3.87E+01	2.85E+01	1.02E+02	8.70E+01	6.41E+01	2.85E+01	6.41E+01
PM Reduction (g/yr)	-	2.71E+04	2.70E+04	3.10E+04	3.18E+04	3.18E+04	3.18E+04	3.17E+04	3.17E+04	3.18E+04	3.18E+04	3.18E+04
Annual PM Cost Benefit (\$/g)	-	**	8.10E-04	3.96E-03	**	**	**	1.03E-03	**	**	**	**
Annual PM Cost Benefit (\$/ton)	-	**	7.35E+02	3.59E+03	**	**	**	9.34E+02	**	**	**	**

Table 3.3.13b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in High HDD

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	1.96E+04	6.30E+03	4.95E+03	1.08E+01	2.78E+01	2.38E+01	8.93E+00	3.02E+02	2.59E+02	1.91E+02	2.07E+01	1.91E+02
VOC Reduction (g/yr)	-	1.33E+04	1.47E+04	1.96E+04	1.96E+04	1.96E+04	1.96E+04	1.93E+04	1.94E+04	1.94E+04	1.96E+04	1.94E+04
Annual VOC Cost Benefit (\$/g)	-	**	1.49E-03	6.26E-03	**	**	**	1.69E-03	**	**	**	**
Annual VOC Cost Benefit (\$/ton)	-	**	1.35E+03	5.68E+03	**	**	**	1.53E+03	**	**	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	1.55E+05	4.39E+04	3.08E+04	4.32E+03	2.34E+02	2.01E+02	2.30E+02	7.06E+01	6.05E+01	4.46E+01	1.60E+02	4.46E+01
CO Reduction (g/yr)	-	1.11E+05	1.24E+05	1.51E+05	1.55E+05	1.55E+05	1.55E+05	1.55E+05	1.55E+05	1.55E+05	1.55E+05	1.55E+05
Annual CO Cost Benefit (\$/g)	-	**	1.76E-04	8.13E-04	**	**	**	2.11E-04	**	**	**	**
Annual CO Cost Benefit (\$/ton)	-	**	1.60E+02	7.38E+02	**	**	**	1.91E+02	**	**	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	3.02E+03	7.12E+02	4.03E+03	1.03E+03	6.38E+02	5.47E+02	3.18E+02	6.59E+02	5.65E+02	4.16E+02	3.18E+02	4.16E+02
NO _x Reduction (g/yr)	-	2.31E+03	<1.02E+03>	1.99E+03	2.38E+03	2.47E+03	2.70E+03	2.36E+03	2.45E+03	2.60E+03	2.70E+03	2.60E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	6.16E-02	**	**	**	1.39E-02	**	**	**	**
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	5.59E+04	**	**	**	1.26E+04	**	**	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	4.16E+02	1.25E+02	1.15E+02	8.64E+01	2.79E+00	2.39E+00	1.76E+00	4.41E+01	3.78E+01	2.79E+01	1.76E+00	2.79E+01
SO ₂ Reduction (g/yr)	-	2.91E+02	3.01E+02	3.30E+02	4.13E+02	4.14E+02	4.14E+02	3.72E+02	3.78E+02	3.88E+02	4.14E+02	3.88E+02
Annual SO ₂ Cost Benefit (\$/g)	-	**	7.28E-02	3.72E-01	**	**	**	8.78E-02	**	**	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	**	6.60E+04	3.37E+05	**	**	**	7.97E+04	**	**	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.14a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Medium HDD, Supporting Information

0.50 cords/yr Burned per Cordwood Fireplace in Medium HDD

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	11,989	3,597	3,320	3,083	3,597	3,083	2,272	3,597	3,083	2,272	2,272	2,272
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	93.54	28.06	25.90	48.32	56.65	48.56	35.78	86.52	74.16	54.65	35.78	54.65
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	243.54	389.38	425.05	472.93	264.79	256.69	243.92	292.77	280.41	260.89	178.79	196.34
Cost Difference (\$/yr)	-	145.84	181.51	229.39	21.25	13.15	0.38	49.23	36.87	17.35	<64.75>	<47.20>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.14b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Medium HDD

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	9.47E+03	1.39E+03	1.44E+03	2.46E+02	1.35E+01	1.15E+01	8.50E+00	3.02E+01	2.59E+01	1.91E+01	8.50E+00	1.91E+01
PM Reduction (g/yr)	-	8.08E+03	8.04E+03	9.23E+03	9.46E+03	9.46E+03	9.46E+03	9.44E+03	9.45E+03	9.45E+03	9.46E+03	9.45E+03
Annual PM Cost Benefit (\$/g)	-	1.81E-02	2.26E-02	2.49E-02	2.25E-03	1.39E-03	3.96E-05	5.21E-03	3.90E-03	1.84E-03	**	**
Annual PM Cost Benefit (\$/ton)	-	1.64E+04	2.05E+04	2.26E+04	2.04E+03	1.26E+03	3.59E+01	4.73E+03	3.54E+03	1.67E+03	**	**

Table 3.3.14b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Medium HDD

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	5.84E+03	1.88E+03	1.47E+03	3.21E+00	8.27E+00	7.09E+00	2.66E+00	8.99E+01	7.71E+01	5.68E+01	6.16E+00	5.68E+01
VOC Reduction (g/yr)	-	3.96E+03	4.36E+03	5.84E+03	5.83E+03	5.83E+03	5.84E+03	5.75E+03	5.76E+03	5.78E+03	5.83E+03	5.78E+03
Annual VOC Cost Benefit (\$/g)	-	3.68E-02	4.16E-02	3.93E-02	3.64E-03	2.26E-03	6.43E-05	8.56E-03	6.40E-03	3.00E-03	**	**
Annual VOC Cost Benefit (\$/ton)	-	3.34E+04	3.77E+04	3.57E+04	3.31E+03	2.05E+03	5.83E+01	7.77E+03	5.81E+03	2.72E+03	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	4.62E+04	1.31E+04	9.17E+03	1.29E+03	6.98E+01	5.98E+01	6.84E+01	2.10E+01	1.80E+01	1.33E+01	4.77E+01	1.33E+01
CO Reduction (g/yr)	-	3.31E+04	3.70E+04	4.49E+04	4.61E+04	4.61E+04	4.61E+04	4.62E+04	4.62E+04	4.62E+04	4.61E+04	4.62E+04
Annual CO Cost Benefit (\$/g)	-	4.40E-03	4.90E-03	5.11E-03	4.61E-04	2.85E-04	8.13E-06	1.07E-03	7.99E-04	3.76E-04	**	**
Annual CO Cost Benefit (\$/ton)	-	4.00E+03	4.45E+03	4.63E+03	4.18E+02	2.59E+02	7.38E+00	9.67E+02	7.24E+02	3.41E+02	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	8.98E+02	2.12E+02	1.20E+03	3.05E+02	1.90E+02	1.63E+02	9.47E+01	1.96E+02	1.68E+02	1.24E+02	9.45E+01	1.24E+02
NO _x Reduction (g/yr)	-	6.86E+02	<3.02E+02>	5.93E+02	7.08E+02	7.35E+02	8.03E+02	7.02E+02	7.30E+02	7.74E+02	8.03E+02	7.74E+02
Annual NO _x Cost Benefit (\$/g)	-	2.13E-01	NA	3.87E-01	3.00E-02	1.79E-02	4.67E-04	7.01E-02	5.05E-02	2.24E-02	**	**
Annual NO _x Cost Benefit (\$/ton)	-	1.93E+05	NA	3.51E+05	2.72E+04	1.62E+04	4.24E+02	6.36E+04	4.58E+04	2.03E+04	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.24E+02	3.72E+01	3.43E+01	2.57E+01	8.31E-01	7.12E-01	5.25E-01	1.31E+01	1.13E+01	8.29E+00	5.25E-01	8.29E+00
SO ₂ Reduction (g/yr)	-	8.67E+01	8.95E+01	9.81E+01	1.23E+02	1.23E+02	1.23E+02	1.11E+02	1.13E+02	1.16E+02	1.23E+02	1.16E+02
Annual SO ₂ Cost Benefit (\$/g)	-	1.68E+00	2.03E+00	2.34E+00	1.73E-01	1.07E-01	3.04E-03	4.45E-01	3.27E-01	1.50E-01	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	1.53E+06	1.84E+06	2.12E+06	1.57E+05	9.69E+04	2.76E+03	4.03E+05	2.97E+05	1.36E+05	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.3.15a

Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Low HDD, Supporting Information
0.51 cords/yr Burned per Cordwood Fireplace in Low HDD

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Type	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Gas Log Set-Natural Gas, Vent Free	Gas Log Set-LPG, Vent Free
Efficiency (%)	18	60	65	70	60	70	95	60	70	95	95	95
Annual Fuel Input (MJ/yr)	12,229	3,669	3,386	3,144	3,669	3,144	2,317	3,669	3,144	2,317	2,317	2,317
Fuel Cost (\$/input MJ)	0.0078	0.0078	0.0078	0.0157	0.0158	0.0158	0.0158	0.0241	0.0241	0.0241	0.0158	0.0241
Annual Fuel Cost (\$/yr)	95.41	28.62	26.42	49.28	57.79	49.53	36.50	88.25	75.64	55.74	36.50	55.74
Annualized Initial Cost (\$/yr)	-	186.21	181.03	233.33	183.02	183.02	183.02	181.13	181.13	181.13	117.89	116.58
Ancillary Cost (\$/yr)	150.00	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Total Cost (\$/yr)	245.41	389.95	425.57	473.89	265.92	257.67	244.63	294.50	281.89	261.99	179.51	197.43
Cost Difference (\$/yr)	-	144.53	180.16	228.48	20.51	12.25	<0.78>	49.09	36.48	16.57	<65.90>	<47.98>

< > - Alternative appliance or fuel type has an annual cost lower than the uncertified cordwood fireplace insert

Table 3.3.15b

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Low HDD

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	9.66E+03	1.42E+03	1.46E+03	2.51E+02	1.37E+01	1.18E+01	8.67E+00	3.08E+01	2.64E+01	1.95E+01	8.67E+00	1.95E+01
PM Reduction (g/yr)	-	8.24E+03	8.20E+03	9.41E+03	9.65E+03	9.65E+03	9.65E+03	9.63E+03	9.64E+03	9.64E+03	9.65E+03	9.64E+03
Annual PM Cost Benefit (\$/g)	-	1.75E-02	2.20E-02	2.43E-02	2.13E-03	1.27E-03	**	5.10E-03	3.79E-03	1.72E-03	**	**
Annual PM Cost Benefit (\$/ton)	-	1.59E+04	1.99E+04	2.20E+04	1.93E+03	1.15E+03	**	4.62E+03	3.43E+03	1.56E+03	**	**

Table 3.3.15b continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in Low HDD

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	5.96E+03	1.91E+03	1.50E+03	3.28E+00	8.44E+00	7.23E+00	2.71E+00	9.17E+01	7.86E+01	5.79E+01	6.28E+00	5.79E+01
VOC Reduction (g/yr)	-	4.04E+03	4.45E+03	5.95E+03	5.95E+03	5.95E+03	5.95E+03	5.86E+03	5.88E+03	5.90E+03	5.95E+03	5.90E+03
Annual VOC Cost Benefit (\$/g)	-	3.58E-02	4.05E-02	3.84E-02	3.45E-03	2.06E-03	**	8.37E-03	6.21E-03	2.81E-03	**	**
Annual VOC Cost Benefit (\$/ton)	-	3.24E+04	3.67E+04	3.48E+04	3.13E+03	1.87E+03	**	7.59E+03	5.63E+03	2.55E+03	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	4.71E+04	1.33E+04	9.36E+03	1.31E+03	7.12E+01	6.10E+01	6.97E+01	2.14E+01	1.84E+01	1.35E+01	4.87E+01	1.35E+01
CO Reduction (g/yr)	-	3.38E+04	3.78E+04	4.58E+04	4.70E+04	4.71E+04	4.70E+04	4.71E+04	4.71E+04	4.71E+04	4.71E+04	4.71E+04
Annual CO Cost Benefit (\$/g)	-	4.28E-03	4.77E-03	4.99E-03	4.36E-04	2.60E-04	**	1.04E-03	7.75E-04	3.52E-04	**	**
Annual CO Cost Benefit (\$/ton)	-	3.88E+03	4.33E+03	4.53E+03	3.96E+02	2.36E+02	**	9.46E+02	7.03E+02	3.19E+02	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	9.16E+02	2.16E+02	1.22E+03	3.11E+02	1.94E+02	1.66E+02	9.66E+01	2.00E+02	1.71E+02	1.26E+02	9.64E+01	1.26E+02
NO _x Reduction (g/yr)	-	7.00E+02	<3.08E+02>	6.04E+02	7.22E+02	7.50E+02	8.19E+02	7.16E+02	7.44E+02	7.89E+02	8.19E+02	7.89E+02
Annual NO _x Cost Benefit (\$/g)	-	2.07E-01	NA	3.78E-01	2.84E-02	1.63E-02	**	6.86E-02	4.90E-02	2.10E-02	**	**
Annual NO _x Cost Benefit (\$/ton)	-	1.87E+05	NA	3.43E+05	2.58E+04	1.48E+04	**	6.22E+04	4.45E+04	1.90E+04	**	**
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.26E+02	3.79E+01	3.50E+01	2.62E+01	8.47E-01	7.26E-01	5.35E-01	1.34E+01	1.15E+01	8.46E+00	5.35E-01	8.46E+00
SO ₂ Reduction (g/yr)	-	8.84E+01	9.13E+01	1.00E+02	1.25E+02	1.26E+02	1.26E+02	1.13E+02	1.15E+02	1.18E+02	1.26E+02	1.18E+02
Annual SO ₂ Cost Benefit (\$/g)	-	1.63E+00	1.97E+00	2.28E+00	1.63E-01	9.76E-02	**	4.35E-01	3.18E-01	1.41E-01	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	1.48E+06	1.79E+06	2.07E+06	1.48E+05	8.85E+04	**	3.94E+05	2.88E+05	1.28E+05	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

**: Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

3.4. Centralized Cordwood Heating System

The most likely replacements for an existing centralized cordwood heating system include a pellet furnace or boiler, and a gas furnace or boiler (gas includes both LPG and natural gas). Replacement of the centralized cordwood heating system requires the proper disposal of the old unit, which adds approximately \$100 to the total installation cost of the replacement unit. Calculations and assumptions for replacement of a centralized cordwood heating system include further explanation of those already listed in Section 3.

Calculations and Assumptions

Annual fuel input for new unit: input MJ/yr (new)
MJ/yr (old) X (efficiency (old) / efficiency (new))

Efficiency References:

Centralized Cordwood Heating System:	10, 30.1-30.2
Pellet Furnace/Boiler:	same as for pellet stoves
Gas Furnace/Boiler:	41

Annualized installation/replacement cost: \$/yr⁴²

Install/replace, gas plumbing, and old unit removal cost; all divided by the unit lifetime

- Pellet furnace/boiler: \$4,475 / 16 yrs = \$279.70/yr
- Gas furnace/boiler – natural gas, LPG: \$3,675 / 16 yrs = \$229.70/yr

Ancillary costs: sum of a b and c per appliance: \$/yr

a) Chimney cleaning – cost per cleaning X cleanings per year = \$/yr⁴⁴

- Centralized Cordwood Heating System: \$150 X 1 cleaning/yr = \$150/yr
- Pellet furnace/boiler: \$150 X 1 cleaning/yr = \$150/yr

b) Electricity costs:

Hours of use per year⁶¹ (for 6 month heating season, Oct-March) assumed to be:
182days @ 14 hrs/day = 2,548 hrs/yr

- Centralized Cordwood Heating System: 0.489 kw X 2,548 hrs/yr X \$0.13/kw-h
= \$158.69/yr
- Pellet furnace/boiler: 0.739 kw X 2,548 hrs/yr X \$0.13/kw-h = \$239.91/yr
- Gas furnace/boiler – natural gas, LPG: 0.489 kw X 2,548 hrs/yr X \$0.13/kw-h
= \$158.69/yr

Total annual emissions for each category: g/yr

Total annual emissions = emission factor (g/MJ) X annual fuel input (MJ/yr)

Emission factors in g/input MJ

Wood burning emission factors converted from g/kg^{10,26-29} to g/MJ by dividing the g/kg emission factor by the average fuel LHV⁴⁵ (MJ/kg)

Pellet furnace/boiler emission factors converted from g/kg^{4,07,4.11,4.18-4.19,10,24,26-27} to g/MJ by dividing the g/kg emission factor by the average pellet heat content⁴⁷ (MJ/kg)

Natural Gas furnace/boiler emission factors converted to g/MJ³⁷⁻³⁹

LPG Gas furnace/boiler emission factors converted to g/MJ³⁴⁻³⁵

Table 3.4.01a
 Replacement of an Existing Centralized Cordwood Heating System in Connecticut, Supporting
 Information

3.41 cords/yr Burned per Centralized Cordwood Heating System in Connecticut

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	88,124	55,224	52,428	52,428
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	687.58	865.53	825.84	1,261.23
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	996.27	1,541.38	1,214.22	1,649.62
Cost Difference (\$/yr)	-	545.11	217.95	653.35

Table 3.4.01b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 Connecticut

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers-Natural Gas	Gas Furnaces and Boilers-LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	6.28E+04	4.36E+03	1.96E+02	4.40E+02
PM Reduction (g/yr)	-	5.84E+04	6.26E+04	6.24E+04
Annual PM Cost Benefit (\$/g)	-	9.33E-03	3.48E-03	1.05E-02
Annual PM Cost Benefit (\$/ton)	-	8.46E+03	3.16E+03	9.50E+03
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	2.66E+04	5.69E+01	1.21E+02	1.31E+03
VOC Reduction (g/yr)	-	2.66E+04	2.65E+04	2.53E+04
Annual VOC Cost Benefit (\$/g)	-	2.05E-02	8.22E-03	2.58E-02
Annual VOC Cost Benefit (\$/ton)	-	1.86E+04	7.46E+03	2.34E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	4.18E+05	2.28E+04	9.07E+02	3.06E+02
CO Reduction (g/yr)	-	3.95E+05	4.17E+05	4.17E+05
Annual CO Cost Benefit (\$/g)	-	1.38E-03	5.23E-04	1.56E-03
Annual CO Cost Benefit (\$/ton)	-	1.25E+03	4.74E+02	1.42E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	4.19E+03	5.42E+03	2.37E+03	2.86E+03
NO _x Reduction (g/yr)	-	<1.23E+03>	1.81E+03	1.33E+03
Annual NO _x Cost Benefit (\$/g)	-	NA	1.20E-01	4.91E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	1.09E+05	4.46E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	4.60E+03	4.56E+02	1.21E+01	1.91E+02
SO ₂ Reduction (g/yr)	-	4.14E+03	4.58E+03	4.41E+03
Annual SO ₂ Cost Benefit (\$/g)	-	1.32E-01	4.75E-02	1.48E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	1.19E+05	4.31E+04	1.35E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.02a
 Replacement of an Existing Centralized Cordwood Heating System in Delaware, Supporting
 Information
 0.75 cords/yr Burned per Centralized Cordwood Heating System in Delaware

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	17,536	10,989	10,433	10,433
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	136.82	172.23	164.33	250.97
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	445.51	848.08	552.71	639.35
Cost Difference (\$/yr)	-	402.56	107.20	193.84

Table 3.4.02b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 Delaware

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	1.25E+04	8.68E+02	3.90E+01	8.76E+01
PM Reduction (g/yr)	-	1.16E+04	1.25E+04	1.24E+04
Annual PM Cost Benefit (\$/g)	-	3.46E-02	8.60E-03	1.56E-02
Annual PM Cost Benefit (\$/ton)	-	3.14E+04	7.81E+03	1.42E+04
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	5.30E+03	1.13E+01	2.40E+01	2.61E+02
VOC Reduction (g/yr)	-	5.29E+03	5.27E+03	5.04E+03
Annual VOC Cost Benefit (\$/g)	-	7.61E-02	2.03E-02	3.85E-02
Annual VOC Cost Benefit (\$/ton)	-	6.91E+04	1.84E+04	3.49E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	8.31E+04	4.54E+03	1.80E+02	6.09E+01
CO Reduction (g/yr)	-	7.86E+04	8.30E+04	8.31E+04
Annual CO Cost Benefit (\$/g)	-	5.12E-03	1.29E-03	2.33E-03
Annual CO Cost Benefit (\$/ton)	-	4.65E+03	1.17E+03	2.12E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	8.33E+02	1.08E+03	4.73E+02	5.69E+02
NO _x Reduction (g/yr)	-	<2.45E+02>	3.61E+02	2.65E+02
Annual NO _x Cost Benefit (\$/g)	-	NA	2.97E-01	7.33E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	2.70E+05	6.65E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	9.15E+02	9.08E+01	2.41E+00	3.81E+01
SO ₂ Reduction (g/yr)	-	8.24E+02	9.12E+02	8.77E+02
Annual SO ₂ Cost Benefit (\$/g)	-	4.89E-01	1.18E-01	2.21E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	4.43E+05	1.07E+05	2.01E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.03a
 Replacement of an Existing Centralized Cordwood Heating System in Maine, Supporting
 Information
 5.38 cords/yr Burned per Centralized Cordwood Heating System in Maine

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	115,931	72,650	68,972	68,972
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	904.54	1,138.64	1,086.43	1,659.21
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	1,213.23	1,814.49	1,474.81	2,047.59
Cost Difference (\$/yr)	-	601.26	261.58	834.36

Table 3.4.03b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 Maine

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	8.26E+04	5.74E+03	2.58E+02	5.79E+02
PM Reduction (g/yr)	-	7.69E+04	8.24E+04	8.20E+04
Annual PM Cost Benefit (\$/g)	-	7.82E-03	3.18E-03	1.02E-02
Annual PM Cost Benefit (\$/ton)	-	7.09E+03	2.88E+03	9.23E+03
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	3.50E+04	7.48E+01	1.59E+02	1.72E+03
VOC Reduction (g/yr)	-	3.50E+04	3.49E+04	3.33E+04
Annual VOC Cost Benefit (\$/g)	-	1.72E-02	7.50E-03	2.51E-02
Annual VOC Cost Benefit (\$/ton)	-	1.56E+04	6.81E+03	2.27E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	5.50E+05	3.00E+04	1.19E+03	4.03E+02
CO Reduction (g/yr)	-	5.20E+05	5.48E+05	5.49E+05
Annual CO Cost Benefit (\$/g)	-	1.16E-03	4.77E-04	1.52E-03
Annual CO Cost Benefit (\$/ton)	-	1.05E+03	4.33E+02	1.38E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	5.51E+03	7.13E+03	3.12E+03	3.76E+03
NO _x Reduction (g/yr)	-	<1.62E+03>	2.38E+03	1.75E+03
Annual NO _x Cost Benefit (\$/g)	-	NA	1.10E-01	4.77E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	9.95E+04	4.33E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	6.05E+03	6.00E+02	1.59E+01	2.52E+02
SO ₂ Reduction (g/yr)	-	5.45E+03	6.03E+03	5.80E+03
Annual SO ₂ Cost Benefit (\$/g)	-	1.10E-01	4.34E-02	1.44E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	1.00E+05	3.93E+04	1.31E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.04a
 Replacement of an Existing Centralized Cordwood Heating System in Maryland, Supporting
 Information

1.26 cords/yr Burned per Centralized Cordwood Heating System in Maryland

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	29,695	18,609	17,667	17,667
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	231.69	291.65	278.28	424.99
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	540.38	967.50	666.66	813.38
Cost Difference (\$/yr)	-	427.12	126.28	272.99

Table 3.4.04b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 Maryland

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers-Natural Gas	Gas Furnaces and Boilers-LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	2.12E+04	1.47E+03	6.61E+01	1.48E+02
PM Reduction (g/yr)	-	1.97E+04	2.11E+04	2.10E+04
Annual PM Cost Benefit (\$/g)	-	2.17E-02	5.99E-03	1.30E-02
Annual PM Cost Benefit (\$/ton)	-	1.97E+04	5.43E+03	1.18E+04
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	8.97E+03	1.92E+01	4.06E+01	4.42E+02
VOC Reduction (g/yr)	-	8.95E+03	8.93E+03	8.53E+03
Annual VOC Cost Benefit (\$/g)	-	4.77E-02	1.41E-02	3.20E-02
Annual VOC Cost Benefit (\$/ton)	-	4.33E+04	1.28E+04	2.90E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	1.41E+05	7.69E+03	3.06E+02	1.03E+02
CO Reduction (g/yr)	-	1.33E+05	1.40E+05	1.41E+05
Annual CO Cost Benefit (\$/g)	-	3.21E-03	8.99E-04	1.94E-03
Annual CO Cost Benefit (\$/ton)	-	2.91E+03	8.15E+02	1.76E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	1.41E+03	1.83E+03	8.00E+02	9.63E+02
NO _x Reduction (g/yr)	-	<4.15E+02>	6.11E+02	4.48E+02
Annual NO _x Cost Benefit (\$/g)	-	NA	2.07E-01	6.09E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	1.88E+05	5.53E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.55E+03	1.54E+02	4.08E+00	6.45E+01
SO ₂ Reduction (g/yr)	-	1.40E+03	1.54E+03	1.48E+03
Annual SO ₂ Cost Benefit (\$/g)	-	3.06E-01	8.17E-02	1.84E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	2.78E+05	7.42E+04	1.67E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.05a
 Replacement of an Existing Centralized Cordwood Heating System in Massachusetts,
 Supporting Information
 4.38 cords/yr Burned per Centralized Cordwood Heating System in Massachusetts

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	108,108	67,747	64,317	64,317
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	843.50	1,061.80	1,013.11	1,547.24
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	1,152.19	1,737.65	1,401.49	1,935.63
Cost Difference (\$/yr)	-	585.46	249.30	783.43

Table 3.4.05b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 Massachusetts

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers-Natural Gas	Gas Furnaces and Boilers-LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	7.71E+04	5.35E+03	2.41E+02	5.40E+02
PM Reduction (g/yr)	-	7.17E+04	7.68E+04	7.65E+04
Annual PM Cost Benefit (\$/g)	-	8.17E-03	3.25E-03	1.02E-02
Annual PM Cost Benefit (\$/ton)	-	7.41E+03	2.94E+03	9.29E+03
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	3.27E+04	6.98E+01	1.48E+02	1.61E+03
VOC Reduction (g/yr)	-	3.26E+04	3.25E+04	3.11E+04
Annual VOC Cost Benefit (\$/g)	-	1.80E-02	7.67E-03	2.52E-02
Annual VOC Cost Benefit (\$/ton)	-	1.63E+04	6.96E+03	2.29E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	5.13E+05	2.80E+04	1.11E+03	3.76E+02
CO Reduction (g/yr)	-	4.85E+05	5.11E+05	5.12E+05
Annual CO Cost Benefit (\$/g)	-	1.21E-03	4.87E-04	1.53E-03
Annual CO Cost Benefit (\$/ton)	-	1.10E+03	4.42E+02	1.39E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	5.14E+03	6.65E+03	2.91E+03	3.51E+03
NO _x Reduction (g/yr)	-	<1.51E+03>	2.22E+03	1.63E+03
Annual NO _x Cost Benefit (\$/g)	-	NA	1.12E-01	4.80E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	1.02E+05	4.36E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	5.64E+03	5.60E+02	1.49E+01	2.35E+02
SO ₂ Reduction (g/yr)	-	5.08E+03	5.62E+03	5.40E+03
Annual SO ₂ Cost Benefit (\$/g)	-	1.15E-01	4.43E-02	1.45E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	1.05E+05	4.02E+04	1.32E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.06a
 Replacement of an Existing Centralized Cordwood Heating System in New Hampshire,
 Supporting Information
 5.38 cords/yr Burned per Centralized Cordwood Heating System in New Hampshire

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	126,355	79,183	75,173	75,173
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	985.87	1,241.03	1,184.12	1,808.41
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	1,294.57	1,916.88	1,572.50	2,196.79
Cost Difference (\$/yr)	-	622.31	277.93	902.22

Table 3.4.06b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in New Hampshire

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers-Natural Gas	Gas Furnaces and Boilers-LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	9.01E+04	6.26E+03	2.81E+02	6.31E+02
PM Reduction (g/yr)	-	8.38E+04	8.98E+04	8.94E+04
Annual PM Cost Benefit (\$/g)	-	7.43E-03	3.10E-03	1.01E-02
Annual PM Cost Benefit (\$/ton)	-	6.74E+03	2.81E+03	9.15E+03
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	3.82E+04	8.16E+01	1.73E+02	1.88E+03
VOC Reduction (g/yr)	-	3.81E+04	3.80E+04	3.63E+04
Annual VOC Cost Benefit (\$/g)	-	1.63E-02	7.31E-03	2.49E-02
Annual VOC Cost Benefit (\$/ton)	-	1.48E+04	6.63E+03	2.26E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	5.99E+05	3.27E+04	1.30E+03	4.39E+02
CO Reduction (g/yr)	-	5.66E+05	5.98E+05	5.99E+05
Annual CO Cost Benefit (\$/g)	-	1.10E-03	4.65E-04	1.51E-03
Annual CO Cost Benefit (\$/ton)	-	9.97E+02	4.22E+02	1.37E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	6.00E+03	7.77E+03	3.41E+03	4.10E+03
NO _x Reduction (g/yr)	-	<1.76E+03>	2.60E+03	1.91E+03
Annual NO _x Cost Benefit (\$/g)	-	NA	1.07E-01	4.73E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	9.70E+04	4.29E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	6.59E+03	6.54E+02	1.74E+01	2.74E+02
SO ₂ Reduction (g/yr)	-	5.94E+03	6.57E+03	6.32E+03
Annual SO ₂ Cost Benefit (\$/g)	-	1.05E-01	4.23E-02	1.43E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	9.51E+04	3.84E+04	1.30E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.07a

Replacement of an Existing Centralized Cordwood Heating System in New Jersey, Supporting Information

1.22 cords/yr Burned per Centralized Cordwood Heating System in New Jersey

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers-Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	28,416	17,808	16,906	16,906
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	221.72	279.10	266.30	406.70
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	530.41	954.95	654.68	795.08
Cost Difference (\$/yr)	-	424.54	124.27	264.67

Table 3.4.07b

Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in New Jersey

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	2.03E+04	1.41E+03	6.32E+01	1.42E+02
PM Reduction (g/yr)	-	1.88E+04	2.02E+04	2.01E+04
Annual PM Cost Benefit (\$/g)	-	2.25E-02	6.16E-03	1.32E-02
Annual PM Cost Benefit (\$/ton)	-	2.04E+04	5.58E+03	1.19E+04
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	8.59E+03	1.83E+01	3.89E+01	4.23E+02
VOC Reduction (g/yr)	-	8.57E+03	8.55E+03	8.16E+03
Annual VOC Cost Benefit (\$/g)	-	4.96E-02	1.45E-02	3.24E-02
Annual VOC Cost Benefit (\$/ton)	-	4.50E+04	1.32E+04	2.94E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	1.35E+05	7.35E+03	2.92E+02	9.87E+01
CO Reduction (g/yr)	-	1.27E+05	1.34E+05	1.35E+05
Annual CO Cost Benefit (\$/g)	-	3.33E-03	9.24E-04	1.97E-03
Annual CO Cost Benefit (\$/ton)	-	3.02E+03	8.39E+02	1.78E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	1.35E+03	1.75E+03	7.66E+02	9.21E+02
NO _x Reduction (g/yr)	-	<3.97E+02>	5.84E+02	4.29E+02
Annual NO _x Cost Benefit (\$/g)	-	NA	2.13E-01	6.17E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	1.93E+05	5.60E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	1.48E+03	1.47E+02	3.91E+00	6.17E+01
SO ₂ Reduction (g/yr)	-	1.34E+03	1.48E+03	1.42E+03
Annual SO ₂ Cost Benefit (\$/g)	-	3.18E-01	8.41E-02	1.86E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	2.88E+05	7.63E+04	1.69E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.08a

Replacement of an Existing Centralized Cordwood Heating System in New York, Supporting Information

5.30 cords/yr Burned per Centralized Cordwood Heating System in New York

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers-Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	131,834	82,616	78,433	78,433
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	1,028.62	1,294.83	1,235.46	1,886.81
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	1,337.31	1,970.68	1,623.84	2,275.19
Cost Difference (\$/yr)	-	633.37	286.53	937.88

Table 3.4.08b

Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in New York

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers-Natural Gas	Gas Furnaces and Boilers-LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	9.40E+04	6.53E+03	2.93E+02	6.59E+02
PM Reduction (g/yr)	-	8.74E+04	9.37E+04	9.33E+04
Annual PM Cost Benefit (\$/g)	-	7.24E-03	3.06E-03	1.01E-02
Annual PM Cost Benefit (\$/ton)	-	6.57E+03	2.78E+03	9.12E+03
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	3.98E+04	8.51E+01	1.80E+02	1.96E+03
VOC Reduction (g/yr)	-	3.97E+04	3.97E+04	3.79E+04
Annual VOC Cost Benefit (\$/g)	-	1.59E-02	7.23E-03	2.48E-02
Annual VOC Cost Benefit (\$/ton)	-	1.45E+04	6.56E+03	2.25E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	6.25E+05	3.41E+04	1.36E+03	4.58E+02
CO Reduction (g/yr)	-	5.91E+05	6.24E+05	6.25E+05
Annual CO Cost Benefit (\$/g)	-	1.07E-03	4.59E-04	1.50E-03
Annual CO Cost Benefit (\$/ton)	-	9.72E+02	4.17E+02	1.36E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	6.26E+03	8.10E+03	3.55E+03	4.27E+03
NO _x Reduction (g/yr)	-	<1.84E+03>	2.71E+03	1.99E+03
Annual NO _x Cost Benefit (\$/g)	-	NA	1.06E-01	4.71E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	9.59E+04	4.28E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	6.88E+03	6.82E+02	1.81E+01	2.86E+02
SO ₂ Reduction (g/yr)	-	6.19E+03	6.86E+03	6.59E+03
Annual SO ₂ Cost Benefit (\$/g)	-	1.02E-01	4.18E-02	1.42E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	9.28E+04	3.79E+04	1.29E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.09a
 Replacement of an Existing Centralized Cordwood Heating System in Pennsylvania, Supporting
 Information

2.93 cords/yr Burned per Centralized Cordwood Heating System in Pennsylvania

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	74,072	46,419	44,068	44,068
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	577.94	727.52	694.16	1,060.13
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	886.63	1,403.37	1,082.54	1,448.51
Cost Difference (\$/yr)	-	516.73	195.90	561.87

Table 3.4.09b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 Pennsylvania

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	5.28E+04	3.67E+03	1.65E+02	3.70E+02
PM Reduction (g/yr)	-	4.91E+04	5.26E+04	5.24E+04
Annual PM Cost Benefit (\$/g)	-	1.05E-02	3.72E-03	1.07E-02
Annual PM Cost Benefit (\$/ton)	-	9.54E+03	3.38E+03	9.72E+03
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	2.24E+04	4.78E+01	1.01E+02	1.10E+03
VOC Reduction (g/yr)	-	2.23E+04	2.23E+04	2.13E+04
Annual VOC Cost Benefit (\$/g)	-	2.31E-02	8.79E-03	2.64E-02
Annual VOC Cost Benefit (\$/ton)	-	2.10E+04	7.98E+03	2.40E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	3.51E+05	1.92E+04	7.62E+02	2.57E+02
CO Reduction (g/yr)	-	3.32E+05	3.50E+05	3.51E+05
Annual CO Cost Benefit (\$/g)	-	1.56E-03	5.59E-04	1.60E-03
Annual CO Cost Benefit (\$/ton)	-	1.41E+03	5.07E+02	1.45E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	3.52E+03	4.55E+03	2.00E+03	2.40E+03
NO _x Reduction (g/yr)	-	<1.03E+03>	1.52E+03	1.12E+03
Annual NO _x Cost Benefit (\$/g)	-	NA	1.29E-01	5.03E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	1.17E+05	4.56E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	3.86E+03	3.83E+02	1.02E+01	1.61E+02
SO ₂ Reduction (g/yr)	-	3.48E+03	3.85E+03	3.70E+03
Annual SO ₂ Cost Benefit (\$/g)	-	1.48E-01	5.08E-02	1.52E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	1.35E+05	4.61E+04	1.38E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.10a
 Replacement of an Existing Centralized Cordwood Heating System in Rhode Island, Supporting
 Information

1.96 cords/yr Burned per Centralized Cordwood Heating System in Rhode Island

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	47,358	29,678	28,175	28,175
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	369.51	465.14	443.81	677.79
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	678.20	1,140.99	832.19	1,066.18
Cost Difference (\$/yr)	-	462.79	153.99	387.97

Table 3.4.10b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 Rhode Island

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	3.38E+04	2.34E+03	1.05E+02	2.37E+02
PM Reduction (g/yr)	-	3.14E+04	3.36E+04	3.35E+04
Annual PM Cost Benefit (\$/g)	-	1.47E-02	4.58E-03	1.16E-02
Annual PM Cost Benefit (\$/ton)	-	1.34E+04	4.15E+03	1.05E+04
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	1.43E+04	3.06E+01	6.48E+01	7.04E+02
VOC Reduction (g/yr)	-	1.43E+04	1.42E+04	1.36E+04
Annual VOC Cost Benefit (\$/g)	-	3.24E-02	1.08E-02	2.85E-02
Annual VOC Cost Benefit (\$/ton)	-	2.94E+04	9.81E+03	2.59E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	2.25E+05	1.23E+04	4.87E+02	1.65E+02
CO Reduction (g/yr)	-	2.12E+05	2.24E+05	2.24E+05
Annual CO Cost Benefit (\$/g)	-	2.18E-03	6.87E-04	1.73E-03
Annual CO Cost Benefit (\$/ton)	-	1.98E+03	6.24E+02	1.57E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	2.25E+03	2.91E+03	1.28E+03	1.54E+03
NO _x Reduction (g/yr)	-	<6.61E+02>	9.74E+02	7.15E+02
Annual NO _x Cost Benefit (\$/g)	-	NA	1.58E-01	5.43E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	1.43E+05	4.93E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	2.47E+03	2.45E+02	6.51E+00	1.03E+02
SO ₂ Reduction (g/yr)	-	2.23E+03	2.46E+03	2.37E+03
Annual SO ₂ Cost Benefit (\$/g)	-	2.08E-01	6.25E-02	1.64E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	1.89E+05	5.67E+04	1.49E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.11a

Replacement of an Existing Centralized Cordwood Heating System in the District of Columbia,
 Supporting Information
 0.68 cords/yr Burned per Centralized Cordwood Heating System in the District of Columbia

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	16,006	10,030	9,523	9,523
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	124.88	157.21	150.00	229.08
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	433.58	833.05	538.38	617.46
Cost Difference (\$/yr)	-	399.47	104.80	183.88

Table 3.4.11b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in the
 District of Columbia

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	1.14E+04	7.92E+02	3.56E+01	8.00E+01
PM Reduction (g/yr)	-	1.06E+04	1.14E+04	1.13E+04
Annual PM Cost Benefit (\$/g)	-	3.76E-02	9.22E-03	1.62E-02
Annual PM Cost Benefit (\$/ton)	-	3.41E+04	8.36E+03	1.47E+04
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	4.84E+03	1.03E+01	2.19E+01	2.38E+02
VOC Reduction (g/yr)	-	4.83E+03	4.81E+03	4.60E+03
Annual VOC Cost Benefit (\$/g)	-	8.28E-02	2.18E-02	4.00E-02
Annual VOC Cost Benefit (\$/ton)	-	7.51E+04	1.97E+04	3.63E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	7.59E+04	4.14E+03	1.65E+02	5.56E+01
CO Reduction (g/yr)	-	7.17E+04	7.57E+04	7.58E+04
Annual CO Cost Benefit (\$/g)	-	5.57E-03	1.38E-03	2.42E-03
Annual CO Cost Benefit (\$/ton)	-	5.05E+03	1.26E+03	2.20E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	7.61E+02	9.84E+02	4.31E+02	5.19E+02
NO _x Reduction (g/yr)	-	<2.23E+02>	3.29E+02	2.42E+02
Annual NO _x Cost Benefit (\$/g)	-	NA	3.18E-01	7.61E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	2.89E+05	6.91E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	8.35E+02	8.29E+01	2.20E+00	3.48E+01
SO ₂ Reduction (g/yr)	-	7.52E+02	8.33E+02	8.00E+02
Annual SO ₂ Cost Benefit (\$/g)	-	5.31E-01	1.26E-01	2.30E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	4.82E+05	1.14E+05	2.08E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.12a
 Replacement of an Existing Centralized Cordwood Heating System in Vermont, Supporting
 Information
 5.38 cords/yr Burned per Centralized Cordwood Heating System in Vermont

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	130,194	81,589	77,457	77,457
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	1,015.83	1,278.73	1,220.10	1,863.35
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	1,324.52	1,954.58	1,608.48	2,251.73
Cost Difference (\$/yr)	-	630.06	283.96	927.21

Table 3.4.12b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 Vermont

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	9.28E+04	6.45E+03	2.90E+02	6.51E+02
PM Reduction (g/yr)	-	8.63E+04	9.25E+04	9.21E+04
Annual PM Cost Benefit (\$/g)	-	7.30E-03	3.07E-03	1.01E-02
Annual PM Cost Benefit (\$/ton)	-	6.62E+03	2.78E+03	9.13E+03
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	3.93E+04	8.40E+01	1.78E+02	1.94E+03
VOC Reduction (g/yr)	-	3.93E+04	3.92E+04	3.74E+04
Annual VOC Cost Benefit (\$/g)	-	1.61E-02	7.25E-03	2.48E-02
Annual VOC Cost Benefit (\$/ton)	-	1.46E+04	6.58E+03	2.25E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	6.17E+05	3.37E+04	1.34E+03	4.52E+02
CO Reduction (g/yr)	-	5.84E+05	6.16E+05	6.17E+05
Annual CO Cost Benefit (\$/g)	-	1.08E-03	4.61E-04	1.50E-03
Annual CO Cost Benefit (\$/ton)	-	9.79E+02	4.18E+02	1.36E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	6.19E+03	8.00E+03	3.51E+03	4.22E+03
NO _x Reduction (g/yr)	-	<1.82E+03>	2.68E+03	1.96E+03
Annual NO _x Cost Benefit (\$/g)	-	NA	1.06E-01	4.72E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	9.62E+04	4.28E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	6.79E+03	6.74E+02	1.79E+01	2.83E+02
SO ₂ Reduction (g/yr)	-	6.12E+03	6.77E+03	6.51E+03
Annual SO ₂ Cost Benefit (\$/g)	-	1.03E-01	4.19E-02	1.42E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	9.34E+04	3.80E+04	1.29E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.13a

Replacement of an Existing Centralized Cordwood Heating System in High HDD Category,
 Supporting Information
 5.38 cords/yr Burned per Centralized Cordwood Heating System in High HDD Category

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	128,999	80,839	76,746	76,746
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	1,006.50	1,266.99	1,208.89	1,846.24
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	1,315.19	1,942.84	1,597.27	2,234.62
Cost Difference (\$/yr)	-	627.65	282.08	919.43

Table 3.4.13b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in High
 HDD Category

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	9.19E+04	6.39E+03	2.87E+02	6.45E+02
PM Reduction (g/yr)	-	8.56E+04	9.17E+04	9.13E+04
Annual PM Cost Benefit (\$/g)	-	7.34E-03	3.08E-03	1.01E-02
Annual PM Cost Benefit (\$/ton)	-	6.66E+03	2.79E+03	9.14E+03
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	3.90E+04	8.33E+01	1.77E+02	1.92E+03
VOC Reduction (g/yr)	-	3.89E+04	3.88E+04	3.71E+04
Annual VOC Cost Benefit (\$/g)	-	1.61E-02	7.27E-03	2.48E-02
Annual VOC Cost Benefit (\$/ton)	-	1.46E+04	6.60E+03	2.25E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	6.12E+05	3.34E+04	1.33E+03	4.48E+02
CO Reduction (g/yr)	-	5.78E+05	6.10E+05	6.11E+05
Annual CO Cost Benefit (\$/g)	-	1.09E-03	4.62E-04	1.50E-03
Annual CO Cost Benefit (\$/ton)	-	9.85E+02	4.19E+02	1.36E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	6.13E+03	7.93E+03	3.48E+03	4.18E+03
NO _x Reduction (g/yr)	-	<1.80E+03>	2.65E+03	1.95E+03
Annual NO _x Cost Benefit (\$/g)	-	NA	1.06E-01	4.72E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	9.65E+04	4.28E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	6.73E+03	6.68E+02	1.77E+01	2.80E+02
SO ₂ Reduction (g/yr)	-	6.06E+03	6.71E+03	6.45E+03
Annual SO ₂ Cost Benefit (\$/g)	-	1.04E-01	4.20E-02	1.43E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	9.39E+04	3.81E+04	1.29E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.14a

Replacement of an Existing Centralized Cordwood Heating System in Medium HDD Category,
Supporting Information

1.83 cords/yr Burned per Centralized Cordwood Heating System in Medium HDD Category

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers-Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	43,879	27,497	26,105	26,105
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	342.36	430.97	411.20	628.00
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	651.05	1,106.81	799.58	1,016.38
Cost Difference (\$/yr)	-	455.76	148.53	365.32

Table 3.4.14b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 Medium HDD Category

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	3.13E+04	2.17E+03	9.76E+01	2.19E+02
PM Reduction (g/yr)	-	2.91E+04	3.12E+04	3.11E+04
Annual PM Cost Benefit (\$/g)	-	1.57E-02	4.76E-03	1.18E-02
Annual PM Cost Benefit (\$/ton)	-	1.42E+04	4.32E+03	1.07E+04
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	1.33E+04	2.83E+01	6.00E+01	6.53E+02
VOC Reduction (g/yr)	-	1.32E+04	1.32E+04	1.26E+04
Annual VOC Cost Benefit (\$/g)	-	3.45E-02	1.13E-02	2.90E-02
Annual VOC Cost Benefit (\$/ton)	-	3.13E+04	1.02E+04	2.63E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	2.08E+05	1.14E+04	4.52E+02	1.52E+02
CO Reduction (g/yr)	-	1.97E+05	2.08E+05	2.08E+05
Annual CO Cost Benefit (\$/g)	-	2.32E-03	7.16E-04	1.76E-03
Annual CO Cost Benefit (\$/ton)	-	2.10E+03	6.49E+02	1.59E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	2.08E+03	2.70E+03	1.18E+03	1.42E+03
NO _x Reduction (g/yr)	-	<6.13E+02>	9.02E+02	6.62E+02
Annual NO _x Cost Benefit (\$/g)	-	NA	1.65E-01	5.52E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	1.49E+05	5.01E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	2.29E+03	2.27E+02	6.03E+00	9.53E+01
SO ₂ Reduction (g/yr)	-	2.06E+03	2.28E+03	2.19E+03
Annual SO ₂ Cost Benefit (\$/g)	-	2.21E-01	6.51E-02	1.67E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	2.01E+05	5.90E+04	1.51E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 3.4.15a
 Replacement of an Existing Centralized Cordwood Heating System in Low HDD Category,
 Supporting Information
 0.75 cords/yr Burned per Centralized Cordwood Heating System in Low HDD Category

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Appliance/Fuel Type	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers-LPG
Efficiency (%)	47	75	79	79
Annual Fuel Input (MJ/yr)	17,983	11,269	10,699	10,699
Fuel Cost (\$/input MJ)	0.0078	0.0157	0.0158	0.0241
Annual Fuel Cost (\$/yr)	140.31	176.63	168.53	257.38
Annualized Initial Cost (\$/yr)	-	285.94	229.69	229.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Total Cost (\$/yr)	449.01	852.47	556.91	645.76
Cost Difference (\$/yr)	-	403.47	107.90	196.75

Table 3.4.15b
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in Low
 HDD Category

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers- Natural Gas	Gas Furnaces and Boilers- LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	1.28E+04	8.90E+02	4.00E+01	8.99E+01
PM Reduction (g/yr)	-	1.19E+04	1.28E+04	1.27E+04
Annual PM Cost Benefit (\$/g)	-	3.38E-02	8.45E-03	1.55E-02
Annual PM Cost Benefit (\$/ton)	-	3.07E+04	7.66E+03	1.40E+04
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	5.43E+03	1.16E+01	2.46E+01	2.67E+02
VOC Reduction (g/yr)	-	5.42E+03	5.41E+03	5.17E+03
Annual VOC Cost Benefit (\$/g)	-	7.44E-02	1.99E-02	3.81E-02
Annual VOC Cost Benefit (\$/ton)	-	6.75E+04	1.81E+04	3.46E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	8.53E+04	4.65E+03	1.85E+02	6.25E+01
CO Reduction (g/yr)	-	8.06E+04	8.51E+04	8.52E+04
Annual CO Cost Benefit (\$/g)	-	5.01E-03	1.27E-03	2.31E-03
Annual CO Cost Benefit (\$/ton)	-	4.54E+03	1.15E+03	2.10E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	8.54E+02	1.11E+03	4.85E+02	5.83E+02
NO _x Reduction (g/yr)	-	<2.51E+02>	3.70E+02	2.71E+02
Annual NO _x Cost Benefit (\$/g)	-	NA	2.92E-01	7.25E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	2.65E+05	6.58E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	9.38E+02	9.31E+01	2.47E+00	3.91E+01
SO ₂ Reduction (g/yr)	-	8.45E+02	9.36E+02	8.99E+02
Annual SO ₂ Cost Benefit (\$/g)	-	4.77E-01	1.15E-01	2.19E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	4.33E+05	1.05E+05	1.99E+05

* NO_x - Total nitrogen oxides reported as NO₂.

< > represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

3.5. Addition of Log Set or Use of Wax/Fiber Firelog with Existing Fireplace

The pollution reduction cost benefit analyses for existing fireplaces without inserts used for aesthetic purposes are not conducted in the same manner as the aforementioned categories, which are used for heat. The most likely changes to an existing fireplace without insert used for aesthetic purposes include using wax/fiber firelogs, adding a vent-free gas log set, or adding a vented gas log set (gas includes both LPG and natural gas). Since aesthetic use is more concerned with the look and feel of the fire and not the heat produced from fire, the fuel use rate is used instead of efficiency. Total fuel used for each appliance and fuel category is calculated by multiplying the fuel use rate by the average use of a fireplace without insert used for aesthetics, since it is assumed that the average appliance annual usage for aesthetics will be the same regardless of the appliance type. On the same note, this section does not include tables for each state and HDD category since average appliance usage for aesthetics does not vary significantly with the HDD category (or state) in which the appliance is located, and hence, the tables are representative of the entire MANE-VU region.

Calculations and Assumptions

1. Annual appliance usage for all appliances: hr/yr

Cords burned per year by fireplaces without inserts used for aesthetics (0.069 cords/yr)³³
X average mass per cord (1238.3 kg/cord)⁵⁴⁻⁶⁰ divided by burn rate of fireplace
without inserts (4.20 kg/hr)^{4.01,12,17-17.19} = 20 hr/yr (It should be noted that the standard
deviation of state values around the mean mass per cord in the MANE-VU region is
only 4.5 % of the overall mean, hence the variation of mean mass per cord by state
has only a very small affect in calculating appliance usage.)

2. Total annual emissions: g/yr

Emission rate (g/hr) X annual appliance usage (hr/yr)

Emission rate references:

Fireplace without inserts burning cordwood: 16-19, 25

Fireplace without inserts burning wax/fiber firelogs: 31

Natural Gas log sets: 36-39

LPG Gas log sets: 34-35

3. Emissions reduction: g/yr

Total emissions (old unit) – Total emissions (new unit)

4. Annual fuel use: fuel unit/yr

fuel use rate (fuel unit used/hr,) X annual appliance usage (hr/yr)

Fuel use rate references:

Fireplace without inserts burning cordwood: See step 1.

Fireplace without inserts burning wax/fiber firelogs: 7, 16, 16.01, 16.07,16.09, 16.12,
16.16, 17.12, 17.21-17.24

Gas log sets:

Vent Free Gas Log Set (natural gas)

25,000 Btu/hr X 1055J/Btu = 2.64 X10⁷ J/hr

$$= 26.4 \text{ MJ/hr}$$

$$2.64 \times 10^7 \text{ J/hr} / 38 \times 10^6 \text{ J/m}^3 = 0.69 \text{ m}^3/\text{hr}$$

Vented Gas Log Set (natural gas)

$$40,000 \text{ Btu/hr} \times 1055 \text{ J/Btu} = 4.22 \times 10^7 \text{ J/hr}$$

$$= 42.2 \text{ MJ/hr}$$

$$4.22 \times 10^7 \text{ J/hr} / 38 \times 10^6 \text{ J/m}^3 = 1.11 \text{ m}^3/\text{hr}$$

Vent Free Gas Log Set (LPG)

$$2.64 \times 10^7 \text{ J/hr} / 25.1 \times 10^6 \text{ J/l} = 1.05 \times 10^{-3} \text{ l/hr}$$

Vented Gas Log Set (LPG)

$$4.22 \times 10^7 \text{ J/hr} / 25.1 \times 10^6 \text{ J/l} = 1.68 \times 10^{-3} \text{ l/hr}$$

5. Annual fuel cost: \$/yr

Cost per fuel unit (\$/fuel unit) X annual fuel use (fuel unit/yr)

Fuel cost:

- Cordwood: \$0.15/kg⁴⁶
- Natural gas: \$0.60/m³⁵⁰
- LPG: \$0.61/l⁴⁹
- Wax/fiber firelogs: \$1.06/kg⁵²⁻⁵³

6. Annualized installation cost: \$/yr⁴²⁻⁴³

Installation and gas plumbing cost; all divided by the unit lifetime

- Vent free gas log set – natural gas: \$1,493 / 12.7 yrs = \$117.90\$/yr
- Vented gas log set – natural gas: \$1,477 / 12.7 yrs = \$116.60/yr
- Vent free gas log set – LPG: \$1,483 / 12.7 yrs = \$116.80/yr
- Vented gas log set – LPG: \$1,467 / 12.7 yrs = \$115.50/yr
- Wax/fiber firelogs: no installation/replacement necessary - \$0/yr

7. Ancillary Costs: sum of a and b per appliance: \$/yr

a) Chimney cleaning – cost per cleaning X cleanings per year = \$/yr⁴⁴

- Fireplace without insert burning cordwood or wax/fiber firelogs: \$150 every 2 years = \$75/yr
- b) Electricity costs - \$0.13/kwh X kw usage X average hours use per year
- Gas log set fan: 0.144 kw X 21 hrs/yr X \$0.13/kw-h = \$0.39/yr

8. Total annual costs: Sum of annual fuel costs, ancillary costs, and annualized installation/replacement costs: \$/yr

9. Cost difference: Total annual cost (new unit) – total annual cost (old unit)

10. Annual pollution reduction cost benefit:

Cost difference (\$/yr) / emissions reduction (g/yr) = \$/g

\$/g X 454 g/lb X 2000 lb/ton = \$/ton

Table 3.5.1
Addition of Log Set or Use of Wax/Fiber Firelog with Existing Fireplace Supporting Information

Scenario	Addition of Log Set or Use of Wax/Fiber Firelog with Existing Fireplace					
Appliance / Fuel Category (unit)	Cordwood Fireplace Used for Aesthetic Purposes	Vent-Free Gas Log Set-Natural Gas	Vented Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG	Vented Gas Log Set-LPG	Wax/Fiber Firelog Fuel
Appliance Usage (hr/yr)	20	20	20	20	20	20
Fuel Usage Rate	4.20 kg/hr	0.69 m ³ /hr**	1.11 m ³ /hr***	1.05 l/hr**	1.68 l/hr***	0.74 kg/hr
Fuel Cost	0.15 \$/kg	0.605 \$/m ³	0.605 \$/m ³	0.612 \$/l	0.612 \$/l	1.061 \$/kg
Annual Fuel Cost (\$/yr)	12.83	8.49	13.66	13.06	20.90	15.97
Annualized Install Cost (\$/yr)	-	117.9	116.8	116.6	115.5	NA
Ancillary Costs (\$/yr)	75.00	0.39	0.39	0.39	0.39	75.00
Total Annual Cost	87.83	126.77	130.85	130.03	136.77	90.97
Cost Difference	-	38.94	43.01	42.19	48.94	3.14

*NA is Not Applicable

**25,000 Btu/hr

***40,000 Btu/hr

Table 3.5.2
Cost Benefit for the Addition of a Log Set or Use of Wax/Fiber Firelog with Existing Fireplaces

Scenario	Addition of Log Set or Use of Wax/Fiber Firelog with Existing Fireplace					
Appliance / Fuel Category	Cordwood Fireplace Used for Aesthetic Purposes	Vent-Free Gas Log Set-Natural Gas	Vented Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG	Vented Gas Log Set-LPG	Wax/Fiber Firelog Fuel
PM (g/hr)	6.43E+01	9.87E-02	1.58E-01	2.21E-01	3.54E-01	9.00E+00
Total PM (g/yr)	1.31E+03	2.01E+00	3.21E+00	4.50E+00	7.20E+00	1.83E+02
PM Reduction (g/yr)	-	1.31E+03	1.30E+03	1.30E+03	1.30E+03	1.12E+03
Annual Cost Benefit PM (\$/g)	-	2.98E-02	3.30E-02	3.24E-02	3.76E-02	2.79E-03
Annual Cost Benefit PM (\$/ton)	-	2.71E+04	2.99E+04	2.94E+04	3.41E+04	2.53E+03
VOC (g/hr)	3.96E+01	7.15E-02	9.71E-02	6.60E-01	1.06E+00	1.22E+01
Total VOC (g/yr)	8.06E+02	1.45E+00	1.98E+00	1.34E+01	2.16E+01	2.48E+02
VOC Reduction (g/yr)	-	8.04E+02	8.04E+02	7.92E+02	7.84E+02	5.58E+02
Annual Cost Benefit VOC (\$/g)	-	4.84E-02	5.35E-02	5.33E-02	6.24E-02	5.63E-03
Annual Cost Benefit VOC (\$/ton)	-	4.39E+04	4.85E+04	4.83E+04	5.66E+04	5.11E+03

Table 3.5.2 continued
 Cost Benefit for the Addition of a Log Set or Use of Wax/Fiber Firelog with Existing Fireplaces

Scenario	Addition of Log Set or Use of Wax/Fiber Firelog with Existing Fireplace					
	Cordwood Fireplace Used for Aesthetic Purposes	Vent-Free Gas Log Set-Natural Gas	Vented Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG	Vented Gas Log Set-LPG	Wax/Fiber Firelog Fuel
CO (g/hr)	3.13E+02	5.54E-01	1.17E+00	1.54E-01	2.46E-01	4.19E+01
Total CO (g/yr)	6.37E+03	1.13E+01	2.38E+01	3.13E+00	5.00E+00	8.52E+02
CO Reduction (g/yr)	-	6.36E+03	6.35E+03	6.37E+03	6.37E+03	5.52E+03
Annual Cost Benefit CO (\$/g)	-	6.12E-03	6.77E-03	6.62E-03	7.68E-03	5.69E-04
Annual Cost Benefit CO (\$/ton)	-	5.55E+03	6.14E+03	6.01E+03	6.97E+03	5.16E+02
NO _x * (g/hr)	6.09E+00	1.10E+00	2.03E+00	1.44E+00	2.29E+00	2.50E+00
Total NO _x (g/yr)	1.24E+02	2.24E+01	4.13E+01	2.93E+01	4.66E+01	5.09E+01
NO _x Reduction (g/yr)	-	1.02E+02	8.26E+01	9.46E+01	7.73E+01	7.30E+01
Annual Cost Benefit NO _x (\$/g)	-	3.84E-01	5.21E-01	4.46E-01	6.33E-01	4.30E-02
Annual Cost Benefit NO _x (\$/ton)	-	3.48E+05	4.72E+05	4.05E+05	5.74E+05	3.90E+04
SO ₂ (g/hr)	8.40E-01	6.10E-03	9.75E-03	9.64E-02	1.54E-01	1.43E+00
Total SO ₂ (g/yr)	1.71E+01	1.24E-01	1.98E-01	1.96E+00	3.13E+00	2.91E+01
SO ₂ Reduction (g/yr)	-	1.70E+01	1.69E+01	1.51E+01	1.40E+01	<1.20E+01>
Annual Cost Benefit SO ₂ (\$/g)	-	2.30E+00	2.55E+00	2.79E+00	3.51E+00	NA
Annual Cost Benefit SO ₂ (\$/ton)	-	2.08E+06	2.31E+06	2.53E+06	3.18E+06	NA

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

4. Average MANE-VU Pollution Reduction Cost Benefit of Improved Technologies and Alternative Fuels

Section 3 provided pollution reduction cost benefit analyses for each of the five existing appliance categories. Due to the many permutations of the data contained in these tables, average MANE-VU pollution reduction cost benefit analyses are included as a summary to provide an overall average of the Section 3 data for the MANE-VU region. Because the Section 3.5 pollution reduction cost benefit table is, in itself, a MANE-VU average, it is repeated with the rest of the MANE-VU tables for completeness.

Table 4.1.1

Cost Benefit for Replacement of an Existing Uncertified Freestanding Cordwood Stove in MANE-VU Region

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove - Natural Gas, B Vent	Gas Stove - Natural Gas, Direct Vent	Gas Stove - Natural Gas, Vent Free	Gas Stove - LPG, B Vent	Gas Stove - LPG, Direct Vent	Gas Stove - LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.26E+04	1.57E+04	1.63E+04	2.80E+03	1.51E+02	1.31E+02	1.00E+02	3.40E+02	2.95E+02	2.26E+02
PM Reduction (g/yr)	-	2.68E+04	2.63E+04	3.98E+04	4.24E+04	4.24E+04	4.25E+04	4.22E+04	4.23E+04	4.23E+04
Annual PM Cost Benefit (\$/g)	-	1.29E-03	3.64E-03	9.88E-03	5.90E-03	3.89E-03	8.32E-04	1.38E-02	1.08E-02	6.06E-03
Annual PM Cost Benefit (\$/ton)	-	1.17E+03	3.30E+03	8.96E+03	5.35E+03	3.53E+03	7.55E+02	1.26E+04	9.76E+03	5.50E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	4.61E+04	2.11E+04	1.67E+04	3.66E+01	9.32E+01	8.07E+01	3.14E+01	1.01E+03	8.78E+02	6.72E+02
VOC Reduction (g/yr)	-	2.50E+04	2.94E+04	4.60E+04	4.60E+04	4.60E+04	4.61E+04	4.51E+04	4.52E+04	4.54E+04
Annual VOC Cost Benefit (\$/g)	-	1.39E-03	3.26E-03	8.53E-03	5.44E-03	3.59E-03	7.67E-04	1.30E-02	1.01E-02	5.65E-03
Annual VOC Cost Benefit (\$/ton)	-	1.26E+03	2.96E+03	7.74E+03	4.94E+03	3.26E+03	6.96E+02	1.18E+04	9.13E+03	5.13E+03
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.97E+05	1.47E+05	1.04E+05	1.46E+04	7.86E+02	6.81E+02	8.09E+02	2.37E+02	2.05E+02	1.57E+02
CO Reduction (g/yr)	-	5.01E+04	9.35E+04	1.83E+05	1.97E+05	1.97E+05	1.97E+05	1.97E+05	1.97E+05	1.97E+05
Annual CO Cost Benefit (\$/g)	-	6.93E-04	1.02E-03	2.15E-03	1.27E-03	8.39E-04	1.80E-04	2.97E-03	2.31E-03	1.30E-03
Annual CO Cost Benefit (\$/ton)	-	6.29E+02	9.29E+02	1.95E+03	1.15E+03	7.61E+02	1.63E+02	2.69E+03	2.09E+03	1.18E+03
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.22E+03	2.38E+03	1.36E+04	3.48E+03	2.14E+03	1.85E+03	1.12E+03	2.21E+03	1.91E+03	1.46E+03
NO _x Reduction (g/yr)	-	8.38E+02	<1.04E+04>	<2.52E+02>	1.08E+03	1.37E+03	2.10E+03	1.02E+03	1.31E+03	1.76E+03
Annual NO _x Cost Benefit (\$/g)	-	4.15E-02	NA	NA	2.31E-01	1.21E-01	1.68E-02	5.76E-01	3.47E-01	1.46E-01
Annual NO _x Cost Benefit (\$/ton)	-	3.76E+04	NA	NA	2.09E+05	1.09E+05	1.52E+04	5.22E+05	3.15E+05	1.32E+05
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.52E+02	4.18E+02	3.89E+02	2.93E+02	9.36E+00	8.11E+00	6.21E+00	1.48E+02	1.28E+02	9.81E+01
SO ₂ Reduction (g/yr)	-	<1.67E+02>	<1.37E+02>	<4.09E+01>	2.42E+02	2.44E+02	2.46E+02	1.04E+02	1.24E+02	1.54E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	1.03E+00	6.78E-01	1.44E-01	5.62E+00	3.68E+00	1.67E+00
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	9.36E+05	6.15E+05	1.31E+05	5.10E+06	3.34E+06	1.51E+06

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 4.1.2
Cost Benefit for the Replacement of an Existing Uncertified Cordwood Fireplace Insert in MANE-VU Region

Scenario	Replacement of an Existing Uncertified Fireplace Insert									
	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
PM (g/input MJ)	8.73E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03
Total PM (g/yr)	4.26E+04	1.54E+04	1.59E+04	2.72E+03	1.49E+02	1.28E+02	9.41E+01	3.34E+02	2.87E+02	2.11E+02
PM Reduction (g/yr)	-	2.71E+04	2.67E+04	3.98E+04	4.24E+04	4.24E+04	4.25E+04	4.22E+04	4.23E+04	4.23E+04
Annual PM Cost Benefit (\$/g)	-	**	**	5.71E-03	2.10E-03	**	**	9.90E-03	6.65E-03	1.54E-03
Annual PM Cost Benefit (\$/ton)	-	**	**	5.18E+03	1.91E+03	**	**	8.98E+03	6.04E+03	1.40E+03
VOC (g/input MJ)	9.45E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02
Total VOC (g/yr)	4.61E+04	2.08E+04	1.63E+04	3.56E+01	9.16E+01	7.85E+01	2.94E+01	9.95E+02	8.53E+02	6.29E+02
VOC Reduction (g/yr)	-	2.53E+04	2.98E+04	4.60E+04	4.60E+04	4.60E+04	4.61E+04	4.51E+04	4.52E+04	4.55E+04
Annual VOC Cost Benefit (\$/g)	-	**	**	4.94E-03	1.94E-03	**	**	9.27E-03	6.22E-03	1.43E-03
Annual VOC Cost Benefit (\$/ton)	-	**	**	4.48E+03	1.76E+03	**	**	8.41E+03	5.64E+03	1.30E+03
CO (g/input MJ)	4.05E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03
Total CO (g/yr)	1.97E+05	1.45E+05	1.02E+05	1.42E+04	7.73E+02	6.62E+02	7.57E+02	2.33E+02	1.99E+02	1.47E+02
CO Reduction (g/yr)	-	5.26E+04	9.59E+04	1.83E+05	1.97E+05	1.97E+05	1.97E+05	1.97E+05	1.97E+05	1.97E+05
Annual CO Cost Benefit (\$/g)	-	**	**	1.24E-03	4.54E-04	**	**	2.12E-03	1.43E-03	3.30E-04
Annual CO Cost Benefit (\$/ton)	-	**	**	1.13E+03	4.12E+02	**	**	1.92E+03	1.29E+03	3.00E+02
NO _x * (g/input MJ)	6.61E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02
Total NO _x (g/yr)	3.22E+03	2.34E+03	1.33E+04	3.38E+03	2.10E+03	1.80E+03	1.05E+03	2.17E+03	1.86E+03	1.37E+03
NO _x Reduction (g/yr)	-	8.79E+02	<1.01E+04>	<1.56E+02>	1.12E+03	1.42E+03	2.17E+03	1.05E+03	1.36E+03	1.85E+03
Annual NO _x Cost Benefit (\$/g)	-	**	NA	NA	7.96E-02	**	**	3.97E-01	2.06E-01	3.52E-02
Annual NO _x Cost Benefit (\$/ton)	-	**	NA	NA	7.22E+04	**	**	3.60E+05	1.87E+05	3.19E+04
SO ₂ (g/input MJ)	5.16E-03	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03
Total SO ₂ (g/yr)	2.52E+02	4.11E+02	3.80E+02	2.85E+02	9.20E+00	7.88E+00	5.81E+00	1.45E+02	1.25E+02	9.18E+01
SO ₂ Reduction (g/yr)	-	<1.59E+02>	<1.28E+02>	<3.27E+01>	2.43E+02	2.44E+02	2.46E+02	1.06E+02	1.27E+02	1.60E+02
Annual SO ₂ Cost Benefit (\$/g)	-	NA	NA	NA	3.68E-01	**	**	3.93E+00	2.21E+00	4.07E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	NA	NA	NA	3.34E+05	**	**	3.56E+06	2.00E+06	3.69E+05

* NO_x - Total nitrogen oxides reported as NO₂

<> represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 4.1.3

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in MANE-VU Region

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
PM (g/input MJ)	7.90E-01	3.88E-01	4.32E-01	7.97E-02	3.74E-03	3.74E-03	3.74E-03	8.40E-03	8.40E-03	8.40E-03	3.74E-03	8.40E-03
Total PM (g/yr)	2.00E+04	2.95E+03	3.03E+03	5.19E+02	2.84E+01	2.44E+01	1.80E+01	6.39E+01	5.47E+01	4.03E+01	1.80E+01	4.03E+01
PM Reduction (g/yr)	-	1.71E+04	1.70E+04	1.95E+04	2.00E+04	2.00E+04	2.00E+04	2.00E+04	2.00E+04	2.00E+04	2.00E+04	2.00E+04
Annual PM Cost Benefit (\$/g)	-	4.27E-03	6.25E-03	9.18E-03	**	**	**	2.07E-03	7.66E-04	**	**	**
Annual PM Cost Benefit (\$/ton)	-	3.88E+03	5.67E+03	8.33E+03	**	**	**	1.88E+03	6.95E+02	**	**	**
VOC (g/input MJ)	4.87E-01	5.22E-01	4.44E-01	1.04E-03	2.30E-03	2.30E-03	1.17E-03	2.50E-02	2.50E-02	2.50E-02	2.71E-03	2.50E-02
Total VOC (g/yr)	1.23E+04	3.97E+03	3.12E+03	6.79E+00	1.75E+01	1.50E+01	5.62E+00	1.90E+02	1.63E+02	1.20E+02	1.30E+01	1.20E+02
VOC Reduction (g/yr)	-	8.38E+03	9.22E+03	1.23E+04	1.23E+04	1.23E+04	1.23E+04	1.22E+04	1.22E+04	1.22E+04	1.23E+04	1.22E+04
Annual VOC Cost Benefit (\$/g)	-	8.71E-03	1.15E-02	1.45E-02	**	**	**	3.41E-03	1.26E-03	**	**	**
Annual VOC Cost Benefit (\$/ton)	-	7.90E+03	1.04E+04	1.32E+04	**	**	**	3.09E+03	1.14E+03	**	**	**
CO (g/input MJ)	3.85E+00	3.64E+00	2.76E+00	4.17E-01	1.94E-02	1.94E-02	3.01E-02	5.84E-03	5.84E-03	5.84E-03	2.10E-02	5.84E-03
Total CO (g/yr)	9.76E+04	2.76E+04	1.94E+04	2.72E+03	1.47E+02	1.26E+02	1.45E+02	4.44E+01	3.81E+01	2.80E+01	1.01E+02	2.80E+01
CO Reduction (g/yr)	-	7.00E+04	7.82E+04	9.49E+04	9.75E+04	9.75E+04	9.75E+04	9.76E+04	9.76E+04	9.76E+04	9.75E+04	9.76E+04
Annual CO Cost Benefit (\$/g)	-	1.04E-03	1.36E-03	1.89E-03	**	**	**	4.24E-04	1.57E-04	**	**	**
Annual CO Cost Benefit (\$/ton)	-	9.45E+02	1.23E+03	1.71E+03	**	**	**	3.85E+02	1.42E+02	**	**	**
NO _x * (g/input MJ)	7.49E-02	5.89E-02	3.62E-01	9.90E-02	5.28E-02	5.28E-02	4.17E-02	5.45E-02	5.45E-02	5.45E-02	4.16E-02	5.45E-02
Total NO _x (g/yr)	1.90E+03	4.48E+02	2.54E+03	6.45E+02	4.01E+02	3.44E+02	2.00E+02	4.14E+02	3.55E+02	2.62E+02	2.00E+02	2.62E+02
NO _x Reduction (g/yr)	-	1.45E+03	<6.39E+02>	1.25E+03	1.50E+03	1.55E+03	1.70E+03	1.48E+03	1.54E+03	1.64E+03	1.70E+03	1.64E+03
Annual NO _x Cost Benefit (\$/g)	-	5.03E-02	NA	1.43E-01	**	**	**	2.79E-02	9.91E-03	**	**	**
Annual NO _x Cost Benefit (\$/ton)	-	4.56E+04	NA	1.30E+05	**	**	**	2.53E+04	8.99E+03	**	**	**

Table 4.1.3 continued

Cost Benefit for the Installation of an Insert or Gas Log Set into an Existing Cordwood Fireplace without Insert Used for Heating in MANE-VU Region

Scenario	Addition of an Insert or Gas Log-Set into an Existing Fireplace without Insert Used for Heating											
Appliance/Fuel Category	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
SO ₂ (g/input MJ)	1.03E-02	1.03E-02	1.03E-02	8.34E-03	2.31E-04	2.31E-04	2.31E-04	3.65E-03	3.65E-03	3.65E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	2.62E+02	7.85E+01	7.25E+01	5.43E+01	1.76E+00	1.51E+00	1.11E+00	2.77E+01	2.38E+01	1.75E+01	1.11E+00	1.75E+01
SO ₂ Reduction (g/yr)	-	1.83E+02	1.89E+02	2.07E+02	2.60E+02	2.60E+02	2.61E+02	2.34E+02	2.38E+02	2.44E+02	2.61E+02	2.44E+02
Annual SO ₂ Cost Benefit (\$/g)	-	3.98E-01	5.61E-01	8.63E-01	**	**	**	1.77E-01	6.43E-02	**	**	**
Annual SO ₂ Cost Benefit (\$/ton)	-	3.61E+05	5.09E+05	7.83E+05	**	**	**	1.61E+05	5.83E+04	**	**	**

* NO_x - Total nitrogen oxides reported as NO₂

< > represents an increase in pollutant

** : Since the annual total cost of high technology and/or alternative fuel is less than that of the existing device, there is no cost associated with the pollutant reduction.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 4.1.4
 Cost Benefit for the Replacement of an Existing Centralized Cordwood Heating System in
 MANE-VU Region

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
	Centralized Cordwood Heating Systems (Furnaces and Boilers)	Pellet Furnaces and Boilers	Gas Furnaces and Boilers-Natural Gas	Gas Furnaces and Boilers-LPG
PM (g/input MJ)	7.13E-01	7.90E-02	3.74E-03	8.40E-03
Total PM (g/yr)	7.10E+04	4.93E+03	2.22E+02	4.98E+02
PM Reduction (g/yr)	-	6.60E+04	7.07E+04	7.05E+04
Annual PM Cost Benefit (\$/g)	-	8.61E-03	3.33E-03	1.03E-02
Annual PM Cost Benefit (\$/ton)	-	7.81E+03	3.03E+03	9.37E+03
VOC (g/input MJ)	3.02E-01	1.03E-03	2.30E-03	2.50E-02
Total VOC (g/yr)	3.01E+04	6.43E+01	1.36E+02	1.48E+03
VOC Reduction (g/yr)	-	3.00E+04	2.99E+04	2.86E+04
Annual VOC Cost Benefit (\$/g)	-	1.89E-02	7.88E-03	2.54E-02
Annual VOC Cost Benefit (\$/ton)	-	1.72E+04	7.15E+03	2.31E+04
CO (g/input MJ)	4.74E+00	4.13E-01	1.73E-02	5.84E-03
Total CO (g/yr)	4.72E+05	2.58E+04	1.02E+03	3.46E+02
CO Reduction (g/yr)	-	4.46E+05	4.71E+05	4.72E+05
Annual CO Cost Benefit (\$/g)	-	1.27E-03	5.01E-04	1.54E-03
Annual CO Cost Benefit (\$/ton)	-	1.16E+03	4.54E+02	1.40E+03
NO _x * (g/input MJ)	4.75E-02	9.81E-02	4.53E-02	5.45E-02
Total NO _x (g/yr)	4.73E+03	6.12E+03	2.68E+03	3.23E+03
NO _x Reduction (g/yr)	-	<1.39E+03>	2.05E+03	1.50E+03
Annual NO _x Cost Benefit (\$/g)	-	NA	1.15E-01	4.84E-01
Annual NO _x Cost Benefit (\$/ton)	-	NA	1.05E+05	4.39E+05
SO ₂ (g/input MJ)	5.22E-02	8.26E-03	2.31E-04	3.65E-03
Total SO ₂ (g/yr)	5.19E+03	5.15E+02	1.37E+01	2.16E+02
SO ₂ Reduction (g/yr)	-	4.68E+03	5.18E+03	4.98E+03
Annual SO ₂ Cost Benefit (\$/g)	-	1.21E-01	4.55E-02	1.46E-01
Annual SO ₂ Cost Benefit (\$/ton)	-	1.10E+05	4.13E+04	1.33E+05

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

Table 4.1.5
Cost Benefit for the Addition of a Log Set or Use of Wax/Fiber Firelog with Existing Fireplaces

Scenario	Addition of Log Set or Use of Wax/Fiber Firelog with Existing Fireplace					
	Cordwood Fireplace Used for Aesthetic Purposes	Vent-Free Gas Log Set-Natural Gas	Vented Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG	Vented Gas Log Set-LPG	Wax/Fiber Firelog Fuel
PM (g/hr)	6.43E+01	9.87E-02	1.58E-01	2.21E-01	3.54E-01	9.00E+00
Total PM (g/yr)	1.31E+03	2.01E+00	3.21E+00	4.50E+00	7.20E+00	1.83E+02
PM Reduction (g/yr)	-	1.31E+03	1.30E+03	1.30E+03	1.30E+03	1.12E+03
Annual Cost Benefit PM (\$/g)	-	2.98E-02	3.30E-02	3.24E-02	3.76E-02	2.79E-03
Annual Cost Benefit PM (\$/ton)	-	2.71E+04	2.99E+04	2.94E+04	3.41E+04	2.53E+03
VOC (g/hr)	3.96E+01	7.15E-02	9.71E-02	6.60E-01	1.06E+00	1.22E+01
Total VOC (g/yr)	8.06E+02	1.45E+00	1.98E+00	1.34E+01	2.16E+01	2.48E+02
VOC Reduction (g/yr)	-	8.04E+02	8.04E+02	7.92E+02	7.84E+02	5.58E+02
Annual Cost Benefit VOC (\$/g)	-	4.84E-02	5.35E-02	5.33E-02	6.24E-02	5.63E-03
Annual Cost Benefit VOC (\$/ton)	-	4.39E+04	4.85E+04	4.83E+04	5.66E+04	5.11E+03
CO (g/hr)	3.13E+02	5.54E-01	1.17E+00	1.54E-01	2.46E-01	4.19E+01
Total CO (g/yr)	6.37E+03	1.13E+01	2.38E+01	3.13E+00	5.00E+00	8.52E+02
CO Reduction (g/yr)	-	6.36E+03	6.35E+03	6.37E+03	6.37E+03	5.52E+03
Annual Cost Benefit CO (\$/g)	-	6.12E-03	6.77E-03	6.62E-03	7.68E-03	5.69E-04
Annual Cost Benefit CO (\$/ton)	-	5.55E+03	6.14E+03	6.01E+03	6.97E+03	5.16E+02
NO _x * (g/hr)	6.09E+00	1.10E+00	2.03E+00	1.44E+00	2.29E+00	2.50E+00
Total NO _x (g/yr)	1.24E+02	2.24E+01	4.13E+01	2.93E+01	4.66E+01	5.09E+01
NO _x Reduction (g/yr)	-	1.02E+02	8.26E+01	9.46E+01	7.73E+01	7.30E+01
Annual Cost Benefit NO _x (\$/g)	-	3.84E-01	5.21E-01	4.46E-01	6.33E-01	4.30E-02
Annual Cost Benefit NO _x (\$/ton)	-	3.48E+05	4.72E+05	4.05E+05	5.74E+05	3.90E+04
SO ₂ (g/hr)	8.40E-01	6.10E-03	9.75E-03	9.64E-02	1.54E-01	1.43E+00
Total SO ₂ (g/yr)	1.71E+01	1.24E-01	1.98E-01	1.96E+00	3.13E+00	2.91E+01
SO ₂ Reduction (g/yr)	-	1.70E+01	1.69E+01	1.51E+01	1.40E+01	<1.20E+01>
Annual Cost Benefit SO ₂ (\$/g)	-	2.30E+00	2.55E+00	2.79E+00	3.51E+00	NA
Annual Cost Benefit SO ₂ (\$/ton)	-	2.08E+06	2.31E+06	2.53E+06	3.18E+06	NA

* NO_x - Total nitrogen oxides reported as NO₂.

<> represents an increase in pollutant.

NA = Not Applicable since the amount of pollutant increased, there is no pollutant benefit after changing appliances.

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Appendix A

State and Local Residential Wood Combustion Air Quality Regulations

State and Local Residential Wood Combustion Air Quality Regulations

Table of Contents

Arizona

1. Maricopa County

Bi-State (California and Nevada)

2. Tahoe Regional Planning Agency

California

3. Bay Area Air Quality Management District
4. Butte County Air Quality Management District
5. Feather River Air Quality Management District
6. Glenn County Air Pollution Control District
7. Great Basin Unified Pollution Control District
8. Kern County Air Pollution Control District
9. Placer County
10. San Joaquin Valley Unified Air Pollution Control District
11. San Luis Obispo County Air Pollution Control District
12. Shasta County Air Quality Management District
13. Yolo-Solano Air Quality Management District

Colorado

14. State of Colorado
15. City of Aspen and Pitkin County
16. City of Fort Collins
(with discussions on RWC regulations in the State of Colorado, Larimer County, Poudre Fire Authority, City and County of Denver, Weld County/Greeley, Loveland, Boulder, El Paso County/Colorado Springs, Mesa County, Grand Junction, Fruita, and Telluride)

Montana

17. Lincoln County
18. Missoula County

Nevada

19. Clark County
20. Washoe County

Oregon

21. State of Oregon

Washington

22. State of Washington

Maricopa County

MARICOPA COUNTY

Adopted 10/05/94

Revised 04/21/99

Revised 11/17/99

RESIDENTIAL WOODBURNING RESTRICTION ORDINANCE

SECTION 1 - GENERAL

A. PURPOSE: The Residential Woodburning Restriction Ordinance restricts residential woodburning in a non-approved device when monitoring or forecasting indicates that the carbon monoxide (CO) standard and/or the particulate matter no-burn standard are likely to be exceeded.

B. APPLICABILITY: The Residential Woodburning Restriction Ordinance applies to any residential woodburning device in sections of Area A that are within Maricopa County or within incorporated cities and towns in such sections.

SECTION 2 - DEFINITIONS: For the purpose of this ordinance, the following definitions shall apply:

A. ADEQUATE SOURCE OF HEAT - A permanently installed furnace or heating system, connected to or disconnected from its energy source, designed to heat utilizing oil, natural gas, electricity, or propane, and designed to maintain a minimum of 70° Fahrenheit at a point three feet above the floor in all normally inhabited areas of a residence.

B. APPROVED WOODBURNING DEVICE - The following residential devices shall be approved woodburning devices, even though such devices may burn a solid fuel other than wood:

1. A device that has been certified by the Environmental Protection Agency (EPA) as conforming to Phase II EPA Standards Of Performance For Wood Heaters in 40 Code Of Federal Regulations (CFR) 60, Subpart AAA as amended through July 1, 1998.
2. Any pellet stove.
3. Any gas burning hearth appliances, including a dedicated gas logset permanently installed in any kind of woodburning fireplace.
4. Any masonry heater or any other solid fuel burning device that meets performance standards that are equivalent to the standards in 40 CFR 60, Subpart AAA as amended through July 1, 1998, and that is approved by the Control Officer and the Administrator of EPA.

C. AREA A - As defined in Arizona Revised Statutes (ARS) §49-541(1), the area in Maricopa County delineated as follows:

Township 8 North, Range 2 East and Range 3 East
Township 7 North, Range 2 West through Range 5 East
Township 6 North, Range 2 West through Range 6 East
Township 5 North, Range 2 West through Range 7 East
Township 4 North, Range 2 West through Range 8 East
Township 3 North, Range 2 West through Range 8 East
Township 2 North, Range 2 West through Range 8 East
Township 1 North, Range 2 West through Range 7 East
Township 1 South, Range 2 West through Range 7 East
Township 2 South, Range 2 West through Range 7 East

D. BURN DOWN PERIOD - That period of time, not to exceed three hours after declaring a restricted-burn period, required for the cessation of combustion within any residential woodburning device by withholding fuel or by modifying the air-to-fuel ratio.

- E. CARBON MONOXIDE (CO) STANDARD** - The maximum allowable eight-hour concentration that is nine parts of contaminant per million parts of air by volume (ppm).
- F. CHIMNEY** - A passage for smoke that is usually made of bricks, stone, or metal and often rises two feet above the roof of a building. An approved, factory-built chimney will have a label on each chimney connector and gas vent specifying that such chimney can be used for all fuels and will show the minimum safe clearances to combustibles.
- G. INAPPROPRIATE FUEL** - Includes, but is not limited to, leaves, grass clippings, green plants, refuse, paper, rubbish, books, magazines, fiberboard, packaging, rags, fabrics, animal waste, animal carcasses, coal, waste oil, liquid or gelatinous hydrocarbons, tar, asphaltic products, waste petroleum products, paints and solvents, chemically soaked wood, wood with a moisture content of greater than 30 percent, treated wood, plastic or plastic products, rubber or rubber products, office records, sensitive or classified wastes, or any substance which normally emits dense smoke or obnoxious odors other than paper to start the fire or properly seasoned wood.
- H. NONATTAINMENT AREA** - An area so designated by the Administrator of the EPA, acting pursuant to Section 107 of the Clean Air Act, as exceeding national primary or secondary ambient air standards for a particular pollutant or pollutants.
- I. PARTICULATE MATTER NO-BURN STANDARD** - The maximum allowable 24-hour concentration that is 120 micrograms per cubic meter.
- J. PARTICULATE MATTER STANDARD** - The maximum allowable 24-hour concentration that is 150 micrograms per cubic meter.
- K. RESIDENTIAL WOODBURNING DEVICE** - A device designed for solid fuel combustion so that usable heat is derived for the interior of a residence. Residential woodburning devices do not include barbecue devices, fire pits, or mesquite grills.
- L. RESTRICTED-BURN PERIOD** - A condition declared by the Control Officer whenever meteorological conditions are conducive to an accumulation of CO and/or particulate matter in exceedance of the standards or when air quality reaches other limits established by the Control Officer.
- M. SOLE SOURCE OF HEAT** - One or more residential woodburning devices which constitute the only source of heat in a residence and/or the sole source of fuel for cooking for a residence. No residential woodburning device shall be considered the sole source of heat if the residence is equipped with a permanently installed furnace or heating system which utilizes oil, natural gas, electricity, or propane and which is designed to heat the residence whether or not such furnace or heating system is connected to or disconnected from its energy source. However, this definition shall not supersede County Building Code requirements.

SECTION 3 - RESTRICTED-BURN PERIODS

A. RESTRICTED OPERATION OF A RESIDENTIAL WOODBURNING DEVICE:

During a declared restricted-burn period from October 1 through February 29, a person shall be restricted from operating a residential woodburning device in sections of Area A that are within Maricopa County or within incorporated cities and towns in such sections. Exemptions to this requirement are described in Section 3(C) (Lawful Operation Of Specified Residential Woodburning Devices) of this ordinance.

B. UNLAWFUL OPERATION OF A RESIDENTIAL WOODBURNING DEVICE:

1. A person shall not operate a residential woodburning device such that emissions to the atmosphere from the chimney, flue, or exhaust duct are visible during a restricted-burn period declared by the Control Officer.
2. A person shall not operate a residential woodburning device unless such device has been installed according to the instructions and restrictions specified by the manufacturer.
3. A person shall not use a fuel in a residential woodburning device except

those fuels that are recommended by the manufacturer.

4. A person shall not burn inappropriate fuel in a residential woodburning device.

C. LAWFUL OPERATION OF SPECIFIED RESIDENTIAL WOODBURNING DEVICES:

1. During a declared restricted-burn period from October 1 through February 29, a person may operate a residential woodburning device if the Control Officer has issued an exemption for such device according to Section 4 of this ordinance and if no visible emissions to the atmosphere are produced after 20 consecutive minutes immediately following an ignition of or a refueling of such residential woodburning device.

2. During a declared restricted-burn period from October 1 through February 29, a person may operate a residential woodburning device if such device meets the requirements of Maricopa County Air Pollution Control Regulations Rule 318 (Approval Of Residential Woodburning Devices) and if no visible emissions to the atmosphere are produced after 20 consecutive minutes immediately following an ignition of or a refueling of such residential woodburning device.

D. DECLARATION OF A RESTRICTED-BURN PERIOD: The Control Officer shall declare a restricted-burn period if, after reviewing available meteorological data, atmospheric conditions, and ambient temperatures, the Control Officer determines that air pollution levels could exceed the carbon monoxide (CO) standard and/or the particulate matter no-burn standard. A person responsible for a residential woodburning device, excluding those devices described in Section 3(C) of this ordinance, already in operation at the time a restricted-burn period is declared shall withhold new fuel from the residential woodburning device for the duration of the restricted-burn period. Any person operating or in control of a residential woodburning device in sections of Area A that are within Maricopa County and within incorporated cities and towns in such sections has a duty to know when a restricted-burn period has been declared.

And in accordance with ARS §11-871(C):

1. When the Control Officer has reasonable cause to believe that any person has violated or is in violation of any provision of this ordinance, the Control Officer shall issue, for the first violation of this ordinance, a warning notice which includes a summary of the Maricopa County Residential Woodburning Restriction Ordinance and information on proper woodburning techniques.

2. The Control Officer may impose a civil penalty of \$50 for the second violation of this ordinance to any person who violates this ordinance within a one year period after having been issued a warning notice for the first violation of this ordinance. In addition, the Control Officer may impose a civil penalty of \$100 for the third and subsequent violations of this ordinance. After having been issued a citation for a violation of this ordinance, the violation may be refuted by demonstration that the smoke was not caused by a residential woodburning device or by proof of an exemption pursuant to Section 4 of this ordinance.

3. Only those violations of this ordinance which have occurred within one year of a present offense shall be considered as prior violations. No person shall be cited for a violation of this ordinance more than once in any calendar day. Each day of violation constitutes a separate offense.

SECTION 4 - EXEMPTIONS

A. RESIDENTIAL SOLE SOURCE OF HEAT EXEMPTION: The Control Officer may grant a residential sole source of heat exemption if the Control Officer determines that a residential woodburning device meets the criteria of sole source of heat as described in Section 2(M) of this ordinance. The recipient of a residential sole source of heat exemption must apply annually to the Control Officer for renewal of such exemption, if such exemption is still

necessary. The Control Officer shall not issue a residential sole source of heat exemption after December 31, 1995. However, the Control Officer may renew a residential sole source of heat exemption if such exemption was issued before December 31, 1995 and if the residential woodburning device meets the criteria of sole source of heat as described in Section 2(M) of this ordinance.

B. TEMPORARY SOLE SOURCE OF HEAT EXEMPTION: The Control Officer may issue a temporary sole source of heat exemption for economic or health reasons if the Control Officer determines that the applicant qualifies for financial assistance, according to the economic guidelines established under the Food Stamps, Medicaid, or low income energy assistance programs, as administered by the Income Support Division, or if the Control Officer determines that failure to grant a temporary sole source of heat exemption would endanger the health of the applicant. A temporary sole source of heat exemption shall not be issued for more than 150 days.

C. EMERGENCY EXEMPTION: The Control Officer may issue an emergency exemption if the Control Officer determines that an emergency situation exists. An emergency exemption shall be valid for a period determined by the Control Officer, but shall not exceed one year from the date it is issued. An emergency situation shall include, but is not limited to, the following:

1. A situation where a person demonstrates that his heating system, other than a residential woodburning device, is inoperable for reasons other than his own actions; or
2. A situation where a person demonstrates that his heating system has been involuntarily disconnected by a utility company or other fuel supplier.

D. INADEQUATE ALTERNATE SOURCE OF HEAT EXEMPTION: The Control Officer may issue an inadequate alternate source of heat exemption if the Control Officer determines:

1. That there is a heat source other than a residential woodburning device available to the residence;
2. That such heat source is not a sole source of heat, as defined in Section 2(L) of this ordinance, and that such heat source is used in conjunction with a residential woodburning device;
3. That such heat source is not an approved woodburning device, as defined in Maricopa County Air Pollution Control Regulations Rule 318 (Approval Of Residential Woodburning Devices); and
4. That such heat source is not an adequate source of heat, as defined in Section 2(A) of this ordinance.

Tahoe Regional Planning Agency

Chapter 91

AIR QUALITY CONTROL §

Chapter Contents

91.0 Purpose

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91.2 Vehicle Inspection and Maintenance Program

91.3 Combustion Appliances

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91.7 Idling Restrictions

91.0 Purpose: This chapter aids the implementation of the Air Quality Subelement, Land Use Element, of the Goals and Policies, and the 1992 Air Quality Plan, for the purpose of attaining and maintaining applicable state and federal air quality standards and TRPA thresholds.

91.1 Applicability: The provisions of this chapter apply to direct sources of air pollution in the Tahoe Region, including certain motor vehicles registered in the Region, combustion heaters installed in the Region, open burning, stationary sources of air pollution, and idling combustion engines.

91.2 Vehicle Inspection And Maintenance Program: TRPA adopted an inspection/maintenance program for certain vehicles registered in the carbon monoxide (CO) non-attainment area as a CO control measure in the 1992 Air Quality Plan. The California Air Resources Board included this provision in its official State Implementation Plan (SIP). To avoid duplication of effort in implementation of an inspection/maintenance program, TRPA shall work with the affected state agencies to plan for the application of state inspection/maintenance programs to the Tahoe Region. Before TRPA requests the states to implement an inspection/ maintenance program in the Tahoe Region, TRPA will determine what the expected benefits from such a program are, based on the latest available scientific information.

91.3 Combustion Appliances: The following air quality standards shall be met by combustion appliances.

91.3.A Gas Heaters: The following standards apply to natural gas or propane-fired water heaters or central furnaces to be installed in the Region.

- (1) Emission Standards: Natural gas or propane-fired water heaters or central furnaces installed in the Region shall meet the following emission standards:
 - (a) Water heaters shall not emit greater than 40 nanograms of nitrogen oxide (as NO₂) per joule of heat output. Water heaters installed in mobile homes shall not emit greater than 50 nanograms of nitrogen oxide (as NO₂) per joule (80 lb per billion But) of heat output.
 - (b) Central furnaces shall not emit greater than 40 nanograms of nitrogen oxide (as NO₂) per joule of useful heat delivered to the heated space.
 - (c) Central furnaces with rated input of 175,000 But or greater, combination units with a cooling rate of greater than 65,000 But per hour, and water heaters with a rated heat input of 75,000 But or greater, shall be reviewed under the standards contained in Section 91.5.
- (2) List of Approved Heaters: TRPA shall maintain a list of gas heaters that are in compliance with the air quality standards in Subparagraph 91.3.A(1). The list shall include the names and model numbers of the heaters. A heater certified by the South Coast Air Quality Management District of California under SCHEMED Rules 1111 and 1121 shall be considered in compliance with Subparagraph 91.3.A.(1).
- (3) Exemptions: The requirements of Subsection 91.3.A shall not apply to the following:

- (a) Decorative gas appliances certified under ANSI Standard Z21.50.
- (b) Gas central furnaces installed in mobile homes or gas heaters installed in recreational vehicles.
- (c) Wall mounted gas heaters, other than water heaters, that are not central furnaces as defined in Section 2.2.

91.3.B Wood Heaters: The sale of wood heaters which do not meet the emission standards of this subsection is prohibited in the Tahoe Region. Wood heaters to be installed, in the Region, either as new or replacement units, shall meet the requirements of this subsection. Coal shall not be used as a fuel source.

- (1) Emission Standards: Wood heaters installed in the Region shall meet the following emission standards for total suspended particulates of smoke emissions:
 - (a) Catalytic wood heaters shall not cause emissions of greater than 5.5 grams per hour. Following July 1, 1990, catalytic wood heaters shall not cause emissions of more than 4.1 grams per hour.
 - (b) Non-catalytic wood heaters shall not cause emissions of greater than 9.0 grams per hour. Following July 1, 1990, non-catalytic wood heaters shall not cause emissions of more than 7.5 grams per hour.
 - (c) Wood heaters certified to meet the above standards by the U.S. EPA under 40 CFR Part 60 or the Oregon Woodstove Certification Program, shall be deemed in compliance with the above standards. Pellet fueled wood heaters labeled as exempt from 40 CFR Part 60 shall be deemed in compliance with the above standards.
- (2) Limitations: Wood heaters shall be sized appropriately for the space they are designed to serve. Multi-residential projects of five or more units, tourist accommodations, commercial, recreation and public service projects shall be limited to one wood heater per project area.
- (3) Wood Heater Retrofit Program: Effective January 1, 1993, prior to any sale, transfer or conveyance of any building, all existing wood heaters in the building, excluding legally existing open fireplaces which are not primary heat sources, shall be in conformance with the emission standards contained in subsection 91.3.B.
 - (a) Compliance with this section shall be evidenced by a statement of the seller made under penalty of perjury, on a form provided by TRPA, that all existing wood heaters in the building, excluding legally existing open fireplaces which are not primary heat sources, either conform to the emission standards in subsection 91.3.B or have been replaced with conforming units, or that the structure does not contain any existing wood heaters. The statement shall be submitted to TRPA prior to the sale, transfer or conveyance.
 - (b) A statement of wood heater conformance shall be required for any subsequent sales, transfers or conveyances.

Bay Area Air Quality Management District

A MODEL ORDINANCE PERTAINING
TO THE REDUCTION OF AIR POLLUTION BY REGULATING THE
NEW CONSTRUCTION OR REPLACEMENT OF WOODBURNING APPLIANCES
BE IT ORDAINED BY the City or County of

[]:

WHEREAS, the State Air Resources Board (ARB) adopted a particulate matter (PM10) Ambient Air Quality Standard (AAQS) in December, 1982, and levels for the PM10 AAQS were selected pursuant to California Code of Regulations Title 17 Section 70200 to protect the health of people who are sensitive to exposure to fine particles; and

WHEREAS, research indicates that woodsmoke is a significant contributor to PM10 levels that pose significant health risks; and

WHEREAS, the [] desires to lessen the risk to life and property from air pollution from woodburning appliances; and

WHEREAS, the [] finds that the proposed regulation will significantly reduce the increase in particulate emissions from future installation and construction activities; and,

WHEREAS, the [] finds a need exists to adopt regulations which apply to woodburning combustion emissions; and

The [] Code shall be amended by adding the following:

APPLICABILITY: This ordinance shall apply within the limits of the [city, county] of [] as specified herein.

All wood burning appliances installed in new residential units or woodburning appliances being added to or replacing woodburning appliances in existing residential units shall comply with this ordinance. All woodburning appliances installed in new commercial buildings or woodburning appliances being added to or replacing woodburning appliance in existing commercial buildings shall comply with this ordinance. Commercial buildings shall include, but not be limited to, hotels and restaurants. Gas fireplaces shall be exempt from this ordinance. However, the conversion of a gas fireplace to burn wood shall constitute the installation of a woodburning appliance and shall be subject to the requirements of this ordinance. A woodburning appliance shall comply with this ordinance if (1) it is reconstructed, (2) additions, alterations, or repairs are made to the appliance that require opening up immediately-adjacent walls, or (3) the residential unit or commercial building in which the appliance is located is renovated, and the renovation includes opening up walls immediately adjacent to the appliance.

DEFINITIONS:

1. "Bay Area Air Quality Management District" means the air quality agency for the San Francisco Bay Area pursuant to California Health and Safety Code Section 40200.
2. "E.P.A." means United States Environmental Protection Agency.
3. "E.P.A. certified wood heater" means any wood heater that meets the standards in Title 40, Part 60, Subpart AAA, Code of Federal Regulations in effect at the time of installation and is certified and labeled pursuant to those regulations.
4. "Fireplace" means any permanently installed masonry or factory-built woodburning

appliance, except a pellet-fueled wood heater, designed to be used with an air-to-fuel ratio greater than or equal to 35 to 1.

5. "Garbage means all solid, semi-solid and liquid wastes generated from residential, commercial and industrial sources, including trash, refuse, rubbish, industrial wastes, asphaltic products, manure, vegetable or animal solids and semi-solid wastes, and other discarded solid and semi-solid wastes.
6. "Gas fireplace" means any device designed to burn natural gas in a manner that simulates the appearance of a woodburning fireplace.
7. "Paints" means all exterior and interior house and trim paints, enamels, varnishes, lacquers, stains, primers, sealers, undercoatings, roof coatings, wood preservatives, shellacs, and other paints or paint-like products.
8. "Paints solvents" means all original solvents sold or used to thin paints or to clean up painting equipment.
9. "Pellet-fueled wood heater" means any woodburning appliance that operates exclusively on wood pellets.
10. "Solid fuel" means wood or any other non-gaseous or non-liquid fuel.
11. "Treated wood" means wood of any species that has been chemically impregnated, painted or similarly modified to improve resistance to insects or weathering.
12. "Waste petroleum products" means any petroleum product other than gaseous fuels that has been refined from crude oil, and has been used, and as a result of use, has been contaminated with physical or chemical impurities.
13. "Woodburning appliance" means fireplace, wood heater, or pellet-fired wood heater or any similar device burning any solid fuel used for aesthetic or space-heating purposes.

GENERAL REQUIREMENTS: It shall be unlawful to:

1. Use any woodburning appliance when the Bay Area Air Quality Management District issues a "Spare the Air Tonight" warning and when an alternate approved heat source is available.
2. Install a woodburning appliance that is not one of the following: (1) a pellet-fueled wood heater, (2) an EPA certified wood heater, or, (3) a fireplace certified by EPA should EPA develop a fireplace certification program.
3. Use any of the following prohibited fuels in a woodburning appliance.
 - a) Garbage g) Paint solvents
 - b) Treated wood h) Coal
 - c) Plastic products I) Glossy or colored papers
 - d) Rubber products j) Particle board
 - e) Waste petroleum products k) Salt water driftwood
 - f) Paints

Any person violating any of the provisions of this Ordinance shall be deemed guilty of a misdemeanor and upon conviction shall be punishable as provided by law.

IF ANY SECTION, subsection, sentence, clause or phrase or word of this ordinance is for any reason held to be unconstitutional by a court of competent jurisdiction, such decision shall not affect the validity of the remaining portions of this ordinance. The [] of the [] hereby declares

that it would have passed and adopted this ordinance and all provisions thereof irrespective of the fact that any one or more of said provision be declared unconstitutional.

Butte County Air Quality Management District

BUTTE COUNTY AIR QUALITY MANAGEMENT DISTRICT

RULE 207 - RESIDENTIAL WOOD COMBUSTION

(Adopted October 25, 2001; Recodified August 22, 2002)

RULE 207 CONTENTS

1. APPLICABILITY
2. DEFINITIONS
3. REQUIREMENTS
4. EXEMPTIONS
5. TEST METHODS
6. DISTRICT-APPROVED DEVICES

RULE 207

1 APPLICABILITY: This Rule shall apply within the boundaries of Butte County to any person who owns, operates, installs, builds, inspects, sells or offers for sale a wood burning device for any dwelling unit as defined herein.

2 DEFINITIONS

2.1 Coal means any of the natural, rocklike, burnable solid, brown to black derivatives of forest-type plant material usually accumulated in peat beds, including anthracite, bituminous, and lignite varieties.

2.2 Consumer means any person other than a distributor or a retailer who buys a wood burning device.

2.3 Dwelling Unit means any building or portion thereof, which contains living facilities, including provisions for sleeping, eating, cooking and sanitation. For the purpose of this Rule, dwelling unit includes single and multi-family residences, mobile and/or modular homes, hotels, motels and other similar occupancies.

2.4 EPA means the United States Environmental Protection Agency.

2.5 EPA-accredited laboratory means a laboratory as specified by Title 40, Code of Federal Regulations, Subpart AAA (Standards of Performance for New Residential Wood Heaters), Section 60.535

2.6 EPA-Certified Wood Burning Device means any wood burning device that meets the performance and emission standards set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988.

2.7 Freestanding Fireplace means any wood burning device other than a wood heater that is not inset into the walls of a structure, and vents smoke via a flue pipe through the wall or roof of the structure.

2.8 Fireplace means any permanently installed masonry or factory built wood burning device with an open front or glass door and which does not meet the definition of a wood heater.

2.9 Fireplace Insert means any wood heater designed to be installed in an existing masonry or factory-built fireplace.

2.10 Garbage means all solid, semisolid, and liquid wastes generated from residential, commercial, and industrial sources, including trash, refuse, rubbish, industrial wastes, asphaltic products, manure, vegetable or animal matter, and other discarded solid and semisolid wastes which have not been sorted and recycled for use in wood combustion devices.

2.11 Gas-Fired Fireplace means any device dedicated to burn natural or liquified petroleum gas as its fuel through a ceramic, or otherwise noncombustible gas log, and which cannot be converted to a wood burning device.

2.12 Manufacturer means any person who constructs or imports a woodburning device.

2.13 Oregon-Certified means any wood heater meeting the performance and emission standards set forth in Sections 100 through 190 of Chapter 340, Division 21, Oregon Administrative Rules.

2.14 Paints means all exterior and interior house and trim paints, enamels, varnishes, lacquers, stains, primers, sealers, undercoaters, roof coatings, wood preservatives, shellacs, and other paints or paint-like products.

2.15 Paint Solvents means all organic solvents sold or used to thin paints or to clean up painting equipment.

2.16 Pellet-Fueled Wood Heaters are devices that burn pellet fuel exclusively, and are either United States Environmental Protection Agency (EPA)- Certified or exempted under EPA requirements set forth in Part 60, Title 40, Subpart AAA, Code of Federal Regulations, February 26, 1988.

2.17 Permanently Inoperable means modified in such a way that a device can no longer operate as a wood heater.

2.18 Person means any person, firm, association, organization, partnership, business trust, corporation, company, contractor, supplier, installer, user, owner, State or local governmental agency or public district, or any officer or employee thereof.

2.19 Petroleum Product means any petroleum product other than gaseous fuels.

2.20 Plastic Product mean any material that contains any of numerous organic synthetic or processed materials that are mostly thermoplastic or thermosetting polymers of high molecular weight and that can be made into objects, films, or filaments.

2.21 Retailer means any person engaged in the sale of wood burning devices directly to the consumer.

2.22 Rubber Products means any material either natural or synthetic, which can be stretched at room temperature to at least twice its original length and, immediately upon release of the stress, returns with force to its approximate original length.

2.23 Seasoned Wood means any wood that has been sufficiently dried so as to contain 20 percent or less moisture by weight.

2.24 Treated Wood means wood of any species that has been chemically impregnated, painted, or similarly modified to improve resistance to insects or weathering.

2.25 Used Wood Heater means any wood heater that has been sold and/or used at least once, except wood heaters that have been used by retailers for the purpose of demonstration.

2.26 Wood Composition Products means plywood, particle board, masonite or any other manufactured wood product containing chemical adhesives, bonding agents, or any other non-wood material.

2.27 Wood Burning Cookstove means a wood burning appliance designed primarily for cooking food, with a separate oven for cooking or baking which is contained in, and is an integral part of, the body of the appliance.

2.28 Wood Burning Device means any fireplace, free standing fireplace, fireplace insert, wood stove, or other wood heater, that burns wood or any other nongaseous or nonliquid fuels, or any similar device burning any wood used for aesthetic or space-heating purposes in a private residence or commercial establishment, having a heat input less than one million British thermal units per hour.

2.29 Wood Heater means an enclosed, wood-burning appliance capable of and intended for space heating that meets all of the following criteria:

2.29.1 An air-to-fuel ratio in the combustion chamber averaging less than 35-to-1 as determined by tests specified in Section 6.1.

2.29.2 A usable firebox volume less than 20 cubic feet.

2.29.3 A minimum burn rate less than 5 kg/hr.

2.29.4 A maximum weight of less than 800 kg. For the purpose of this Rule, fixtures and devices that are normally sold separately, such as flue pipe, chimney and masonry components that are not an integral part of the appliance or heat distribution ducting do not count as part of the appliance weight.

2.30 Zero Clearance Fireplace means any factory-built fireplace designed to be installed into wood-frame construction.

3 REQUIREMENTS

3.1 Public Awareness Requirements

3.1.1 Each retailer shall supply public awareness information with each sale of a wood burning device in the form of pamphlets, brochures or factsheets on the following topics:

3.1.1.1 Proper operation and maintenance of wood heaters;

3.1.1.2 Proper sizing of wood heaters;

3.1.1.3 Proper fuel selection and use;

3.1.1.4 Weatherization methods for the home;

3.1.1.5 Proper fuel storage to maintain low moisture content;

3.1.1.6 Health benefits from low-emission wood burning devices.

3.1.2 Retailers may use pamphlets prepared by the Butte County Air Quality Management District (DISTRICT), the California Air Resources Board, or industry, subject to the Air Pollution Control Officer's (APCO) approval.

3.2 Installation of Wood Burning Devices in New or Existing Dwelling

Units

3.2.1 No wood burning device for which a building permit application is submitted on or after October 25, 2001 may be installed in any new or existing dwelling unit unless it is a DISTRICT-approved device as defined in Section 6.1 of this Rule.

3.2.2 An inspection by the APCO or his designee shall be performed upon completion of the installation, or prior to issuance of final approval for any new dwelling unit(s), to verify that all wood burning devices installed are DISTRICT-approved devices as defined in Section 6.1.

3.3 Sale and Installation of Used Wood Burning Devices: Effective October 25, 2001 no person shall sell, advertise or offer for sale, supply, install, or transfer ownership of a used wood burning device unless it has been rendered permanently inoperable, or is either EPA-Certified, Oregon-Certified, a Pellet-Fueled Wood Heater, or other DISTRICT-approved device as defined in Section 6.1.

3.4 Prohibited Fuel Types

3.4.1 No person shall cause or allow the burning of any of the following materials in a wood burning device:

3.4.1.1 Garbage;

3.4.1.2 Treated wood or wood composition products;

3.4.1.3 Plastic products;

3.4.1.4 Rubber products;

3.4.1.5 Petroleum products, including tar or tar paper;

3.4.1.6 Paints and paint solvents;

3.4.1.7 Coal;

3.4.1.8 Other material which may produce noxious odors or toxic compounds when burned.

3.4.2 This provision shall not apply to firewood or other wood or plant products designed and marketed specifically for use as a fuel in wood burning devices.

4 EXEMPTIONS

4.1 Wood burning cookstoves, wood burning furnaces, wood burning boilers and other wood burning devices not specifically defined herein are exempt from the requirements of this Rule.

4.2 Wood burning devices classified as antique or having historical significance may be exempted from the requirements of this Rule by APCO upon presentation of evidence that they qualify as an antique or historically significant device.

4.3 Wood burning devices sold as appurtenances to real property in an escrow transaction shall be exempt from the provisions of Section 3.3 of this Rule.

5 TEST METHODS

5.1 The standard for determining air/fuel ratios and emissions testing where allowed under Section 6.1.2 and 6.1.3 below for wood heater combustion is EPA's test procedure set forth in Part 60.534, Title 40, Code of Federal Regulations.

5.2 Wood moisture content shall be measured by the American Society for Testing and Materials (ASTM) Methods D 2016-74, D4442-84, or other test method as specified by the APCO.

6 DISTRICT-APPROVED DEVICES

6.1 DISTRICT-approved devices for installation in new and existing dwelling units shall include the following:

6.1.1 All EPA-Certified Phase II wood burning devices;

6.1.2 Catalytic wood burning devices which emit less than or equal to 4.1 grams per hour of particulate matter which are not EPACertified but meet the documentation requirements defined in Section 6.2 below;

6.1.3 Non-catalytic wood burning devices which emit less than or equal to 7.5 grams per hour of particulate matter which are not U.S. EPA-Certified but meet the documentation requirements defined in Section 6.2 below;

6.1.4 Pellet- fueled woodheaters;

6.1.5 Dedicated gas-fired fireplaces.

6.2 The APCO shall maintain a current list of approved wood burning devices. The APCO shall update and/or add new wood burning devices to this list upon completion of review and verification of the following information for each device under consideration:

6.2.1 A dated letter from an EPA-accredited laboratory which includes:

6.2.1.1 Product model identification;

6.2.1.2 Date(s) of emissions testing and test method used;

6.2.1.3 Explanation of the reason why the product was exempted from EPA certification or is classified as a nonaffected facility;

6.2.1.4 Listing of the grams/hour particulate emission rate for the model tested.

6.2.2 Documentation of the quality assurance program used by the manufacturer to ensure that tolerances and materials used in the model line under consideration are the same as those used for the tested device. Listing by a nationally-recognized testing lab shall be deemed adequate to satisfy this requirement.

6.2.3 Documentation of the warranty coverage provided for the product model.

6.2.4 A copy of the owner's manual for the product model.

6.3 Devices approved as clean-burn by other air quality agencies may be added to the list of DISTRICT-approved devices at the discretion of the APCO.

Feather River Air Quality Management District

FEATHER RIVER AIR QUALITY MANAGEMENT DISTRICT

RULE 3.17 - WOOD STOVE HEATING

(Adopted 6/96)

A. DEFINITIONS

A.1 EPA-certified wood heating device means any wood or other solid-fuel-burning appliance utilized for space or water heating or cooking that is certified by the U.S. Environmental Protection Agency (EPA) as meeting the performance and emission standards as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988:

Phase I appliances must meet the emission requirements of no more than 5.5 grams per hour particulate-matter emission for catalytic and 8.5 grams per hour for noncatalytic appliances.

Phase II appliances must meet the emission requirements of no more than 4.1 grams per hour particulate-matter emission for catalytic and 7.5 grams per hour for noncatalytic appliances.

A.2 Fireplace means any permanently installed masonry or factory built device designed to be used with an air-to-fuel ratio greater than or equal to 35-to-1. Fireplaces installed with a dedicated natural gas or propane connection under the Uniform Building Code Section 3707(n) and not convertible to solid fuel appliances are exempt from the requirements of this Rule.

A.3 Insert Device means any EPA Phase II or equivalent wood-heating device specifically designed to convert an open uncontrolled fireplace to a useful wood-heating device.

A.4 Oregon-Certified means any wood heater certified by the State of Oregon as meeting the performance and emission standards set forth in Sections 100 through 190 of Chapter 340, Division 21, Oregon Administrative Rules.

A.5 Pellet-Fueled Wood Heater means any wood heater that operates on pellet wood or other solid fuel and is either EPA certified or is exempt under EPA requirements as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988.

A.6 Permanently Inoperable means modified in such a way that a device can no longer operate as a wood heater.

A.7 Person means any person, firm, association, organization, partnership, business trust, corporation, company contractor, supplier, installer, user, owner, state or local governmental agency or public district, or any officer or employee thereof.

A.8 Solid Fuel Appliances means any fireplace or wood heater that burns wood, coal, or any other nongaseous or nonliquid fuels, or any similar device burning any solid fuel, used as a water heater or for aesthetic or space-heating purposes in a private residence or commercial establishment, which has a heat input less than

one million British thermal units per hour.

A.9 Used Wood Heating Device means any wood heater that has been used at least once, except wood heaters that have been used by retailers for the purpose of demonstration.

A.10 Wood Cook Stove means any wood-burning appliance designed primarily for cooking food with a separate oven for cooking or baking which is contained in and is an integral part of the body of the appliance.

A.11 Wood-Heating Device means any enclosed appliance capable of burning wood or other solid fuel and intended for space heating or domestic water heating. This term does not include fireplaces or wood cook stoves.

B. REQUIREMENTS

B.1 All wood-heating devices used for the first time in existing buildings and those used in all new residential and commercial building projects constructed after the effective date of this rule within the boundaries of Feather River Air Quality Management District shall meet emission and performance requirements equivalent to EPA Phase II devices as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988.

B.2 No person shall cause or allow materials to be burned in a fireplace or wood-heating device such that the discharge of air contaminants would cause a public nuisance, pursuant to Section 41700 of the California Health and Safety Code.

B.3 No person shall sell, offer for sale, supply, install, or transfer a used wood heating device unless it meets one of the following criteria:

- a. It is certified by the EPA as meeting the performance and emission standards as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988; or it is certified by the Oregon Department of Environmental Quality as meeting the performance and emission standards set forth in Sections 100 through 190 of Chapter 340, Division 21, Oregon Administrative Rules.
- b. It is exempted from certification by the EPA.
- c. It is a pellet-fueled wood heater.
- d. It has been rendered permanently inoperable as determined by the Air Pollution Control Officer.

Section B.3 shall not apply to an existing wood heating device which is permanently installed in a structure which is being offered for sale.

B.4 The Air Pollution Control Officer may issue an advisory through local communications media to voluntarily curtail the use of uncertified solid fuel appliances whenever conditions within the District are projected to cause ambient air quality concentrations of inhalable particulate matter (PM10) that exceed 60 micrograms per cubic meter.

C. ENFORCEMENT

C.1 Noncompliance with any part of this Rule shall be considered to be a violation of a District regulation and subject the violator to a civil penalty of up to one thousand dollars (\$1,000) per day in which a violation occurs (Health and Safety Code Section 42402).

C.2 Any person who negligently emits an air contaminant in violation of this Rule shall be liable for a civil penalty of up to fifteen thousand dollars (\$15,000) per day in which a violation occurs (Health and Safety Code section 42402.1).

D. EFFECTIVE DATE

D.1 This Rule shall become effective June 3, 1996.

E. APPLICABILITY

E.1 The provisions of this rule shall apply at all elevations within the Feather River Air Quality Management District

Glenn County Air Pollution Control District

SECTION 99.2.

FIREPLACE AND SOLID FUEL HEATING DEVICE USAGE.

A. Definitions :

1. ***EPA-certified wood heating device*** means any wood or other solid-fuel-burning appliance utilized for space or water heating or cooking that meets the performance and emission standards as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, Feb. 26, 1988.
 - a. Phase I appliances must meet the emission requirements of no more than 5.5 grams per hour particulate-matter emission for catalytic and 8.5 grams per hour for non catalytic appliances.
 - b. Phase II emission requirements are 4.1 and 7.5 grams per hour, respectively.
2. ***Fireplace*** means any permanently installed masonry or factory built device designed to be used with an air-to-fuel ratio greater than or equal to 35-to-1. Fireplaces installed with a dedicated natural gas connection as decorative units under the Uniform Building Code Section 3707 (n) are exempt from the requirements of this Rule.
3. ***Garbage*** means all solid, semi-solid, and liquid wastes generated from residential, commercial, and industrial sources. This definition excludes paper and cardboard, but includes trash, refuse, rubbish, industrial wastes, asphaltic products, manure, vegetable or animal solid and semi-solid wastes.
4. ***Pellet-Fueled Wood Heater*** means any wood heater that operates on pellet wood and is either EPA certified or is exempted under EPA requirements as set forth in Part 60, Title 40, Subpart AAA of Federal Regulations, 2-26-88.
5. ***Wood-Heating Device*** means any enclosed wood-burning appliance capable of and intended for space heating or domestic water heating. This term does not include fireplaces.

B. Requirements.

1. All wood-heating devices used for the first time in existing buildings and those used in all new residential and commercial building projects constructed after the date of adoption of this rule within the boundaries of the District shall be EPA-certified or certified and labeled in a permanent and accessible manner as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988.
2. No person shall cause or allow any of the following materials to be burned in a fireplace or wood-heating device: garbage, chemically treated wood, plastic products, rubber products, waste petroleum products, paints and paint solvents, or coal.
3. No person shall sell, offer for sale, supply, install, or transfer a used wood heating device unless:
 - a. It is certified by the EPA, or Oregon Department of Environmental Quality, or other agencies acceptable to the APCO, or
 - b. It is a pellet-fueled wood heater, or
 - c. It has been rendered permanently inoperable.

4. The Air Pollution Control Officer (APCO) shall issue an advisory through local communications media to voluntarily curtail the use of uncertified solid fuel appliances whenever weather conditions are projected to cause ambient air quality concentrations of inhalable particulate matter (PM10) that exceed 60 micrograms per cubic meter.
5. After July 1, 1995, all fireplaces used in new construction projects within the boundaries of Glenn County shall conform to a maximum emission limit of 7.5 grams per hour by either:
 - a. being initially and permanently equipped with an insert device which is EPA-certified to meet the above standard, or
 - b. being certified and labeled in a permanent and accessible manner to meet the above emission limit by an EPA accredited laboratory, or other agencies acceptable to the APCO.

C. Enforcement.

1. Noncompliance with any part of this Rule shall be considered to be a violation of a District regulation and subject the violator to a civil penalty of up to one thousand dollars (\$1,000) per day in which a violation occurs (Health and Safety Code Section 42402).
2. Any person who negligently emits an air contaminant in violation of this Rule's limitations concerning prohibited materials to be burned shall be liable for a civil penalty of up to ten thousand dollars (\$10,000) per day in which a violation occurs (Health and Safety Code Section 42402.1).

D. Effective Date.

1. This Rule shall become effective upon the date of adoption by the Air Pollution Control Board of Glenn County.

Great Basin Unified Pollution Control District

GREAT BASIN UNIFIED AIR POLLUTION CONTROL DISTRICT

RULE 431 - PARTICULATE EMISSIONS - TOWN OF MAMMOTH LAKES

(Adopted 12/07/90)

A. Purpose.

The purpose of this chapter is to improve and maintain the level of air quality of the Town of Mammoth Lakes so as to protect and enhance the health of its citizens by controlling the emissions of particulate matter into the air of the community of Mammoth Lakes.

B. Definitions.

1. "EPA" shall mean the United States Environmental Protection Agency.
2. "EPA-Certified Appliance" means any wood or other solid fuel burning appliance utilized for space or water heating or cooking that meets the performance and emission standards as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988. Phase I appliances must meet the emission requirements of no more than 5.5 grams per hour particulate matter emissions for catalytic and 8.5 grams per hour for non-catalytic appliances. Phase II requirements are 4.1 and 7.5 grams per hour respectively. Pellet fueled wood heaters shall be considered as meeting Phase II requirements. For existing appliances, Oregon Department of Environmental Quality (DEQ) certification shall be equivalent to EPA certification. All other solid fuel appliances, including fireplaces, shall be considered non-certified.
3. "Pellet Fueled Wood Heater" means any wood heater designed to heat the interior of a building that operates on pelletized wood and has an automatic feed.
4. "Permanently Inoperable" means modified in such a way that the appliance can no longer function as a solid fuel heater or easily be remodified to function as a solid fuel heater. Conversion to other fuels, such as gas, is permitted.
5. "Solid Fuel Burning Appliance, Heater, or Device" means any fireplace, wood heater, or coal stove or structure that burns wood, coal, or any other nongaseous or nonliquid fuels, or any similar device burning any solid fuel used for aesthetic, water heating, or space heating purposes.

C. Standards For Regulation Of Solid Fuel Appliances.

1. After December 7, 1990 (the effective date of this ordinance), no solid fuel burning appliance shall be permitted to be installed within the Town of Mammoth Lakes unless said device is certified as meeting the emission requirements of the U.S. Environmental Protection Agency (EPA) for Phase II certification. This shall not prohibit retailers from selling, prior to January 1, 1991, stock on hand as of the date of this ordinance as long as that stock meets EPA certification for Phase I and the seller can document through invoices or other means that the device was acquired prior to the adoption of this ordinance. After January 1, 1991, all appliances installed in the Town of Mammoth Lakes must meet EPA Phase II certification.

2. The restrictions of this chapter shall apply to all solid fuel devices including unregulated fireplaces. Exceptions will be made for fireplaces supplied with gas and fitted with artificial logs and for one fireplace located in a hotel/motel lobby or similar common area lobby or in the common area of a condominium project. Said common area fireplaces shall be subject to burning curtailment episodes as administered under Section I.
3. For the purposes of enforcing this chapter, the Town shall keep a record of all certified appliances installed in Mammoth Lakes in accordance with this Chapter and of properties which have been determined to conform to the requirements of this Chapter.

D. Density Limitations.

1. No more than one solid fuel appliance may be installed in any new dwelling or nonresidential property. Existing properties with one or more existing solid fuel appliances may not install additional solid fuel appliances. One pellet fueled wood heater per dwelling shall be excepted from the provisions of this paragraph.
2. Solid fuel appliances shall not be considered to be the primary form of heat in any new construction.
3. All new and replacement appliances shall not be installed without first obtaining a building permit from the Town of Mammoth Lakes. All installations shall require an inspection and approval by the Building Division prior to operation.
4. Verification of compliance may be certified by an inspector of the Building Division, by an individual certified by the Wood Heating Education and Research Foundation for the installation of solid fuel appliances, or by individuals possessing equivalent certification. The inspector of record shall verify in writing that the appliance complies with the required emissions standards and shall file said certification with the Town. Inspectors independent of the Town shall verify their qualifications with the Town Building Division before appliance certification will be accepted by the Town.

E. Replacement Of Non-Certified Appliances Upon Sale Of Property.

1. Prior to the completion of the sale or transfer of a majority interest in any real property within the Town of Mammoth Lakes, all existing non-certified solid fuel appliances shall be replaced, removed, or rendered permanently inoperable. If the buyer assumes responsibility, in writing on a form approved by the air quality manager, for appliance replacement or removal, the deadline for such action shall be extended to 60 calendar days from the date of completion of the sale or transfer. The Building Department, or a qualified inspector as designated by the Building Department, shall inspect the appliance(s) in question to assure that they meet the requirements of this chapter. Within five working days from the date of the inspection, the Building Department shall issue a written certification of compliance or non-compliance for the affected property. If the inspection reveals that the subject property does not comply with the requirements of this chapter, all noncomplying solid fuel appliances shall be replaced, removed, or rendered permanently inoperable. In this event reinspection shall be required prior to certification of compliance.
2. If real property is to be sold which does not contain a solid fuel appliance, a form approved by the Building Department, containing the notarized signatures of the seller,

the buyer, and the listing real estate agent attesting to the absence of any solid fuel device, may be accepted in lieu of an inspection. A written exemption shall be issued by the Building Department.

3. No appliances removed under the provisions of this Section may be replaced except as provided by this Chapter.
4. This section shall not be applicable to sales or other transfers of real property which have been completed prior to February 15, 1991, nor shall this section apply to National Forest permittees located west of Old Mammoth Rd. in sections 4 and 9 of Township 4 S., Range 27 E., MDBM, or National Forest permittees located above 8500 feet elevation above sea level.

F. Solid Fuel Burning Appliance Replacement Schedule.

The Town shall review emissions levels by January 1, 1993. Should emissions not have reached attainment of the NAAQS, as determined by monitoring by the Great Basin Air Pollution Control District or the Town, by January 1, 1993, all non-certified solid fuel appliances within the Town shall be replaced by November 1, 1994.

G. Opacity Limits.

No person shall cause or permit emissions from a solid fuel appliance to be readily visible, for a period or periods aggregating more than three minutes in any one hour period. Emissions created during a 15 minute start-up period are exempt from this regulation. Readily visible may be equated with an opacity limit of 20% or greater as designated by the shade number one on the Ringelmann Chart.

H. Permitted Fuels.

Burning of any fuels or materials other than the following fuels within the Town of Mammoth Lakes shall be in violation of this ordinance:

1. Untreated wood
2. Uncolored paper
3. Manufactured logs, pellets, and similar manufactured fuels.

I. Mandatory Curtailment.

1. The Town Council shall appoint an Air Quality Manager. The duty of the Air Quality Manager shall be to determine when curtailment of solid fuel combustion in the Town of Mammoth Lakes is necessary, to notify the community that curtailment is required, and to make such other determinations as are necessary to carry out the objectives of this chapter.
2. Determination that curtailment is required shall be made when PM-10 levels have reached 130 micrograms/m³ or when adverse meteorological conditions are predicted to persist. Should it be determined that 130 micrograms/m³ is not a low enough threshold to prevent the Town from violating the National Ambient Air Quality Standard for 24 hours

(NAAQS, 24hr), that threshold may be lowered by resolution of the Town Council of the Town of Mammoth Lakes.

3. Upon the determination that curtailment is required, the Air Quality Manager shall contact all radio stations and television stations in Mammoth Lakes and have them broadcast that it is required that there be no wood or other solid fuel burning. The Air Quality Manager shall also record a notice on a telephone line dedicated to this purpose and post a notice in the Town Offices. Upon such notice, all wood and other solid fuel combustion shall cease.
4. All dwelling units being rented on a transient basis which contain a non-certified solid fuel appliance shall post, in a conspicuous location near said appliance, a notice indicating that no-burn days may be called and informing the tenants about sources of information on no-burn days.
5. All persons renting units for transient occupancy shall inform their tenants that solid fuel burning may be prohibited on certain days and that the person signing the rental agreement shall be responsible for assuring that the no-burn requirements are obeyed during the rental period identified on the rental agreement.
6. For residences where a solid fuel appliance is the sole means of heat, these curtailment regulations do not apply. For a residence to be considered as having solid fuel as its sole source of heat, the owner must apply to the Building Department for an exemption and the Department must inspect the residence and certify that, in fact, no other adequate source of heat is available to the structure. Adequate source shall mean that the alternate source of heat cannot produce sufficient heat for the residence without causing a hazard. A written exemption will then be granted. Where an adequate alternate source of heat is determined to have been removed from the structure in violation of building codes, a sole source exemption shall not be issued. Sole source exemptions shall not be granted for non-residential uses. The sole source exemptions shall expire one year from the date that the Town adopts a financing or incentive program for replacement of non-certified appliances or on November 1, 1994, whichever date is earlier.
7. Households with very low income levels as defined by the Department of Housing and Urban Development may apply to the Air Quality Manager for exemption from no-burn days. The low income exemptions shall expire one year from the date that the Town adopts a financing or incentive program for replacement of non-certified appliances or on November 1, 1994, whichever date is earlier.
8. Appliances certified as meeting the emission requirements of the EPA as defined in Section B.2 and pellet fueled wood heaters shall not be subject to the provisions of this section. Should future monitoring show that exempting certified appliances results in violations of the NAAQS, 24hr, the Town shall implement a total ban on solid fuel burning based upon the thresholds identified above.

J. Pollution Reduction Education Programs.

The Town Manager or his designee is hereby directed to undertake such public education programs as are reasonably calculated to reduce particulate air pollution within the Town of Mammoth Lakes, including particulate emissions from sources other than solid fuel burning devices. In addition to the notification measures listed in Section I.3, the public education

programs shall include additional measures to inform the public of burning curtailment requirements.

K. Road Dust Reduction Measures.

1. The Director of Public Works is hereby directed to undertake a vacuum street sweeping program to reduce PM-10 emissions resulting from excessive accumulations of cinders and dirt.
2. The Town shall, in its review of proposed development projects, incorporate such measures which reduce projected total vehicle miles travelled. Examples of such measures include, but are not limited to, circulation system improvements, mass transit facilities, private shuttles, and design and location of facilities to encourage pedestrian circulation. The goal of the Town's review shall be to limit projected peak vehicle miles travelled to 106,600 on any given day.

L. Fees.

A fee shall be charged for the inspection and permitting services of the Town of Mammoth Lakes. Said fee shall be established in the Town Master Fee Schedule.

M. Penalties.

1. It is illegal to violate any requirements of this chapter. Any owner of any property which is in violation of the requirements of this chapter shall be guilty of an infraction. Any person operating a solid fuel appliance in violation of this chapter is guilty of an infraction. The third violation by the same person within a 12 month period shall constitute a misdemeanor. Prosecution of any violation of Subsection I.6 and 7, relating to exemptions from curtailment, may be against the property owner, the occupant, or both.
2. Violation of any portion of this chapter may result in assessment of civil penalties against the property and against an individual person or persons as follows:

First violation within a 12 month period, \$50.

Second violation within a 12 month period, \$100.

Third violation within a 12 month period, \$250.

Four or more violations within a 12 month period \$500 per violation.

3. Each and every day a violation exists is a new and separate violation. Right of appeal, hearings, and collection of civil penalties shall be pursuant to the procedures set forth in Chapter 7.20, "Nuisances," of the Municipal Code of the Town of Mammoth Lakes.
4. Nothing in this section shall prevent the Town from pursuing criminal penalties or using any other means legally available to it in addressing violations of this chapter.
5. Whenever necessary to make an inspection to enforce any of the provisions of this code, or whenever the Air Quality Manager or his authorized representative has reasonable cause to believe that there exists in any building or upon any premises any condition which violates the provisions of this chapter, the Air Quality Manager or his authorized representative may enter such building or premises at all reasonable times to inspect the

same or to perform any duty imposed upon the Air Quality Manager by this code, provided that if such building or premises be occupied, he shall first present proper credentials and request entry; and if such building or premises be unoccupied, he shall first make a reasonable effort to locate the owner or other persons having charge or control of the building or premises and request entry. If such entry is refused, or if the owner or person having charge or control of the building or premises cannot be contacted, the Air Quality Manager or his authorized representative shall have recourse to every remedy provided by law to secure entry.

Kern County Air Pollution Control District

KERN COUNTY AIR POLLUTION CONTROL DISTRICT
RULE 416.1 - WOOD-BURNING HEATERS AND WOOD-BURNING FIREPLACES
(Adopted 7/8/04)

I. Purpose

The purpose of this Rule is to minimize emissions of smoke (particulate matter), organic gases and carbon monoxide from wood burning fireplaces in new housing subdivisions and wood burning heaters throughout East Kern.

II. Applicability

This Rule applies to:

- A. Any person who manufactures, sells, offers for sale, installs or operates a wood burning heater.
- B. Any person who installs a wood burning fireplace in a new residential subdivision.

III. Exemptions

The following devices are exempt from provisions of this Rule:

- A. Fireplaces, space heaters or stoves that are exclusively fired with a gaseous fuel.
- B. Cookstoves, as described in Code of Federal Regulations 60.531.

IV. Definitions

- A. APCO: the Air Pollution Control Officer of the Kern County Air Pollution Control District.
- B. Distributor: any person other than a manufacturer or a retailer who sells, offers for sale or supplies wood burning heaters to retailers or others for resale.
- C. U.S. EPA: the United State Environmental Protection Agency.
- D. U.S. EPA Phase II Certified: meets performance and emissions standards set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations.
- E. Fireplace: any permanently installed masonry or factory built device designed to operate at an air-to-fuel ratio greater than or equal to 35-to-1.
- F. Manufacturer: any person who constructs or imports a wood burning heater.
- G. New Residential Subdivision: any group of dwellings on one property or contiguous properties under common control of a person (as defined in Rule 102, Subsection X), shown on the latest equalized county assessment roll as a unit or as contiguous units, for which construction begins on or after July 9, 2004. Construction has begun when the foundation for a structure is poured or constructed. Community and/or commercial buildings are not included.
- H. New Wood Burning Heater: any wood burning heater that has not been sold, supplied or exchanged for the first time by the manufacturer, the manufacturer's distributor or agency, or a retailer.
- I. Pellet-Fueled Wood Burning Heater: any wood burning heater which uses pellet fuel and is either U.S. EPA-certified or is exempted under U.S. EPA requirements set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations.
- J. PM₁₀: any particulate matter having an aerodynamic diameter equal to or less than 10 microns.
- K. Retailer: any person engaged, for profit, in the sale of wood burning fireplaces or wood burning heaters directly to the consumer.
- L. Wood Burning Heater: an enclosed, wood burning appliance capable of, and intended for, space heating, i.e., a free standing wood stove or wood burning fireplace insert.

V. Requirements for Wood Burning Heaters

- A. No person shall sell, offer for sale, supply, install or transfer a new wood burning heater unless it is U.S. EPA Phase II Certified or is a pellet-fueled wood burning heater.

B. No retailer shall advertise, sell, offer for sale, supply, install or transfer a used wood burning heater unless it has been rendered permanently inoperable, or is U.S. EPA Phase II Certified, or is a pellet-fueled wood burning heater.

C. Retailers selling or offering for sale new wood burning heaters shall supply public awareness information with each sale of a wood burning heater in the form of pamphlets, brochures or fact sheets concerning topics listed in Subsections 1. through 5. below.

1. Proper installation, operation and maintenance of the wood burning heater,
2. Proper fuel selection and use,
3. Health effects of exposure to wood smoke,
4. Weatherization methods for the home, and
5. Proper sizing of wood burning heaters.

VI. Limitations on Wood Burning Fireplaces in New Residential Subdivisions

Beginning July 9, 2004, no person shall install a wood burning fireplace in a new residential subdivision which will consist of 10 or more dwellings.

VII. Administrative Requirements

Upon request of the APCO, a manufacturer shall demonstrate each wood heater subject to requirements of Section V. meets applicable U.S. EPA's Phase II certification standards.

Placer County

Placer County

Strategy Description Estimated

Cost-Effectiveness (\$/ton)

District Comments

A. Wood-Burning Fireplace and Wood Burning Heaters

(wood-burning heaters include woodstoves and fireplace inserts)

Measures reduce directly emitted PM10 and PM2.5, and as an added benefit reduce NOx, VOC, CO, and air toxic emissions.

Public Awareness Program Inform the public about potential health hazards of wood smoke and encourage better wood burning practices or use of heating devices

Not available Currently part of public awareness program

Curtailment During Period with Predicted High PM Levels May be mandatory or voluntary Not available

Recommend for consideration.

Require All Specified Wood-Burning Devices installed be U.S. EPACertified, Phase II or Equivalent Prohibit the installation of non-EPA certified wood-burning appliances and wood-burning fireplaces

\$3,095 ~ \$5,216 Rule 225 already in place for Squaw Valley, Martis Valley Air Quality Ordinance and CEQA documents.

[RULE 225 WOOD FIRED APPLIANCES

Adopted 06-17-86

A. APPLICABILITY:

1. The provisions of this Rule shall apply to that area known as Squaw Valley as identified on Plate 4, page 58 of the 1983 Squaw Valley General Plan.
2. This regulation shall apply to all commercial and residential wood fired appliance installations.

B. DEFINITIONS:

1. For the purpose of this Rule "Wood Fired Appliance" is defined as an appliance with a closed combustion chamber which maintains an air-to-fuel ratio of less than 30 to 1 during the burning of 90% or more of the fuel mass consumed in the low firing cycle. The low firing cycle means less than or equal to 25% of the maximum burn rate achieved with doors closed or the minimum burn rate, whichever is greater.
2. For the purpose of this Rule "Fireplace" is defined as a combustion chamber which maintains an air to fuel ratio equal to or greater than 30 to 1 during the burning of 90% or more of the fuel mass consumed in the low firing cycle. The low firing cycle means less than or equal to 25% of the maximum burn rate achieved or the minimum burn rate, whichever is greater.
3. For the purpose of this Rule "Catalytic Combuster" is defined as any device coated with platinum, palladium or other rare metal located in the stack or combustion chamber of a wood fired appliance designed to cause relatively complete combustion at lower than normal temperatures.
4. For the purpose of this Rule "Single Family Residential" is defined as: a. A detached building designed for or occupied by one family and located on a parcel where the uses specified in Section 1606.1 of the Placer County Zoning Ordinance are allowable; or b. A detached building, under one roof, designed for or occupied exclusively by, two families living independently of each other and located on a parcel where the use specified in Section 1608.2 of the Placer County Zoning Ordinance is allowable.
5. For the purpose of this Rule "Multiple Unit Residential Development" is defined as dwelling groups or apartments with three or more total units located on a parcel where the use specified in Section 1608 and 1610 of the Placer County Zoning Ordinance is allowable.
6. For the purpose of this Rule "Public Area" is defined as an area of a multiple unit residential development, intended for use by groups of people, including but not limited to a lounge, a restaurant, and a lobby, specifically excluding an office space, a hallway, a bedroom and other associated living areas.

C. STANDARDS:

1. Except as otherwise stated in this Rule, the use of wood fired appliances shall be limited to one certified appliance per commercial or single family residential structure which is approved after July 1, 1986.
 2. After July 1, 1986, no person shall install and use in Squaw Valley, any wood fired appliance that is not certified by the State of Oregon, Department of Environmental Quality or as provided in Section C.6. to emit 15 grams per hour or less of particulate matter for non-catalytic equipped appliances, or 6 grams per hour or less for catalytic equipped appliances.
 3. After July 1, 1988, no person shall install and use in Squaw Valley any wood fired appliance that is not certified by the State of Oregon, Department of Environmental Quality or as provided in Section C.6. to emit 9 grams per hour or less of particulate matter for non-catalytic equipped appliances or 4 grams per hour or less for catalytic equipped appliances.
 4. Wood fired appliances or fireplaces shall not be used in multiple unit residential developments approved after July 1, 1986 except in public areas.
 5. The use of coal as a fuel is prohibited.
 6. Certification: Each appliance proposed for installation shall be certified by the State of Oregon, Department of Environmental Quality as being within the emission limits established in Section C.2. and C.3. Alternative certification may be used if the Air Pollution Control Officer determines that: 1) the test methodology used for certification is equivalent to that used in the State of Oregon's certification program and, 2) the certified emission levels are no greater than those specified in Section C.2. or C.3. of this Rule.
- D. EXCEPTIONS:
1. For single family residential use, approved after July 1, 1986, a person may install and use more than one appliance, as long as the total emissions do not exceed the emission standards specified by Section C.2. or C.3. of this Rule for non-catalytic equipped appliances.
 2. For existing single family residential use, a person with an existing non-certified wood fired appliance may install and use one additional wood fired appliance if the additional appliance is certified to meet the emission standards specified by Section C.2. or C.3. of this Rule.
 3. Existing wood fired appliances may be replaced on a one to one basis with appliances certified to meet the emission standards specified by Section C.2. or C.3. of this Rule.]

Recommend combined rule for all of Placer County.

Number of Units Limits the number of wood-burning fireplaces and wood-burning heaters that can be installed in new residential developments and nonresidential properties. Could also limit the number of additional units in existing properties

Not available Currently covered in Martis Valley Air Quality Ordinance and CEQA documents. Recommend combined rule for all of Placer County.

Replacement of Non-Certified Appliances Upon Sale of Property Non-certified units need to be removed and scrapped

\$8,680 ~ \$12,060 Mandatory woodstove removal program is already in place in Martis Valley. Incentive program in other areas of Placer County. Recommend combined rule for all of Placer County.

Control of Wood Moisture Content Set moisture standard for "seasoned wood" offered for sale, since burning dry wood increases heating performance

Not available Recommend for consideration.

Prohibit Fuel Types Prohibit the burning of material not intended for use in wood-burning fireplaces and heaters
Not available Recommend for consideration.

San Joaquin Valley Unified Air Pollution Control District

SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT
RULE 4901 - WOOD BURNING FIREPLACES AND WOOD BURNING HEATERS

(Adopted July 15, 1993; Amended July 17, 2003)

1.0 Purpose

The purposes of this rule are to limit emissions of carbon monoxide and particulate matter from wood burning fireplaces and wood burning heaters, and to establish a public education program to reduce wood burning emissions.

2.0 Applicability

This rule applies to:

- 2.1 Any person who manufactures, sells, offers for sale, or operates a wood burning fireplace or wood burning heater.
- 2.2 Any person who sells, offers for sale, or supplies wood intended for burning in a wood burning fireplace or wood burning heater.
- 2.3 Any person who transfers or receives a wood burning stove or wood burning heater as part of a real property sale or transfer.
- 2.4 Any person who installs a wood burning fireplace or wood burning heater in a new residential development.

3.0 Definitions

- 3.1 APCO: the Air Pollution Control Officer of the San Joaquin Valley Unified Air Pollution Control District.
- 3.2 Consumer: any person other than a distributor or a retailer who buys a wood burning fireplace or wood burning heater.
- 3.3 Distributor: any person other than a manufacturer or a retailer who sells, offers for sale, or supplies wood burning fireplace or wood burning heater to retailers or others for resale.
- 3.4 EPA: the United States Environmental Protection Agency.
- 3.5 EPA Phase II Certified: meets the performance and emissions standards set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations.
- 3.6 Fireplace: any permanently installed masonry or factory built device designed to be used with an air-to-fuel ratio greater than or equal to 35-to-1.
- 3.7 Garbage: any solid, semisolid, and liquid wastes generated from residential, commercial, and industrial sources, including trash, refuse, rubbish, industrial wastes, asphaltic products, manure, vegetable or animal solid or semisolid wastes, and other discarded solid or semisolid wastes.
- 3.8 Manufacturer: any person who constructs or imports a wood burning fireplace or wood burning heater.
- 3.9 New Residential Development: any single or multi family housing unit, for which construction begins on or after January 1, 2004. Construction has begun when the foundation for the structure is constructed.
- 3.10 New Wood Burning Heater: any wood burning heater that has not been sold, supplied, or exchanged for the first time by the manufacturer, the manufacturer's distributor or agency, or a retailer.
- 3.11 Paints: any exterior and interior house and trim paints, enamels, varnishes, lacquers, stains, primers, sealers, undercoaters, roof coatings, wood preservatives, shellacs, and other paints or paint-like products.

- 3.12 Paint Solvents: any organic solvents sold or used to thin paints or clean up painting equipment.
- 3.13 Pellet-Fueled Wood Burning Heater: any wood burning heater which operates on pellet-fuel and is either EPA-certified or is exempted under EPA requirements set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations.
- 3.14 Permanently Inoperable: modified in such a way that a device can no longer operate as a wood burning heater.
- 3.15 PM-10: any particulate matter having an aerodynamic diameter equal to or less than 10 microns.
- 3.16 Real Property: the land itself and anything that is permanently affixed to the land, such as buildings, and structures. Examples of real property include heating and air conditioning systems, water lines, or electrical systems that primarily are used to control the environment for people and to benefit the land.
- 3.17 Retailer: any person engaged in the sale of wood burning fireplace or wood burning heater directly to the consumer.
- 3.18 Seasoned Wood: wood of any species that has been sufficiently dried so as to contain 20 percent or less moisture by weight.
- 3.19 Sole Source: the only source of heat in a residence.
- 3.20 Treated Wood: wood of any species that has been chemically impregnated, painted, or similarly modified to improve resistance to insects or weathering.
- 3.21 Used Wood Burning Heater: any wood burning heater that has been used at least once, except wood heaters that have been used by retailers for the purpose of demonstration.
- 3.22 Waste Petroleum Product: any petroleum product other than gaseous fuels that has been refined from crude oil, and has been used, and, as a result of use, has been contaminated with physical or chemical impurities.
- 3.23 Wood Burning Heater: an enclosed, wood burning appliance capable of and intended for space heating (i.e. wood stove or wood burning fireplace insert).

4.0 Exemptions

The following devices are exempt from the provisions of this rule:

- 4.1 Devices that are exclusively gaseous-fueled.
- 4.2 Cookstoves, as described in Code of Federal Regulations 60.531.

5.0 Requirements

5.1 Sale of Wood Burning Heaters

- 5.1.1 No person shall sell, offer for sale, supply, install, or transfer a new wood burning heater unless it is EPA Phase II Certified, or is a pellet-fueled wood burning heater.
- 5.1.2 No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning heater unless it has been rendered permanently inoperable, or is EPA Phase II Certified, or is a pellet-fueled wood burning heater.
- 5.1.3 Retailers selling or offering for sale new wood burning heaters shall supply public awareness information with each sale of a wood burning heater in the form of pamphlets, brochures, or fact sheets on the following topics listed in sections 5.1.3.1 through 5.1.3.5. Public awareness information shall be subject to the review and approval of the APCO.
 - 5.1.3.1 Proper installation, operation, and maintenance of the wood burning heater,
 - 5.1.3.2 Proper fuel selection and use, 4901 - 4

- 5.1.3.3 Health effects from wood smoke,
- 5.1.3.4 Weatherization methods for the home, and
- 5.1.3.5 Proper sizing of wood burning heaters.

5.1.4 Sections 5.1.1 and 5.1.2 do not apply to wood burning heaters subject to Section 5.2.

5.2 Sale or Transfer of Real Property

Beginning January 1, 2004,

5.2.1 No person shall sell or transfer any real property which contains a wood burning heater without first assuring that each wood burning heater included in the real property is EPA Phase II Certified, a pellet fueled wood burning heater, permanently rendered inoperable, or removed.

5.2.2 Upon the sale or transfer of real property, the seller shall provide to the recipient of the real property, and to the APCO, documentation of compliance with section 5.2.1 of this rule. Documentation shall be in the form of a statement signed by the seller describing the type(s) of wood burning heater(s) included in the real property transaction, and any action taken to comply with section 5.2.1. The APCO shall make blank forms available to the public for the purpose of fulfilling this requirement.

5.2.3 Documents required by section 5.2.2 shall be retained by the recipient of the real property and shall be made available to the APCO upon request.

5.3 Limitations on Wood Burning Fireplaces or Wood Burning Heaters in New Residential Developments Beginning January 1, 2004,

5.3.1 No person shall install a wood burning fireplace in a new residential development with a density greater than two (2) dwelling units per acre.

5.3.2 No person shall install more than two (2) EPA Phase II Certified wood burning heaters per acre in any new residential development with a density equal to or greater than three (3) dwelling units per acre.

5.3.3 No person shall install more than one (1) wood burning fireplace or wood burning heater per dwelling unit in any new residential development with a density equal to or less than two (2) dwelling units per acre. 4901 - 5

5.4 Advertising Requirements for Sale of Wood

5.4.1 No person shall sell, offer for sale, or supply any wood which is orally or in writing, advertised, described, or in any way represented to be "seasoned wood" unless the wood has a moisture content of 20 percent or less by weight.

5.4.2 The APCO may delegate to another person or agency the authority to test wood for moisture content and determine compliance with section 5.4.1.

5.5 Prohibited Fuel Types: No person shall cause or allow any of the following materials to be burned in a wood burning fireplace or wood burning heater:

5.5.1 Garbage,

5.5.2 Treated wood,

5.5.3 Plastic products,

5.5.4 Rubber products,

5.5.5 Waste petroleum products,

5.5.6 Paints and paint solvents,

5.5.7 Coal, or

5.5.8 Any other material not intended by a manufacturer for use as fuel in a solid fuel burning device.

5.6 Episodic Wood Burning Curtailment

This section shall be in effect during the months of November through February.

5.6.1 No person shall operate a wood burning fireplace or wood burning heater whenever the APCO notifies the public that an Episodic Curtailment is in effect for the region in which the wood burning fireplace or wood burning heater is located.

5.6.2 The APCO shall notify the public of an Episodic Curtailment for a geographic region whenever an Air Quality Index (AQI) value of 150 or greater is predicted for the geographic region (county). AQI is described in 40 CFR Part 58, and is determined daily by the APCO or designee. 4901 - 6

5.6.3 The following wood burning fireplaces and wood burning heaters are not subject to the provisions of sections 5.6.1:

5.6.3.1 Those that are 3,000 feet or more above mean sea level.

5.6.3.2 Those in locations where natural gas service is not available.

5.6.3.3 Those that are the sole source of heat in a residence.

5.6.4 Episodic Curtailment Notice

The APCO shall notify the public of each Episodic Curtailment by any of the following methods:

5.6.4.1 Provide notice to newspapers of general circulation within the San Joaquin Valley.

5.6.4.2 Broadcast of messages presented by radio or television stations operating in the San Joaquin Valley.

5.6.4.3 A recorded telephone message for which the telephone number is published in the telephone directory or newspaper of general circulation within the San Joaquin Valley.

5.6.4.4 Messages posted on the District's website, www.valleyair.org

5.6.4.5 Any other such method as the APCO determines is appropriate.

6.0 Administrative Requirements

6.1 Upon request of the APCO, the manufacturer shall demonstrate that each wood heater subject to the requirements of sections 5.1 or 5.2 meets EPA's Phase II certification standards as applicable.

6.2 Moisture content of wood shall be determined by ASTM Test Method D 4442-92.

San Luis Obispo County Air Pollution Control District

SAN LUIS OBISPO COUNTY AIR POLLUTION CONTROL DISTRICT

RULE 504 - RESIDENTIAL WOOD COMBUSTION

(Adopted 10/19/93)

A. APPLICABILITY

1. This regulation shall apply within the boundaries of San Luis Obispo County to any person who owns, operates, installs, builds, inspects, sells or offers for sale a wood burning device for any dwelling unit as defined herein.

B. DEFINITIONS

1. "Consumer": Means any person other than a distributor or a retailer who buys a wood burning device.
2. "Dwelling Unit": Means any building or portion thereof which contains living facilities, including provisions for sleeping, eating, cooking and sanitation. For the purpose of this rule, dwelling unit includes single and multi-family residences, mobile and/or modular homes, hotels, motels and other similar occupancies.
3. "EPA": Means the United States Environmental Protection Agency.
4. "EPA-Certified Wood Burning Device": Means any wood burning device that meets the performance and emission standards set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988.
5. "Freestanding Fireplace": Means any wood burning device other than a wood heater that is not inset into the walls of a structure, and vents smoke via a flue pipe through the wall or roof of the structure.
6. "Fireplace": Means any permanently installed masonry or factory built woodburning device with an open front or glass door and which does not meet the definition of a wood heater.
7. "Fireplace Insert": Means any woodheater designed to be installed in an existing masonry or factory-built fireplace.
8. "Garbage": Means all solid, semisolid, and liquid wastes generated from residential, commercial, and industrial sources, including trash, refuse, rubbish, industrial wastes, asphaltic products, manure, vegetable or animal matter, and other discarded solid and semisolid wastes which have not been sorted and recycled for use in wood combustion devices.

9. "Gas Fired Fireplace": Means any device dedicated to burn natural or liquified petroleum gas as its fuel through a ceramic, or otherwise noncombustible gas log, and which cannot be converted to a wood burning device.
10. "Manufacturer": Means any person who constructs or imports a wood burning device.
11. "Oregon-Certified": Means any wood heater meeting the performance and emission standards set forth in Sections 100 through 190 of Chapter 340, Division 21, Oregon Administrative Rules.
12. "Paints": Means all exterior and interior house and trim paints, enamels, varnishes, lacquers, stains, primers, sealers, undercoaters, roof coatings, wood preservatives, shellacs, and other paints or paint-like products.
13. "Paint Solvents": Means all organic solvents sold or used to thin paints or to clean up painting equipment.
14. "Pellet-Fueled Wood Heaters": are devices that burn pellet fuel exclusively, and are either EPA-Certified or exempted under EPA requirements set forth in Part 60, Title 40, Subpart AAA, Code of Federal Regulations, February 26, 1988.
15. "Permanently Inoperable": Means modified in such a way that a device can no longer operate as a wood heater.
16. "Person": Means any person, firm, association, organization, partnership, business trust, corporation, company, contractor, supplier, installer, user, owner, state or local governmental agency or public district, or any officer or employee thereof.
17. "Petroleum Product": Means any petroleum product other than gaseous fuels.
18. "Retailer": Means any person engaged in the sale of wood burning devices directly to the consumer.
19. "Seasoned Wood": Means any wood that has been sufficiently dried so as to contain 20 percent or less moisture by weight.
20. "Treated Wood": Means wood of any species that has been chemically impregnated, painted, or similarly modified to improve resistance to insects or weathering.
21. "Used Wood Heater": Means any wood heater that has been sold and/or used at least once, except wood heaters that have been used by retailers for the purpose of demonstration.
22. "Wood Composition Products": Means plywood, particle board, masonite or any other manufactured wood product containing chemical adhesives, bonding agents, or any other non-wood material.

23. "Wood Burning Cookstove": Means a wood burning appliance designed primarily for cooking food, with a separate oven for cooking or baking which is contained in, and is an integral part of, the body of the appliance.
24. "Wood Burning Device": Means any fireplace, free standing fireplace, fireplace insert, wood stove, or other wood heater, that burns wood or any other nongaseous or nonliquid fuels, or any similar device burning any wood used for aesthetic or space-heating purposes in a private residence or commercial establishment, having a heat input less than one million British thermal units per hour.
25. "Wood Heater": Means an enclosed, wood-burning appliance capable of and intended for space heating that meets all of the following criteria:
 - a. An air-to-fuel ratio in the combustion chamber averaging less than 35-to-1 as determined by tests specified in Subsection F.1.
 - b. A usable firebox volume less than 20 cubic feet.
 - c. A minimum burn rate less than 5 kg/hr.
 - d. A maximum weight of less than 800 kg. For the purpose of this rule, fixtures and devices that are normally sold separately, such as flue pipe, chimney and masonry components that are not an integral part of the appliance or heat distribution ducting do not count as part of the appliance weight.
26. "Zero Clearance Fireplace": Means any factory-built fireplace designed to be installed into wood-frame construction.

C. EXEMPTIONS

1. Woodburning cookstoves, woodburning furnaces, woodburning boilers and other woodburning devices not specifically defined herein are exempt from the requirements of this rule.
2. Wood burning devices classified as antique or having historical significance may be exempted from the requirements of this rule by the Air Pollution Control Officer (APCO) upon presentation of evidence that they qualify as an antique or historically significant device.
3. Wood burning devices which are the sole source of heat in a dwelling unit shall be exempt from the provisions of Subsection D.6.
4. District-approved devices as defined in Subsection G.1, as well as Oregon-certified and EPA-Certified Phase I devices, shall be exempt from the provisions of Subsection D.6.
5. Wood burning devices sold as appurtenances to real property in an escrow transaction shall be exempt from the provisions of Subsection D.3.a.

D. REQUIREMENTS

1. Public Awareness Requirements
 - a. Each retailer shall supply public awareness information with each sale of a wood burning device in the form of pamphlets, brochures or factsheets on the following topics:
 1. Proper operation and maintenance of wood heaters;
 2. Proper sizing of wood heaters;
 3. Proper fuel selection and use;
 4. Weatherization methods for the home;
 5. Proper fuel storage to maintain low moisture content;
 6. Health benefits from low-emission woodburning devices .
 - b. Retailers may use pamphlets prepared by the District, the state Air Resources Board, or industry, subject to the APCO's approval.
2. Installation of Wood Burning Devices in New or Existing Dwelling Units
 - a. No wood burning device for which a building permit application is submitted on or after February 1, 1994, may be installed in any new or existing dwelling unit unless it is a District-approved device as defined in Subsection G.1.
 - b. An inspection by the APCO or his designee shall be performed upon completion of the installation, or prior to issuance of final approval for any new dwelling unit(s), to verify that all wood burning devices installed are District-approved devices as defined in Subsection G.1.
3. Sale and Installation of Used Wood Burning Devices
 - a. Effective February 1, 1994, no person shall sell, advertise or offer for sale, supply, install, or transfer ownership of a used wood burning device unless it has been rendered permanently inoperable, or is either EPA-Certified, Oregon-Certified, a Pellet-Fueled Wood Heater, or other District-approved device as defined in Subsection G.1.
4. Moisture Content Limit for Seasoned Wood
 - a. Effective February 1, 1994, no person shall sell, offer for sale, or supply any wood that is orally, or in writing, advertised, described, or is in any way represented as "seasoned" or "dry" wood unless the wood has a moisture content of 20 percent or less by weight.
 - b. Wood moisture content shall be measured in accordance with Subsection F.2.
 - c. The APCO may delegate to another person or agency the authority to test wood for moisture content and determine compliance with Subsection D.4.a.
5. Prohibited Fuel Types
 - a. No person shall cause or allow the burning of any of the following materials in a wood burning device:
 1. Garbage;
 2. Treated wood or wood composition products;
 3. Plastic products;
 4. Rubber products;
 5. Petroleum products, including tar or tar paper;
 6. Paints and paint solvents;

7. Coal;
 8. Other material which may produce noxious odors or toxic compounds when burned.
 - b. This provision shall not apply to firewood or other wood or plant products designed and marketed specifically for use as a fuel in wood burning devices.
6. Voluntary Curtailment
- a. The APCO may declare a voluntary curtailment for burning in wood burning devices when an impaired air quality episode occurs in a geographical area within San Luis Obispo County. The APCO may determine an impaired air quality episode by using criteria set forth in Title 17, California Code of Regulations, Chapter 1, Subchapter 2, Article 3 (commencing with Section 80180) or other criteria established by the APCO.
 - b. The APCO shall provide public notification of voluntary curtailment by one or more of the following methods:
 1. Oral notice presented at least four times during a twelve hour period by radio or television stations operating in the district;
 2. A recorded telephone message for which the telephone number is published in the telephone directory or newspaper of general circulation within the district;
 3. Written notice published in a newspaper of general circulation within the district;
 4. Other methods as the APCO determines appropriate.
 - c. District-approved devices as defined in Subsection G.1, as well as Oregon-certified and EPA-Phase 1 certified devices, shall not be subject to the voluntary curtailment provisions of this rule.

E. RECORDKEEPING

1. Retailers shall maintain a purchase record which includes the customer's name, the address of the building where the appliance is installed, and the make and model number of the device. The retailer shall maintain records for at least three years and make them available for inspection by the APCO upon request.

F. TEST METHODS

1. The standard for determining air/fuel ratios for wood heater combustion is EPA's test procedure set forth in Part 60.534, Title 40, Code of Federal Regulations.
2. Wood moisture content shall be measured by ASTM Test Methods D 2016 - 74, D4442-84, or other test method as specified by the APCO.

G. DISTRICT-APPROVED DEVICES

1. District-approved devices for installation in new and existing dwelling units shall include the following:
 - a. All EPA-Certified Phase II wood burning devices;
 - b. Catalytic wood burning devices which emit less than or equal to 4.1 grams per hour of particulate matter which are not EPA-Certified but meet the documentation requirements defined in Subsection G.2;
 - c. Non-catalytic wood burning devices which emit less than or equal to 7.5 grams per hour of particulate matter which are not EPA-Certified but meet the documentation requirements defined in Subsection G.2;
 - d. Pellet-fueled woodheaters;
 - e. Dedicated gas-fired fireplaces.

2. The APCO shall maintain a current list of approved wood burning devices. The APCO shall update and/or add new wood burning devices to this list upon completion of review and verification of the following information for each device under consideration:
 - a. A dated letter from an EPA-accredited laboratory which includes:
 1. Product model identification;
 2. Date(s) of emissions testing and test method used;
 3. Explanation of the reason why the product was exempted from EPA certification or is classified as a nonaffected facility;
 4. Listing of the grams/hour particulate emission rate for the model tested.
 - b. Documentation of the quality assurance program used by the manufacturer to ensure that tolerances and materials used in the model line under consideration are the same as those used for the tested device. Listing by a nationally-recognized testing lab shall be deemed adequate to satisfy this requirement.
 - c. Documentation of the warranty coverage provided for the product model.
 - d. A copy of the owners manual for the product model.

3. Devices approved as clean-burn by other air quality agencies may be added to the list of District-approved devices at the discretion of the APCO.

Shasta County Air Quality Management District

SHASTA COUNTY AIR QUALITY MANAGEMENT DISTRICT

RULE 3:23 - FIREPLACE AND SOLID FUEL HEATING DEVICE USAGE

(Adopted 3/1/94)

a. Definitions

EPA-certified wood heating device means any wood or other solid-fuel-burning appliance utilized for space or water heating or cooking that meets the performance and emission standards as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988.

- Phase I appliances must meet the emission requirements of no more than 5.5 grams per hour particulate-matter emission for catalytic and 8.5 grams per hour for noncatalytic appliances.
- Phase II emission requirements are 4.1 and 7.5 grams per hour, respectively.

Fireplace means any permanently installed masonry or factory built device designed to be used with an air-to-fuel ratio greater than or equal to 35-to-1. Fireplaces installed with a dedicated natural gas or propane connection under the Uniform Building Code Section 3707(n) and not convertible to solid fuel appliances are exempt from the requirements of this Rule.

Garbage means all solid, semi-solid, and liquid wastes generated from residential, commercial, and industrial sources that have not been sorted and recycled for combustion in wood-heating devices. This definition excludes paper and cardboard, but includes trash, refuse, rubbish, industrial wastes, asphaltic products, manure, vegetable or animal solid and semi-solid wastes.

Insert Device means any EPA Phase II or equivalent wood-heating device specifically designed to convert an open uncontrolled fireplace to a useful wood-heating device.

Oregon-Certified means any wood heater meeting the performance and emission standards set forth in Sections 100 through 190 of Chapter 340, Division 21, Oregon Administrative Rules.

Paints means all exterior and interior house and trim paints, enamels, varnishes, lacquers, stains, primers, sealers, under-coaters, roof coatings, wood preservatives, shellacs, and other paints or paint-like products.

Paint solvents means all organic solvents sold or used to thin paints or to clean up painting equipment.

Pellet-Fueled Wood Heater means any wood heater that operates on pellet wood or other solid fuel and is either EPA certified or is exempted under EPA requirements as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988.

Permanently Inoperable means modified in such a way that a device can no longer operate as a wood heater.

Person means any person, firm, association, organization, partnership, business trust, corporation, company contractor, supplier, installer, user, owner, state or local governmental agency or public district, or any officer or employee thereof.

Solid Fuel Appliances means any fireplace or wood heater that burns wood, coal, or any other nongaseous or nonliquid fuels, or any similar device burning any solid fuel, used for aesthetic or space-heating purposes in a private residence or commercial establishment, which has a heat input less than one million British thermal units per hour.

Used wood heating device means any wood heater that has been used at least once, except wood heaters that have been used by retailers for the purpose of demonstration.

Waste petroleum product means any petroleum product other than gaseous fuels that has been refined from crude oil, and has been used, and, as a result of use, has been contaminated with physical or chemical impurities.

Wood Cook Stove means any wood-burning appliance designed primarily for cooking food with a separate oven for cooking or baking which is contained in and is an integral part of the body of the appliance.

Wood-Heating Device means any enclosed appliance capable of burning wood or other solid fuel and intended for space heating or domestic water heating. This term does not include fireplaces or wood cook stoves.

b. Requirements

1. All wood-heating devices used for the first time in existing buildings and those used in all new residential and commercial building projects constructed after March 1, 1994 within the boundaries of Shasta County shall meet emission and performance requirements equivalent to EPA Phase II devices as set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, February 26, 1988.
2. No person shall cause or allow any of the following materials to be burned in a fireplace or wood-heating device: garbage, chemically treated wood, plastic products, rubber products, waste petroleum products, paints and paint solvents, or coal.
3. No person shall sell, offer for sale, supply, install, or transfer a used wood heating device unless:
 - o It is certified by the EPA or Oregon Department of Environmental Quality, or
 - o It is exempted from certification by the EPA or
 - o It is a pellet-fueled wood heater, or

- It has been rendered permanently inoperable as determined by the Air Pollution Control Officer (APCO).
- 4. The Air Pollution Control Officer (APCO) shall issue an advisory through local communications media to voluntarily curtail the use of uncertified solid fuel appliances whenever weather conditions are projected to cause ambient air quality concentrations of inhalable particulate matter (PM10) that exceed 60 micrograms per cubic meter.
- 5. After July 1, 1994, all masonry and factory-built fireplaces used in new construction or remodel projects within the boundaries of Shasta County shall conform to a maximum emission limit of 7.5 grams per hour of total particulate matter by either:
 - a. being initially and permanently equipped with an insert device which is EPA-certified to meet or exceed the above standard, or
 - b. being certified and labeled in a permanent and accessible manner to meet the above emission limit by an EPA accredited laboratory.

c. Enforcement

1. Noncompliance with any part of this Rule shall be considered to be a violation of a District regulation and subject the violator to a civil penalty of up to one thousand dollars (\$1,000) per day in which a violation occurs (Health and Safety Code Section 42402).
2. Any person who negligently emits an air contaminant in violation of this Rule's limitations concerning prohibited materials to be burned shall be liable for a civil penalty of up to fifteen thousand dollars (\$15,000) per day in which a violation occurs (Health and Safety Code Section 42402.1).

d. Effective Date

1. This Rule shall become effective upon the date of adoption by the Air Pollution Control Board of Shasta County.

e. Applicability

1. The provisions of this rule shall apply at all elevations within Shasta County.

Yolo-Solano Air Quality Management District

YOLO-SOLANO AIR QUALITY MANAGEMENT DISTRICT
RULE 2.40 - WOOD BURNING APPLIANCES

(Adopted December 8, 2004)

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100 GENERAL

101 **PURPOSE:** To manage the emissions of particulate matter, carbon monoxide, and other air contaminants from wood burning appliances.

102 **APPLICABILITY:** This rule applies to the following:

102.1 Any person who manufactures, sells, offers for sale, operates or installs a wood burning appliance.

102.2 Any person who sells, offers for sale, or supplies wood intended for burning in a wood burning appliance.

110 **EXEMPTIONS - GENERAL:** The provisions of this rule shall not apply to the

following:

110.1 Appliances that are exclusively fired with a gaseous fuel.

110.2 Cookstoves.

200 DEFINITIONS

201 **AIR POLLUTION CONTROL OFFICER (APCO):** The Air Pollution Control Officer of the Yolo-Solano Air Quality Management District, or his or her designee.

202 **COOKSTOVE:** Any wood fired appliance primarily for cooking food as described in Code of Federal Regulations 60.531.

203 **EXISTING DEVELOPMENT:** Any residential or commercial, single or multibuilding unit, for which construction is complete.

204 **FIREPLACE:** Any permanently installed masonry or factory built device designed to operate at an air-to-fuel ratio greater than or equal to 35-to-1.

205 **GARBAGE:** Any solid, semisolid, and liquid wastes generated from residential, commercial, and industrial sources, including trash, refuse, rubbish, industrial wastes, asphaltic products, manure, vegetable or animal solid or semisolid wastes, and other discarded solid or semisolid wastes.

206 **MANUFACTURER:** Any person who constructs or imports a wood burning appliance.

207 **NEW DEVELOPMENT:** Any residential or commercial, single or multibuilding unit, which begins construction on or after January 1, 2006. Construction begins when the foundation for the structure is started.

208 **PAINTS:** Any exterior and interior house and trim paints, enamels, varnishes, lacquers, stains, primers, sealers, undercoatings, roof coatings, wood preservatives, shellacs, and other paints or paint-like products.

209 **PAINT SOLVENTS:** All original solvents sold or used to thin paints or to clean up painting equipment.

210 **PELLET-FUELED WOOD BURNING HEATER:** Any wood burning heater which operates on pellet fuel and is either U.S. EPA-certified or is exempted under U.S. EPA requirements set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations.

211 **SEASONED WOOD:** Wood of any species that has been sufficiently dried so as to contain 20 percent or less moisture by weight.

212 **SOLID FUEL:** Any wood or any other non-gaseous or non-liquid fuel.

213 **TREATED WOOD:** Wood of any species that has been chemically impregnated, painted, or similarly modified to improve resistance to insects or weathering.

214 **U.S. EPA:** The United States Environmental Protection Agency.

215 **U.S. EPA Phase II Certified:** Any appliance certified by the U.S. EPA, that the unit meets the performance standards set forth in Part 60, Title 40 Subpart AAA Code of Federal Regulations.

216 **WASTE PETROLEUM PRODUCT:** Any petroleum product other than gaseous fuels that has been refined from crude oil, and has been used, and as a result of use, has been contaminated with physical or chemical impurities.

217 **WOOD BURNING APPLIANCE:** Any fireplace, wood burning heater, or pellet-fired wood heater, or any similar enclosed device burning any solid fuel used for aesthetic or space-heating purposes, which has a heat input of less than one million British thermal units per hour.

218 WOOD BURNING HEATER: An enclosed, wood burning appliance capable of and intended for space heating as described in Code of Federal Regulation 60.531(i.e. a wood stove or fireplace insert).

300 STANDARDS

301 WOOD BURNING APPLIANCES: No person shall sell, offer for sale, supply or install any wood burning appliance in a new or existing development that is not one of the following:

301.1 A pellet-fueled wood burning heater.

301.2 A U.S. EPA Phase II Certified wood burning heater.

301.3 An appliance or fireplace determined to meet the U.S. EPA particulate matter emission standard of less than 7.5 grams per hour for a noncatalytic wood fired appliance or 4.1 grams per hour for a catalytic wood fired appliance and is approved in writing by the APCO.

302 OPERATION OF WOOD BURNING APPLIANCES: All wood burning appliances shall be installed and operated according to the manufacturer's specifications. Any U.S. EPA approved wood burning appliance which has been altered, installed, or disassembled in anyway not specified by the manufacturer, or is operated in any manner that would result in emissions exceeding the U.S. EPA standard set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, shall be considered a non U.S. EPA compliant appliance.

303 PUBLIC INFORMATION: Retailers selling or offering for sale new wood burning appliances, shall supply public education information with each sale of a wood burning appliance in the form of pamphlets, brochures or fact sheets on the following topics:

303.1 Proper installation, operation, and maintenance of the wood burning appliance,

303.2 Proper fuel selection and use,

303.3 Health effects from wood smoke, and

303.4 Proper sizing of wood burning appliances.

Public information shall be subject to the review and approval of the APCO.

304 FUEL LIMITATIONS: No person shall sell, offer for sale, or supply any wood which is orally, or in writing, advertised, described, or in any way represented to be "seasoned" or "dry" wood unless the wood has a moisture content of 20 percent or less by weight.

305 PROHIBITED FUEL TYPES: Except for commercial products expressly manufactured for starting a fire in a wood fired appliance, no person shall cause or allow any of the following materials to be burned in a wood burning appliance:

305.1 Garbage,

305.2 Treated wood,

305.3 Plastic products,

305.4 Rubber products,

305.5 Waste petroleum products,

305.6 Paints and paint solvents,

305.7 Coal,

305.8 Glossy or colored paper,

305.9 Particle board,

305.10 Any other material not intended by a manufacturer for use as fuel in a solid fuel burning device.

400 ADMINISTRATIVE REQUIREMENTS

401 COMPLIANCE REPORT: Upon request, a manufacturer shall submit to the Air Pollution Control Officer a Compliance Report that demonstrates compliance with Section 301 of this

Rule for each wood burning appliance subject to the provisions of this Rule or claiming exemption. The report shall contain all the following information.

401.1 General Information:

- a. Name and address of manufacturer,
- b. Product model identification
- c. Description of the model

401.2 Test Report:

- a. All compliance test procedures and results for each model,
and
- b. All calculations for determining compliance of each model,
or
- c. Explanation of the reason the product is exempt from U.S. EPA certification or is classified as a non-affected facility.

500 MONITORING AND RECORDS

501 TEST METHODS: The test methods listed below are approved for use to demonstrate rule compliance.

501.1 Air-to-fuel ratio: The standard for determining air/fuel ratios for combustion in wood burning appliances is U.S. EPA's test procedure set forth in Part 60.534, Title 40, Code of Federal Regulations.

501.2 Moisture Content: Moisture content of wood shall be determined by the American Society for Testing and Materials (ASTM) Test Method D 4442-92.

PROPOSED MODEL Regulation of Wood Burning Appliances Ordinance

This ordinance establishes regulations and guidelines on the type and usage of wood burning appliances allowed to be installed and operated. Be it ordained by the People of the (*insert name of local agency*): (*Insert name of local agency*) Codes (*need to insert appropriate codes such as ADMINISTRATIVE, GENERAL, BUILDING, or PLANNING, TRAFFIC, ETC.*) are hereby amended by adding Chapter (___), to read as follows:

CHAPTER (___)

WOOD BURNING APPLIANCES

SEC. __.1. FINDINGS AND PURPOSE

The (*insert name of governing board of local agency*) finds that:

(a) Air pollution is a major public health concern in California. The State Air Resources Board (ARB) adopted a particulate matter less than ten microns in size (PM₁₀) Ambient Air Quality Standard (AAQS) in December, 1982, and levels for the PM₁₀ AAQS were selected pursuant to California Code of Regulations Title 17 Section 70200 to protect the health of people who are sensitive to exposure to fine particles. In addition to health impacts, air pollution imposes significant economic costs and negative impacts on our quality of life.

(b) Research indicates that wood smoke is a contributor to PM₁₀ levels and poses health risks to the public.

(c) The (*insert name of governing board of local agency*) has the desire to improve air quality, and lessen the risk to human health and environment by reducing pollution from wood-burning appliances.

(d) A need exists to adopt regulations that apply to emissions from wood burning appliances.

(e) The proposed ordinance will reduce the impact from particulate emissions from wood burning appliances.

SEC. __.2. DEFINITIONS

(a) **AIR POLLUTION CONTROL OFFICER (APCO):** The Air Pollution Control Officer of the Yolo-Solano Air Quality Management District (AQMD), or his or her designee.

(b) **COOKSTOVE:** Any wood fired appliance primarily for cooking food as described in Code of Federal Regulations 60.531.

(c) **EXISTING DEVELOPMENT:** Any residential or commercial, single or multi-building unit, for which construction is complete.

(d) **FIREPLACE:** Any permanently installed masonry or factory built device designed to operate at an air-to-fuel ratio greater than or equal to 35-to-1.

(e) **GARBAGE:** Any solid, semisolid, and liquid wastes generated from residential, commercial, and industrial sources, including trash, refuse, rubbish, industrial wastes, asphaltic products, manure, vegetable or animal solid or semisolid wastes, and other discarded solid or semisolid wastes.

(f) **MANUFACTURER:** Any person who constructs or imports a wood burning appliance.

(g) **NEW DEVELOPMENT:** Any residential or commercial, single or multi-building unit, which begins construction on or after January 1, 2006. Construction begins when the foundation for the structure is started.

(h) **PAINTS:** Any exterior and interior house and trim paints, enamels, varnishes, lacquers, stains, primers, sealers, undercoatings, roof coatings, wood preservatives, shellacs, and other paints or paint-like products.

(i) **PAINT SOLVENTS:** All original solvents sold or used to thin paints or to clean up painting

equipment.

(j) **PELLET-FUELED WOOD BURNING HEATER:** Any wood burning heater which operates on pellet-fuel and is either U.S. EPA-certified or is exempted under U.S. EPA requirements set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations.

(k) **SEASONED WOOD:** Wood of any species that has been sufficiently dried so as to contain 20 percent or less moisture by weight.

(l) **SOLID FUEL:** Any wood or any other non-gaseous or non-liquid fuel.

(m) **TREATED WOOD:** Wood of any species that has been chemically impregnated, painted, or similarly modified to improve resistance to insects or weathering.

(n) **U.S. EPA:** The United States Environmental Protection Agency.

(o) **U.S. EPA Phase II Certified:** Any appliance certified by the U.S. EPA the unit meets the performance standards set forth in Part 60, Title 40 Subpart AAA Code of Federal Regulations.

(p) **WASTE PETROLEUM PRODUCT:** Any petroleum product other than gaseous fuels that has been refined from crude oil, and has been used, and as a result of use, has been contaminated with physical or chemical impurities.

(q) **WOOD BURNING APPLIANCE:** Any fireplace, wood burning heater, or pellet-fired wood heater, or any similar enclosed device burning any solid fuel used for aesthetic or space-heating purposes, which has a heat input of less than one million British thermal units per hour.

(r) **WOOD BURNING HEATER:** An enclosed, wood burning appliance capable of and intended for space heating (i.e. a wood stove or fireplace insert)

SEC. __.3. APPLICABILITY

(a) Any person who manufactures, sells, offers for sale, or operates a wood burning appliance.

(b) Any person who sells, offers for sale, or supplies wood intended for burning in a wood burning appliance.

SEC. __.4. GENERAL REQUIREMENTS

Provisions (a) through (e) are required pursuant to Yolo-Solano AQMD Rule 2.40 and need not be adopted by (local agency) to be enforceable. Based on the (local agency's) desire to obtain further emission reductions and with the support of the Yolo-Solano AQMD, the (local agency) is also adopting provisions (*insert provision letters*).

(a) It shall be unlawful to install or replace a wood burning appliance in a new or existing development that is not one of the following:

1. A pellet-fueled wood heater,
2. A U.S. EPA Phase II Certified wood heater, or
3. A wood burning appliance determined to meet the U.S. EPA Phase II emission standard, and is approved in writing by the APCO.

(b) All wood burning appliances shall be installed and operated according to the manufacturer's specifications. Any U.S. EPA approved wood burning appliance which has been altered, installed, or disassembled in anyway not specified by the manufacturer, or is operated in any manner that would result in emissions exceeding the U.S. EPA standard set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations, shall be considered a non U.S. EPA compliant appliance.

(c) Retailers selling or offering for sale new wood burning appliances shall supply public education information with each sale of a wood burning appliance in the form of pamphlets, brochures or fact sheets on the following topics. Public education information shall be subject to the review and approval of the APCO.

1. Proper installation, operation, and maintenance of the wood burning appliance,

2. Proper fuel selection and use,
3. Health effects from wood smoke, and
4. Proper sizing of wood burning appliances.

(d) Except for commercial products expressly manufactured for starting a fire in a wood burning appliance, no person shall cause or allow any of the following materials to be burned in a wood burning appliance:

1. Garbage,
2. Treated wood,
3. Plastic products,
4. Rubber products,
5. Waste petroleum products,
6. Paints and paint solvents,
7. Coal,
8. Glossy or colored paper,
9. Particle board, or
10. Any other material not intended by a manufacturer for use as fuel in a solid fuel burning device.

(e) No person shall sell, offer for sale, or supply any wood which is orally, or in writing, advertised, described, or in any way represented to be “seasoned” or “dry” wood unless the wood has a moisture content of 20 percent or less by weight.

(f) The ordinance requires the (*insert agency, i.e. city or county*) in conjunction with the YSAQMD, to provide public notification requesting residents to suspend all wood burning activities during poor air quality episodes as determined by the YSAQMD. Methods of notification could include a notice published in local newspapers, email notifications, and notices broadcast through radio or television.

(g) No person shall sell or transfer any real property located within the (*insert jurisdiction, i.e. city or county*), which contains a wood heater without first assuring that each wood heater included in the real property is either U.S. EPA Phase II Certified, approved in writing by the APCO, a pellet-fueled wood heater, permanently rendered inoperable or removed.

(h) Any wood burning heater, freestanding or insert, which is not either U.S. EPA Phase II Certified, approved in writing by the APCO, or a pellet-fueled wood heater, shall be removed, replaced with a compliant appliance, or rendered inoperable when all of the following conditions occur, as determined by (*insert name of agency*):

1. Interior remodel or renovation is done requiring a building permit, and
2. The valuation of the remodel or renovation exceeds \$3,500, and
3. The remodel is in the same room as the wood appliance.

(i) Effective (*insert date*), it shall be unlawful to operate any wood heater within the (*insert jurisdiction*) which is not U.S. EPA Phase II Certified, a pellet-fueled heater, or approved by the APCO. (*Insert Agency*) may grant an exception to this section in case of hardship.

Hardship can include one of the following:

1. A residential sole source of heat,
2. A temporary sole source of heat, or
3. An inadequate alternative source of heat.

SEC. 5. EXEMPTIONS

This chapter does not apply to the following

- (a) Any appliance exclusively fired with a gaseous fuel, or

(b) Any wood burning appliance specifically designed for cooking such as a cookstove.

SEC. __.6. ENFORCEMENT

Any person who plans to install or replace a wood burning appliance or wood heater must submit documentation to the (*insert appropriate building department*), with a building permit application, demonstrating that the appliance is in compliance with this ordinance.

SEC. __.7. VIOLATION

Every person who violates any provision of this Ordinance shall be deemed guilty of a misdemeanor and upon conviction shall be punishable as provided by law.

SEC. __.8. SEVERABILITY

If any section, subsection, paragraph, subparagraph, sentence, clause or phrase of this Chapter is for any reason held to be unconstitutional, invalid, or ineffective by any court of competent jurisdiction, such decision shall not affect the validity or effectiveness of the remaining portions of this Chapter. The (*insert name of governing board of local agency*) declares that it would have passed each section, subsection, paragraph, subparagraph, sentence, clause or phrase of this Chapter irrespective of the fact that any portion of this Chapter could be declared unconstitutional, invalid or ineffective.

SEC. __.9. EFFECTIVE DATE

The provisions of this Chapter shall be effective upon adoption by the (*insert name of governing board of local agency*) and certified by the (*insert City Clerk or other appropriate official*).

APPROVED AS TO FORM:

(Insert Agency Name) Attorney

By: _____

Name

State of Colorado

REGULATION NO. 4

Concerning the Sale of New Woodstoves and the Use of Certain Woodburning Appliances During High Pollution Days

Revised and readopted: 2/16/95

Effective: 4/30/95 REGULATION NO. 4 - ADOPTION CHRONOLOGY

To set a standard test methodology, an emission standard developed, establish a certification fee, and develop an emission label -

Adopted: June 27, 1985

Effective: July 30, 1985

Revised to raise the certification fee-

Adopted: September 18, 1986

Effective: October 30, 1986

Revised to establish a definition for new woodstoves and exemptions from the woodstove certification program -

Adopted: May 19, 1988

Effective: June 30, 1988

Revised to establish a woodstove certification program -

Adopted: May 17, 1990

Effective: June 30, 1990

Revised to make locally adopted ordinances state enforceable -

Adopted: June 24, 1993

Effective: August 30, 1993

Revised to include provisions for pellet stoves -

Adopted: August 20, 1992

Effective: September 30, 1992

Revised to include provisions for masonry heaters -

Adopted: April 21, 1994

Effective: June 30, 1994

Revised Section X to meet requirements for incorporation by reference -

Adopted: February 16, 1995

REGULATION NO. 4

Concerning the Sale of New Woodstoves and the Use of Certain Woodburning Appliances During High Pollution Days

I. DEFINITIONS

A. Unless otherwise required by the context, as used in this Regulation:

1. "Accredited Laboratory" means an independent testing laboratory which has obtained accreditation pursuant to the Federal Regulations 40 CFR Part 60 Subpart AAA.
2. "Approved Masonry Heater" means a wood burning appliance as defined in Section I.A.12 which has complied with all requirements of Section IV.
3. "Approved Pellet Stove" means a woodburning appliance as defined in Section I.A.(16), which has complied with all the requirements of Section III. ??submitted 4/92??
4. "Boiler" means a domestic solid fuel burning appliance used primarily for heating space where the appliance is located, by the distribution through pipes of a gas or fluid heated in the appliance. This appliance must be

tested and listed as a boiler under accepted U.S. or Canadian safety testing codes.

5. "Burn down time" shall mean that period of time not to exceed three hours following the declaration of a high pollution day required for the cessation of combustion within any wood burning stove, pellet stove, masonry heater or fireplace pursuant to this Regulation.
6. "Certified wood stove" means a wood stove which is a unit of a wood stove model, or which contains a configuration of appliance, for which certification has been granted.
7. "Cookstove" means a domestic wood-fired appliance that is designed primarily for cooking food and that has the following characteristics:
 - a. An oven, with a volume of 1 cubic foot or greater, and an oven rack;
 - b. A device for measuring oven temperatures;
 - c. A flame path that is routed around the oven;
 - d. A shaker grate;
 - e. An ash pan;
 - f. An ash clean-out door below the oven; and
 - g. The absence of a fan or heat channels to dissipate heat from the appliance.
8. "Dealer" means a person who sells wood stoves, pellet stoves or masonry heaters on a regular basis.
9. "Furnace" means a domestic solid fuel burning appliance that is designed to be located outside of ordinary living areas and is used for heating spaces other than the space where the appliance is located by the distribution through ducts of air heated in the appliance. The appliance must be tested and listed as a furnace under accepted U.S. or Canadian safety testing codes.
10. "High pollution day" means those periods of time declared by Colorado Department of Health as provided for in Section 25-7-106.3(1), C.R.S.
11. "Manufacturer" means a person who constructs a wood burning stove or pellet stove or is engaged in the business of designing and constructing masonry heaters.
12. "Masonry Heater" means an appliance designed for or capable of burning wood, capable of and intended for domestic space heating or domestic water heating, which meets the following criteria:
 - a. a factory-built or site-built wood burning appliance whose core is constructed primarily of manufacturer-built, supplied or specified masonry materials (i.e., stone, cemented aggregate, clay, tile, or other non-combustible non-metallic solid materials) which weighs at least 800 kg;
 - b. The firebox effluent of the masonry heater travels horizontally and/or downward through one or more heat absorbing masonry duct(s) for a distance at least the length of the largest single internal firebox dimension before leaving the masonry heater;
For the purposes of this subparagraph:

- i. Horizontal or downward travel distance is defined as the net horizontal and/or downward internal duct length, measured from the top of the uppermost firebox door opening(s) to the exit of the masonry heater as travelled by any effluent on a single pathway through duct channel(s) within the heater (or average of net internal duct lengths for multiple pathways of different lengths, if applicable). Net internal duct length is measured from center of the internal side or top surface of a duct, horizontally or vertically to the center of the opposite side or the bottom surface of the same duct, and summed for multiple ducts or directions on a single pathway, if applicable. For duct channel(s) traversing horizontal angles of less than ninety degrees from vertical, only the net actual horizontal distance travelled is included in the total duct length.
 - ii. The largest single internal firebox dimension is defined as the longest of either the length or the width of the firebox hearth and the height of the firebox, measured from the hearth to the top of the uppermost firebox door opening(s).
 - c. The appliance has one or more air-controlling door(s) for fuel-loading which are designed to be closed during the combustion of fuel loads, and which control the entry of combustion air (beyond simple spark arresting screen(s)) to one or more inlet(s) as prescribed by the masonry heater manufacturer;
 - d. The appliance is assembled in conformance with the underwriters' laboratories-listed and/or manufacturer's specifications for its assembly and, if the core is constructed with a substantial proportion of materials not supplied by the manufacturer, is certified by a representative of the manufacturer to be substantially in conformance with those specifications.
 - f. The appliance has a label permanently affixed to the appliance identifying its manufacturer and model.
13. "Method 5G/5H" is a test method(s) for determination of particulate emissions from woodheaters from dilution tunnel sampling and stack locations as described in 40 CFR, Part 60, Subpart AAA, Appendix A. ??submitted 4/92??
 14. "Method 28" is a test method designed to establish certification test conditions and the particulate matter weighted emission values, as described in 40 CFR Part 60 Subpart AAA, Appendix A. ??submitted 4/92??
 15. "Method 28A" is a test method to measure air to fuel ratios and minimum achievable burn rates as described in 40 CFR, Part 60 Subpart AAA, Appendix A. ??submitted 4/92??
 16. "Model" means a group of wood stoves, pellet stoves or masonry heaters which are identical to one another regarding design, emissions, and heating performance.

17. "New wood stove" means any wood stove other than one which was sold to an individual for his personal use prior to January 1, 1987.
18. "Pellet Stove" means a wood heater which meets the following criteria: (1) the manufacturer makes no reference to burning cordwood in advertising or other literature, (2) the unit is safety listed for pellet fuel only, (3) the unit's operating and instruction manual must state the use of cordwood is prohibited by federal law, and (4) the unit must be manufactured and sold including a hopper and auger combination as integral parts. ??submitted 4/92??
19. "Phase III Certified wood stove" means a wood burning stove which meets the emission standards set forth in Section II.A.1.
20. "Primary source of heat" shall mean one or more residential wood burning stoves, pellet stoves, masonry heaters or fireplaces which provide more than half the annual heating demands for the residence.
21. "Standard method" means the applicable testing procedures and criteria set forth in the Federal Regulations 40 CFR Part 60 Subpart AAA, Appendix A.
22. "Wood burning fireplace" means an appliance designed for or capable of burning wood which does not meet the definition of a wood burning stove or is not exempt under the provisions of section II.C..
23. "Wood burning stove" means an appliance designed for or capable of burning wood, including a fireplace insert, capable of and intended for domestic space heating or domestic water heating that meets all of the following criteria:
 - a. An air-to-fuel ratio in the combustion chamber averaging less than 35-to-1 as determined by EPA method 28A as set forth in the Federal Regulations 40 CFR Part 60 Subpart AAA, Appendix A.
 - b. A useable firebox volume of less than 20 cubic feet.
 - c. A minimum burn rate of less than 5 Kilograms per hour.
 - d. A maximum weight of 800 kilograms.

II. REQUIREMENTS FOR SALE AND INSTALLATION OF WOOD STOVES

- A. On or after July 1, 1991, no person shall advertise to sell, offer to sell, or sell a new wood stove unless it has been tested, certified, and labeled for emission performance in accordance with criteria and procedures specified in the Federal Regulations 40 CFR Part 60, Subpart AAA and meets the emission standards set forth in Subsection 60.532(b)(1) or (2).
- B. The certification requirement shall apply to:
 1. Advertisements for sale and offers for sale communicated by any means to any person in Colorado, including, but not limited to, offers to sell or advertisements for sale which are mailed to any person in Colorado.
 2. Any sale occurring in Colorado, including, but not limited to, sales in which a new wood stove is shipped, delivered, or transported to any person in Colorado by a person located either inside or outside Colorado and to both the initial sale and any subsequent resale of a new wood stove.
- C. Exemptions

1. Wood-fired appliances that are not suitable for heating equipment in or used in connection with residences. For example, portable camping stoves. Such appliances must be exempted by the Division on a case-by-case basis.
 2. Boilers
 3. Furnaces
 4. Cookstoves
- D. On and after January 1, 1993 no person shall sell or install a used wood-burning device within those portions of the counties of Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson which are located in the AIR program area, as such area is defined in Section 42-4-307(8), C.R.S. unless it meets the requirements set forth in Section II.A. Was this supposed to be submitted and approved in 3/20/91 FR??

III. APPROVAL PROCEDURE FOR PELLETT STOVES

??parts submitted 4/92??

- A. No person shall advertise to sell, offer to sell or sell a pellet stove unless it has been designated as an approved pellet stove in accordance with this Section III.
- B. On or after August 1, 1992, a manufacturer of a pellet stove who wishes to have a particular model line designated as an approved pellet stove, shall submit to the Division for their review, the following information:
 1. test results showing an air to fuel ratio of 35:1 or greater, using EPA test method, 28A.
 2. test results using EPA test method 5G or 5H and corrected to 5H which have been conducted under minimum burn conditions, (category 1), using EPA test method 28.
 3. a one page letter signed by the laboratory president, verifying the information required in III. A.1. and 2.
- C. All tests conducted under III. A. shall be performed by an EPA accredited laboratory.
- D. Within twenty (20) working days after receipt of an application for approval, the Division shall notify the applicant if the application is complete. Within thirty (30) working days after receipt of a complete application, the Division shall notify the applicant whether the application satisfies all requirements for approval.
- E. If the Division denies approval, the Division shall notify the applicant in writing of the opportunity for a hearing before the Commission pursuant to Section 24-4-104 (9), C.R.S., (1982).
- F. The Division shall grant approval if all information required by Section III A. is submitted and the test results in Section III.A.2. do not exceed 4.1.G/HR.

IV. APPROVAL PROCEDURES FOR MASONRY HEATERS

- A. No person shall advertise to sell, offer to sell, sell or install a masonry heater unless it has been designated as an approved masonry heater in accordance with this Section IV.
- B. On or after the effective date of this regulation, a manufacturer or builder of a masonry heater who wishes to have a model or design designated as an approved masonry heater, shall submit to the Division for its review the following information:

1. Manufacturer and model identification and specifications and drawings of the firebox and duct system.
 2. Field test results which have been conducted by an EPA-accredited laboratory, showing "in-home" field test particulate emission levels for that model or design of masonry heater of less than 6.0 grams per kilogram.
 3. A letter by the laboratory president verifying: (1) the information required in Section IV.A.1; (2) that the methods used were conducted according to procedures audited by the EPA; and (3) verifying that the masonry heater model or design meets the specifications of the masonry heater definition of this regulation.
- C. Within twenty (20) working days after receipt of an application for approval, the Division shall notify the applicant if the application is complete. Within thirty (30) working days after receipt of a complete application, the Division shall notify the applicant whether the application satisfies all requirements for approval.
- D. If the Division denies approval, the Division shall notify the applicant in writing of the opportunity for a hearing before the Commission pursuant to Section 24-4-104 (9) C.R.S.
- E. The Division shall grant approval if all information required by Section IV is submitted, the masonry heater model is a masonry heater within the definition of this regulation and test results pursuant to section IV.B.2 do not exceed 6.0 grams per kilogram.
- F. The Division may grant approval for a masonry heater model which has not been tested pursuant to Section IV.B.2 upon submission of the following information by the applicant:
1. Manufacturer and model identification and specifications and drawings of the firebox and duct system.
 2. Documentation from the president of an EPA-accredited laboratory that the model is a masonry heater within the definition of this regulation, has substantially the same core construction as a model already approved and is substantially similar to the approved model in firebox and duct design, combustion function and probable emissions performance.

V. ENFORCEMENT

- A. The Division may enter and inspect the property or premises of any manufacturer, or dealer, for the purpose of investigating any actual, suspected, or potential violation of this regulation; and may, at reasonable times, have access to and copy any document, inspect any wood stove, wood stove component, pellet stove, masonry heater or testing equipment, or test the emissions of any wood stove, pellet stove or masonry heater possessed by any manufacturer, or dealer, for the purpose of ascertaining compliance or noncompliance with this regulation.
- B. The Division shall also enforce the provisions of this regulation through all means authorized by Part 1 of Title 25, C.R.S.

VI. LIST OF APPROVED SOLID FUEL APPLIANCES

The Division shall request each dealer to make available to consumers a list of certified wood stoves, exempt, approved pellet stoves and approved masonry heaters to be compiled by the Division.

VII. HIGH POLLUTION DAYS

A. Applicability

Limitations on the use of wood burning stoves, pellet stoves, masonry heaters and fireplaces shall be applicable only in those portions of the counties of Adams, Arapahoe, Boulder, Denver, Douglas, and Jefferson which are located in the AIR program area, as such area is defined in Section 42-4-307(8), C.R.S. but not including those areas above seven thousand feet elevation.

B. Provisions of this section may be enforced by the appropriate local agency.

Local agencies are encouraged to develop suitable enforcement programs and enter into an agreement with the State to promote more effective enforcement of this regulation. Approval of a wood stove, pellet stove or masonry heater model pursuant to this regulation does not constitute authorization not to comply with requirements of any local ordinance or resolution relating to the installation or use of any wood-burning appliance.

C. This section shall not apply within any municipality which had an ordinance mandating restricted use of wood burning stoves, pellet stoves, masonry heaters and fireplaces on high pollution days in effect on January 1, 1990.

1. All such exempt areas shall be required to submit a yearly report to the commission no later than June 30, which provides information concerning the enforcement actions pursuant to their ordinance for the previous heating season.

D. Prohibitions of use

No person shall operate a wood burning stove, pellet stove, masonry heater or fireplace during a high pollution day. A burn-down time shall be allowed for the burn-down of existing fires prior to the initiation of enforcement action.

E. Exemptions

1. Persons utilizing their wood burning stove, pellet stove, masonry heater or fireplace as a primary source of heat.
2. Persons operating a Phase III certified wood burning stove.
3. Persons operating an approved pellet stove. ??submitted 4/92??
4. Persons operating an approved masonry heater.

VIII. REQUIREMENTS FOR INSTALLATION OF FIREPLACES

A. On and after the effective date of this regulation no person shall install any fire place in any dwelling in the area defined in Section VII.A. unless it is one of the following:

1. a gas appliance.
2. an electric device.
3. a fireplace insert that meets the requirements set forth in Section II.A.

4. an approved pellet burning fireplace insert.
 5. an approved masonry heater.
 6. any other clean burning device approved by the Commission which meets the emission standard set forth in Section II.A.
- B. This section shall not apply to any municipality or a county which has a provision in effect on January 1, 1993 which is substantially equivalent of this section as determined by the Commission.

IX. IMPLEMENTATION OF LOCAL CONTROL STRATEGIES

The local jurisdictions listed below shall implement and enforce the indicated ordinances and resolutions, as they exist on January 1, 1993. This ordinance limits wood burning on high pollution days as determined by the Colorado Department of Health. In addition, each shall implement and enforce any ordinance adopted in accordance with this regulation. The indicated ordinances or resolutions may be amended in the sole discretion of the respective governing body, provided that they shall be submitted immediately to the Colorado Air Quality Control Commission and the United States Environmental Protection Agency as revisions to the State Implementation Plan. The listed ordinances and resolutions shall remain in full force and effect until such time as the jurisdiction obtains full approval of a State Implementation Plan revision.

Community	HPD Ordinance Number	Date Enacted	Construction Ordinance	Date Enacted
Arvada		2451		11/87
Aurora	87-118	4/86	92/47	5/92
Boulder	5007	10/86	5445	4/92
Broomfield		794		11/88
Denver	Chapter 4.24	10/86	Chapter 4.24	5/90
Douglas County		R-991-128		11/91
Englewood	31	9/92	39	10/92
Federal Heights		565		1/88
Glendale	2	1/88	15	10/92
Greenwood Village	17	6/88	9	3/92
Jefferson County	R-CC89-873	12/89	R-CC90-617	1/91
Lafayette	24		11/88	7/93
Lakewood	113	12/86	61	10/92

Community	Date Enacted	Construction Ordinance	Date Enacted
Littleton	17	12/88	26 8/92
Longmont		1	1/89
Mountain View		5	1/91
Sheridan	22	11/88	1 1/93
Thornton	2120	10/91	2194 10/92
Westminster	6/14	11/87	20 12/92

X. REFERENCES

Written statements of the basis and purpose of this regulation and revisions as well as all other material referenced in this Regulation is hereby incorporated by reference by the

Air Quality Control Commission and made a part of the Colorado Air Quality Control Commission Regulations. Materials incorporated by reference are those in existence as of the date of this regulation and do not include later amendments. The material incorporated by reference is available for public inspection during regular business hours at the Office of the Commission, located at 4300 Cherry Creek Drive South, Denver, Colorado 80222, or may be examined at any state publications depository library. Parties wishing to inspect these materials should contact the Technical Secretary of the Commission, located at the Office of the Commission.

Effective: April 30, 1995

City of Aspen and Pitkin County

City of Aspen and Pitkin County
FIREPLACE & WOODSTOVE REGISTRATION

*Required—Contact Assessors offices at 920-5160

Registration will not be accepted without a Parcel Id number

List all devices in your home (2 are allowed per building, except for gas appliances)

Note: If the number, type and location on this registration form do not match what is show on your plans or what is actually installed, your permit or Certificate of Occupancy will be denied.

Type of Building (circle one): Residential Other

Type of device Room Existing New Make & Model

Wood burning fireplace (select one)

- Site-built masonry
- Factory built insert: model number: _____

Gas log fireplace (select one)

- Site-built masonry
- Factory built insert: model number: _____

Certified woodstove

Gas fireplace appliance

(attach spec sheet)

If any devices are being removed, please describe here, i.e. “old woodstove removed from living room”

- _____
- _____
- _____

Signature of applicant Date

*Parcel Id number: _____ -- _____ -- _____ -- _____

Street Address: _____

Owners Name: _____

G:\city\building_dept\Aspen 2004 Checklists\fireplace registration .doc

ASPEN/PITKIN COUNTY FIREPLACE AND WOODSTOVE REGULATIONS

In order to keep our air as clean as possible, the elected officials of Aspen and Pitkin County have passed ordinances to regulate the number of fireplaces and woodstoves that can be installed in any building. Building permit applicants must file a fireplace/woodstove registration with the City of Aspen Building Department or the Pitkin County Building Department before the building permit is issued.

Pitkin County is separated into 2 areas. One is the **non attainment area**, which includes the City of Aspen and the Metropolitan areas of the county, i.e. Mountain Valley, Red Mountain, Difficult Ca mpground, T Lazy 7 Ranch, and part of Starwood. The other is the **attainment area** which includes the less densely populated parts of the county, i.e. Brush Creek Village, Holland Hills and Old Snowmass.

Decorative gas appliance: A device utilizing natural gas as a fuel gas designed to appear as a real fireplace with a 4 to 5 inch Class B vent or direct vent, fixed glass door and a firebox no deeper than 24 inches.

Certified Woodstove: Colorado Phase III certified woodstove or a Phase II EPA certified woodstove.

Gas log fireplace: Meet all codes for burning wood but are used with gas logs. They are not allowed in bedrooms.

Aspen and Metropolitan Areas of Pitkin County in the non attainment area

New buildings in the non attainment area may have either 2 gas log fireplace or 2 certified woodstoves or 1 each. They may also have an unlimited number of decorative gas appliances. Wood burning fireplaces cannot be installed, nor may coal be used as fuel.

Remodeling or an addition to an existing home in the non attainment area

- ❑ If the building has 2 or more fireplaces, gas log fireplaces or woodstoves, they only devices you can add are decorative gas appliances.
- ❑ If the building has 1 fireplace, gas log fireplace or woodstove, you may add 1 gas log fireplace and an unlimited number of decorative gas appliances.
- ❑ If a building has more than 2 fireplaces, gas log fireplaces; if one is affected by the remodel it must be removed.
- ❑ If a building has only 1 or 2 fireplaces, woodstoves or gas log fireplaces, please keep in mind:
 - If you alter the firebox of a fireplace, it must be converted to gas logs or removed.
 - If a woodstove is moved, it must be removed or replaced with a department certified woodstove.

Attainment Area in Pitkin County

New residential buildings in this area may have one wood burning fireplace and one gas log or certified woodstove. If there is no fireplace, you may have either 2 gas log fireplaces or 2 certified woodstoves or 1 each. Buildings may also have an unlimited number of decorative gas appliances.

Remodeling or an addition to an existing building in the attainment areas

- ❑ If the building has 2 or more fireplaces or woodstoves, the only devices you can add are decorative gas appliances.
- ❑ If you have 1 fireplace or woodstove, you may add 1 gas log or certified woodstove and an unlimited number of decorative
- ❑ gas appliances
- ❑ If a building has more than 2 fireplaces or woodstoves: if one is affected by a remodel, it must be removed
- ❑ If a building has on 1 or 2 fireplaces, woodstoves or gas log appliances, please keep in mind:
 - If a woodstove is moved, it must be removed or replaced with a department certified device.
 - If you alter the firebox of a fireplace, and already have another fireplace, it must be converted to gas log

Non residential buildings (which include commercial buildings, restaurants, lodges, public buildings, and hotels) in the attainment area of Pitkin County are allowed to have gas appliances.

City of Fort Collins

City of Fort Collins
WOOD SMOKE
PROGRAM REVIEW

Prepared by Intergovernmental Wood Smoke Committee
For The City of Fort Collins Natural Resources Department
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www.fcgov.com/naturalresources/
April 2002
(Minor revision, June 2002)

List of Terms

A.I.R program area

Automotive Inspection and Readjustment Program. Colorado's emissions testing program. In the north front range, the A.I.R. program area covers the southeast portion of the Larimer County, including Berthoud, Loveland, Drake, Fort Collins, and Wellington, but excluding Red Feather and Estes Park. In Weld County, the A.I.R. program area covers the Greeley urban area.

B(a)P

Benzo(a)pyrene [B(a)P, CAS number 50-32-8] is a member of a class of compounds known as polycyclic aromatic hydrocarbons (PAHs). B(a)P is designated a probable human carcinogen by EPA and an animal carcinogen by the International Agency for Research on Cancer (IARC) (EPA, 1998a). Residential wood combustion has been estimated to account for the majority of B(a)P emissions in the Great Lakes Basin (USEPA, 1999). In a 1996 report produced by the Great Lakes Regional Air Toxic Emissions Inventory Project, over half of B(a)P emissions in the Great Lakes Basin are attributed to residential wood combustion (EPA, 1999).

Certified Units

Wood stoves and fireplace inserts manufactured on or after July 1, 1990 -- or sold on or after July 1, 1992 -- are certified by the EPA to meet stringent emission standards.

CDPHE

Colorado Department of Public Health and Environment

Colorado Phase III

A State-designated rating for wood-burning devices. It is exactly the same as "EPA Phase II".

EPA Phase I

July 1, 1988: The EPA's Phase I regulations go into effect. All woodstoves manufactured after this date must emit fewer than 8.5 grams of particulates per hour (5.5 grams/hr if catalytic equipped), and are to be exempted from local "burn bans". Existing inventories of non-approved woodstoves may continue to be sold until 1990. All woodstoves sold at retail after July 1, 1990 must comply with Phase I emissions regulations.

EPA Phase II

July 1, 1990: Phase II regulations go into effect. All woodstoves manufactured after this date must comply with Phase II limits of 7.5 grams/hr (4.1 grams/hr if catalytic equipped). Existing inventories of Phase I approved woodstoves may continue to be sold until 1992. All woodstoves sold at retail after July 1, 1992 must comply with Phase II emissions regulations.

High Pollution Days

Under Colorado Regulation 4, CDPHE issues high pollution advisories in the winter. The five-month high pollution season (November to March) includes red and blue day public advisories. High pollution or "Red" days trigger mandatory wood-burning restrictions. Red days are also accompanied by a request to voluntarily reduce driving, along with information about how individuals can help improve air quality.

No Burn Days

Same as "High Pollution days" above.

Nonattainment Area

A geographical area in which the mean concentration of a specific criteria pollutant exceeds the national ambient air quality standard. Fort Collins is still officially designated nonattainment for carbon monoxide, but will be redesignated soon.

POS - Point of Sale

This refers to the time when homes are sold.

SIP – State Implementation Plan.

A document prepared by the state regulatory agency and approved by EPA which describes a comprehensive plan of action for achieving specified air quality objectives and standards for a particular locality or region within a specified time period.

ZILCH – Zero Interest Loans for Conservation Help.

The City of Fort Collins' zero interest loan program for wood stove removal or upgrade to gas-burning units.

EXECUTIVE SUMMARY

BACKGROUND

The City of Fort Collins has two policies on wood smoke; to reduce area-wide wood smoke emissions, and to reduce the number of non-certified wood stoves and conventional fireplaces. The City currently addresses wood smoke issues with a multipronged program of education, incentive, and regulation.

In recent years, the number of wood smoke complaints has been declining, yet the existing complaints are becoming more difficult to resolve successfully. In light of this situation, the City's Air Quality Action Plan was amended in 2001 to include a task to "*Evaluate City programs designed to reduce residential woodsmoke emissions and recommend improvements, if needed.*"

An intergovernmental committee made up of representatives from the City of Fort Collins, Larimer County, Poudre Health Services District, and Poudre Fire Authority was convened in December 2001 for the purpose of reviewing the City's wood smoke program.

KEY FINDINGS

Forty complaints (unique addresses) and 89 calls were received by the City's Wood Smoke Response Line between 1995 and 2001. An average of seven wood smoke complaints were documented since its inception in 1989. Since 1999, there have been less than seven wood smoke complaints each year. However, City staff still spends a significant amount of time trying to resolve wood smoke complaints. (NOTE: Some multiple complaints about the same location, and complaints to other departments and agencies are not reflected in these numbers.) Estimates of local wood smoke emissions vary. Citizen survey data between 1990 and 2001 suggest that carbon monoxide emissions associated with wood smoke are declining, city-wide. However, the Colorado Department of Public Health and Environment projections show wood smoke emissions steadily increasing from 24 tons CO/day in 1992 to 27 tons CO/day projected for 2015. These projections assume the number of wood stoves would grow proportionally with

population from 1990 levels, and amount of wood burned, by device type, would not change from 1990 levels. Better data are needed to accurately quantify local wood smoke emissions. Recent surveys show that most Fort Collins citizens view wood smoke as a minor source of air pollution, yet 15% view it as a major source. Survey data also show citizen support for more stringent wood smoke controls. In 2001, 85% of citizens agreed or strongly agreed that the City should prohibit wood-burning and 60% of citizens agreed or strongly agreed that the City should require removal of non-certified units at point-of-sale.

The current City opacity restriction (40%) is seriously limited in its ability to resolve wood smoke problems because the readings are not made at night when woodburning typically occurs, and the certified opacity readers are not always available to make the reading at the time of highest opacity. No opacity violations have ever been recorded in Fort Collins, and no air pollution nuisance cases have ever been brought to the City's Municipal Court.

An Internet search revealed that other communities limit opacity to 20%, and three states use a non-EPA-approved method to measure opacity at night. Although wood smoke potentially affects everyone, children, people with respiratory diseases, and the elderly are more likely to be affected. The number of local asthma-related emergency room visits has increased slightly since 1998, and the number of asthma-related hospital admissions has decreased slightly since 1998.

Data on asthma-related doctor visits are not available.

RECOMMENDATIONS

The Committee's recommendations are outlined below, in no special order of priority. They will be submitted to the City's Natural Resources Department, which has primary responsibility for implementing the City's wood smoke program. Recommended regulatory actions will be reviewed with the City government at appropriate levels, and recommendations that are deemed appropriate will be forwarded to City Council, with input from the Air Quality Advisory Board.

Education

1. Manage expectations about the City's ability to resolve complaints.
2. Increase general education about the impacts of wood burning.
3. Modify the Wood Smoke Response Program, and promote widely.
4. Examine the feasibility of reducing smoke in homes.
5. Provide guidelines about how prospective home buyers can avoid smoky neighborhoods.
6. Work more closely with industry to promote wood burning education.
7. Publicize ZILCH more broadly.
8. Insure adequate communication between agencies.
9. Evaluate a voluntary "high pollution day" no burn program.

Incentive

1. Do not offer City-funded incentives that support any wood-burning at all, such as chimney sweeping or stove maintenance.
2. Encourage retailers to develop their own rebate program for upgrade to gas units.
3. Seek grant funding to remove or upgrade problem units to gas.
4. Consider offering incentives for not burning.

Regulation

1. Strengthen the City's opacity restriction.
 - Tighten opacity limit to 20%.
 - Certify a City employee to read opacity.
 - Work with Municipal Judge and Prosecutor so they better understand the opacity limit.
 - Collect more data with each opacity reading.

- Evaluate the opacity limitation for effectiveness two years after adoption.
2. Explore the option of using nighttime opacity measurements.
 3. Evaluate mandatory removal of non-certified units when homes are sold. Provide an incentive program to aid buyers/sellers in achieving this mandate.
 4. Review the general clause of City's Air Pollution Nuisance Ordinance and develop implementation guidelines.

The City of Fort Collins has two policies on wood smoke; to reduce area-wide wood smoke emissions, and to reduce the number of non-certified wood stoves and conventional fireplaces. The City currently addresses wood smoke issues with a multi-pronged program of education, incentive, and regulation. In recent years, the number of wood smoke complaints has been declining, yet the existing complaints are becoming more difficult to resolve successfully. In light of this situation, the City's Air Quality Action Plan was amended in 2001 to include a task to *"Evaluate City programs designed to reduce residential woodsmoke emissions and recommend improvements, if needed."*

An intergovernmental committee was convened in December 2001 for the purpose of reviewing the City's wood smoke program. Committee members included:

City of Fort Collins

Sarah Fox, Planning and Outreach Specialist

Ginny Sawyer, Neighborhood Administrator

Beth Sowder, Code Compliance Case Manager

Lucinda Smith, Senior Environmental Planner

Larimer County

Doug BJORLO, Environmental Health Specialist

Doug Ryan, Environmental Health Planner

Poudre Health Services District

Bruce Cooper, Medical Director

Sue Hewitt, Evaluation Coordinator

Poudre Fire Authority

Rick Baldwin, Assistant Fire Marshal - Investigation

The Committee also received input from David Shohet, Natural Resources Intern, Zoe Shark, Natural Resource Education and Public Involvement Coordinator, and Mike Silverstein, Environmental Protection Specialist with the Colorado Department of Public Health and Environment (CDPHE).

This report contains the information compiled by the Committee on the issue, and the Committee's recommendations. These recommendations will be submitted to the City's Natural Resources Department. Recommended regulatory actions will be reviewed with the City government at appropriate levels, and recommendations that are deemed appropriate will be forwarded to City Council, with input from the Air Quality Advisory Board.

The City currently addresses wood smoke issues with a multi-pronged program of education, incentive, and regulation.

Education

Wood Smoke Response Hotline - The City has helped many residents resolve smoke and odor problems in their neighborhoods through its wood smoke response line. Residents who are concerned about excessive smoke or odor may contact the Natural Resources Department during

normal business hours of 8:00 a.m. to 5:00 p.m., Monday through Friday. Callers are asked to identify the residence where the problem is occurring, or at least describe the approximate location. The City then sends a letter, a copy of City Law, and information about proper woodburning practices to all homes in the area, including the problem address. The City continues to work with the caller and the residence in question until the issue is resolved. While the caller may exercise the option of filing a formal complaint through Municipal Court, none of the complaints received over the past several years have resulted in legal action. Existing Wood Smoke Response Line

Step Details

1. Letters sent to neighborhood (occasionally to home owner also when rental properties). Conducted by City staff in Fort Collins Urban Growth Area and by County staff in rural areas.
2. Letter sent directly to residence in question.
3. In some cases, property visited by staff. Background check with Building and Zoning to determine if the residence has a certified unit. In the past, this step brought positive results.
4. Opacity readings conducted by County staff. Larimer County staff performs opacity readings. Chimney opacity is not measurable at night under existing system, when burning is most common.
5. Free mediation offered by City Neighborhood Resources. This is a relatively new step in the process. It has not yet resulted in successful resolution, because usually at least one party does not want to participate in mediation.
6. The City Air Pollution Nuisance Ordinance may be invoked. City Attorney's Office discourages this because the burden of proof is too difficult to establish. The air pollution nuisance ordinance has never been used to resolve a case.

Incentive

Zero Interest Loans for Conservation Help (ZILCH) - Since 1990, the City has offered a ZILCH loan program to assist residents with the removal or replacement of older, non-certified wood stoves and wood stove inserts. The goal of the program is to reduce wood smoke emissions. Through ZILCH, the City loans between 80% to 95% of the cost of each project based on the pollution-reduction achieved. The maximum loan for upgrades is \$2,300. The maximum loan for removal of units is \$500. The applicant is responsible for any remaining costs.

ZILCH is advertised on the City's Web site and retailers distribute ZILCH pamphlets at their stores. Anecdotal information suggests that wood stove retailers only promote this incentive to customers where a financial need is perceived. It is clear that the ZILCH program needs to be more widely publicized. An increased level of outreach is currently being planned in conjunction with Utilities staff.

Summary of Recent ZILCH Activity

Regulation

Fuel Restrictions. Fort Collins City Code prohibits the burning of treated wood and garbage. The only acceptable fuel that can be burned in a wood stove or fireplace is clean, dry, untreated wood or wood products, or other solid fuel products specifically made for woodburning units. Coal may be burned only in a coal-burning appliance that is the sole source of heat and where no other central heating system exists.

Chimney opacity limited to 40%. After the first fifteen minutes or so of startup, City Code requires smoke from a chimney or stovepipe be less than 40% opacity.

Certified units must be installed. City Code requires that only Colorado Phase III (same as EPA Phase II) units may be installed. This is enforced through building permit requirements.

Definition of general air pollution nuisance (City Code Sec. 20-1)

“The emission or escape into the open air from any source or sources of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors or any other substances or combination of substances in such manner or in such amounts as to endanger or tend to endanger the health, comfort, safety or welfare of the public or to cause unreasonable injury or damage to property or to interfere with the comfortable enjoyment of property or normal conduct of business is hereby found and declared to be a public nuisance. It is unlawful for any person to cause, permit or maintain any such public nuisance within the city.”

The City Code language has proved to be problematic in that it does not provide quantitative standards allowing a judge to rule favorably for a complainant. No air pollution nuisance cases have ever been brought to the City’s Municipal Court.

Public Nuisance Ordinance applies indirectly. The City Public Nuisance Ordinance was passed in 2000 to remedy chronic problems at properties where City Code violations occur that annoy or disturb others. Property owners are held accountable for the use of their properties. The ordinance is invoked when three or more separate City Code violations occur at the same property within 12 months, or five or more occur within 24 months. Written notice must have been sent to the property owner and tenants within 30 days of each violation, except the last one. The last violation must have occurred at least 45 days after the last notice. Each complaint about a separate violation must result in the issuance of a municipal court citation. This ordinance could be applied to chimney opacity readings, but it is not expected to be helpful, given the difficulty making nighttime opacity readings.

Appendix A provides complete sections of City Code discussed above.

Existing City Department Roles in Implementation

Natural Resources

The Natural Resources Department (NRD) takes the lead in implementing the City’s wood smoke program. NRD staff conduct general education and outreach regarding wood smoke and administer the Wood Smoke Response program. NRD contacts other departments for assistance in resolving wood smoke complaints, as needed. NRD also receives and screens wood stove ZILCH loan applications and forwards them to Utilities for processing.

Health and Safety

Health and Safety staff are available to issue tickets to residents in violation of the City's opacity restriction. In addition, Health and Safety staff also are available to conduct site visits to wood smoke complaint residences.

Neighborhood Resources

Neighborhood Resources staff are available to offer mediation in an effort to resolve good smoke complaints between neighbors. Neighborhood Resources also can provide education regarding wood burning to individual neighborhood groups.

City Attorney’s Office

The City Attorney’s Office provides legal advice regarding the air pollution nuisance ordinance.

Municipal Court

Any air pollution nuisance cases would be prosecuted through the City’s Municipal Court.

Building and Zoning

The Building and Zoning Department tracks building permits required when wood burning devices are installed in homes.

Utilities

Utilities staff process wood stove ZILCH loan applications after receiving approved applications from Natural Resources.

Scope of Fort Collins' Wood Smoke Problem

- Only 2% of residences in Fort Collins rely solely on wood burning as the primary source of heat. The number of residences using wood burning as a secondary source of heat dropped from 17% in 1997 to 13% in 2001, based on local survey data.
- Forty complaints (unique addresses) and 89 calls were received by the City's Wood Smoke Response Line between 1995 and 2001. An average of seven wood smoke complaints were documented each year between 1989 and 2001. (Some multiple complaints about the same location, and complaints to other departments and agencies are not reflected in these numbers.)
- City staff time spent on wood smoke complaints has ranged from two to more than forty hours per complaint.
- Carbon monoxide emissions associated with wood smoke appear to be declining citywide, based on local citizen survey data. However, the Colorado Department of Public Health and Environment shows wood smoke emissions steadily increasing from 23.9 tons CO/day in 1992 to 26.9 tons CO/day projected for 2015. Better data are needed to accurately quantify wood smoke emissions.
- 70% of complainants identify a specific residence as the source of wood smoke in their neighborhood.
- Building permit enforcement of the City Code requiring installation of certified units resolved 18% of wood smoke complaint cases. In other words, 18% of cases involved residences where a non-certified unit had been installed without a building permit. The Wood Smoke Response Line process led to the installation of certified units in 18% of the cases, and no further complaints were received.
- However, for the majority of complaints, it is not known whether the source is operating a certified unit or a non-certified unit. In only 13% of the complaints received has the City been able to establish that the source was operating a non-certified unit.
- ZILCH loans are not widely publicized. In recent years, only a small portion of the available fund has been used. Citizen Perspectives on Wood Smoke
- Most citizens view wood smoke as a minor source of air pollution (39%) or a moderate source (39%), yet 15% view it as a major source.
- In 2001, 85% of citizens agreed or strongly agreed that the City should prohibit woodburning and 60% of citizens agreed or strongly agreed that the City should require noncertified units to be removed or upgraded when homes are sold.

Regulations to Reduce Wood Smoke

- The City's general air pollution nuisance code has proved to be problematic in that it does not provide quantitative standards allowing a judge to rule favorably for a complainant. No air pollution nuisance cases have ever been brought to the City's Municipal Court.
- The State's odor regulation (Regulation 2) is violated when an odor is detectable even after it is diluted seven times with clean air. To date, wood smoke has never caused a violation of the State's odor regulation.

- Current City opacity restrictions are seriously limited in their ability to resolve wood smoke problems because readings are not made at night when woodburning typically occurs. Furthermore, Larimer County staff are not always available to make the reading at the time of highest opacity. No opacity violations have ever been recorded in Fort Collins.
- An Internet search revealed that most other government agencies that regulate residential wood smoke limit chimney opacity to 20%.
- California, Hawaii and Alaska use a non-EPA-approved method to measure residential wood smoke chimney opacity at night.

Health Aspects

- Although wood smoke potentially affects everyone, children, people with respiratory diseases, and the elderly are more likely to be affected.
- Scientific studies that were reviewed when EPA revised the national particulate matter (PM) standards in 1997 showed no threshold level dose-response for particulate matter, a component of wood smoke (i.e., PM has an impact regardless how small the dose).
- The number of local asthma-related emergency room visits has increased slightly since 1998, and the number of asthma-related hospital admissions has decreased slightly since 1998. Data on asthma-related doctor visits are not available.

EDUCATION

1. Manage Expectations

Clearly define up front with complainants what the City can and can't do regarding their wood smoke complaint.

The City's Wood Smoke Response Program will continue to:

- Educate the neighborhoods (send a letter to neighborhood residents with City Code and information about proper burning practices),
- Work with the source of the problem,
- Promote mediation, and
- Insure the source is complying with all existing regulations.

Despite these efforts, the Wood Smoke Response Program still may not be able to resolve all cases satisfactorily.

2. Increase general education about the impacts of wood burning.

Increase education efforts about the air quality and health impacts of wood burning, discourage burning, discuss the importance of proper stove maintenance, and provide tips on how to burn clean, etc. through the following actions.

- a) Recognizing pollution prevention as a priority approach, continue to promote the "don't burn if you don't have to" philosophy.
- b) Meet with neighborhood groups in the older part of town to discuss wood smoke.
- c) Print an annual article in City News early each fall, including tips on how to burn clean.
- d) Include articles about wood burning in newsletters printed by neighborhood groups and the City's Neighborhood Resources Office.
- e) Add wood stove information to the *Environmental Homes* curriculum for school children.
- f) Provide one-on-one education to wood burners to resolve complaints.
- g) Consider distributing door-hangers with general wood burning information.
- h) Include standard information about the health impacts of wood smoke in outreach materials, especially identifying at-risk populations.

i) Encourage Poudre Fire Authority to include wood smoke in their general public education efforts. Capitalize on advertising opportunities to raise public awareness about wood smoke issues and the importance of stove maintenance.

3. Modify the Wood Smoke Response Program, and promote widely.

a) Accept e-mail complaints on the Web.

b) Conduct a site visit in every case where the problem is not resolved by letters. Insure that City staff have adequate training to identify certified units and to educate wood burners on proper burning practices. Make sure staff have adequate support to insure their safety during visits.

c) Continue to promote mediation. Work closely with Neighborhood Resources and Health and Safety staff.

d) Expand the type of data collected when complaints are made. To the extent possible, document:

- Weather conditions.

- Whether there any individuals at the complainant residence who have respiratory problems, and if so, what type of problem.

- Whether the caller or anyone in their household is experiencing respiratory problems as a result of the wood smoke.

- Whether it is a high pollution "Red" day in Denver.

- Whether the wood stove being complained about is certified.

- What is the type and condition of fuel being burned.

e) Seek assistance of Police Services in chronic cases. For chronic, difficult-to-resolve cases (historically 1-2 each year), City staff should ask a police officer to accompany them when visiting residents who have been complained about. This would provide increased safety for staff.

4. Examine the feasibility of reducing wood smoke in homes.

Examine the feasibility of providing suggestions to citizens on how wood smoke can be kept out of their homes (e.g., research feasibility of moving vent locations to minimize outside smoke intake), This must be done in conjunction with Wood Smoke Response Program efforts to reduce wood smoke from the source residence, in order not to imply that this problem can and should only be solved by those who are negatively impacted by smoke.

5. Provide guidelines about how prospective homebuyers can avoid smoky neighborhoods.

Provide general guidelines to help prospective homebuyers who are anxious to avoid wood smoke pollution on how to avoid neighborhoods where wood smoke problems occur. General recommendations can be made on the Web, in brochures, in articles, etc. Specifically, provide information about the age of housing stock in relation to the year that the installation of noncertified units was prohibited.

6. Work more closely with industry to promote wood burning education.

Work with wood stove retailers and chimney sweep companies to boost education to customers about the importance of proper stove maintenance and burning practices. Coordinate with the Colorado Department of Public Health and Environment to the extent possible.

7. Publicize ZILCH more broadly.

Publicize ZILCH more broadly for the removal of non-certified units or upgrade to gas units.

8. Insure adequate communication between agencies.

Insure that all government parties in the region clearly know to refer Fort Collins chimney wood smoke complaints to the City of Fort Collins Natural Resources Department and to refer opacity reading requests to the Larimer County Health Department.

9. Evaluate a voluntary “high pollution day ” no burn program

The Committee believes this approach merits further consideration by staff, but lacked adequate information to make specific recommendations regarding forecasting, notification, and enforcement of such a program. The Committee is very interested in this option, primarily as a means of strengthening education and outreach efforts, rather than as a means of reducing emissions on high pollution days in order to avoid exceedances of the federal standard.

Pros

It is simple and straightforward.

Some citizens think it already exists in Fort Collins.

If the program was included in Fort Collins’ CO Maintenance Plan, the City could gain credit in its State Implementation Plan for a voluntary program implemented according to EPA guidelines.

Cons

It might be construed to be in conflict with the year-round pollution prevention message of “Don’t Burn if You Don’t have to.”

It might *encourage* burning on Blue days.

If the program was included in Fort Collins’ CO Maintenance Plan, the City would be obligated to carry it out for the fifteen year period of the CO Maintenance Plan.

Information Needs

Comparison of Fort Collins’ meteorology to Denver’s to determine how well Denver’s high pollution day forecast fits Fort Collins.

Estimation of costs vs. air pollution benefits.

INCENTIVE

1. Do not offer City-funded incentives that support any wood-burning at all, such as chimney sweeping or stove maintenance.

2. Encourage retailers to develop their own rebate program for upgrades to gas units.

Work with wood stove retailers, distributors, and the Hearth Products Association to develop a retailer-run rebate program for upgrades to gas units. (This has been done with EPA funding in several other areas around the country.)

3. Seek grant funding to remove or upgrade problem units to gas.

Explore revenue sources (e.g., the gas company) to fund replacement of problem wood-burning units with gas units or better, in the case of intractable problems.

4. Offer incentives for not burning.

Consider an incentive program offering money for not burning, along the lines of the SMART BUCKS program that offers employees money for not driving.

REGULATION

1. Strengthen the City's opacity restriction.

a) Tighten opacity limit to 20%.

Put teeth into the City's air pollution nuisance ordinance by tightening the chimney opacity limit to 20%. A Web search reveals that all other municipalities use a 20% opacity restriction for residential wood burning. When preparing this recommendation for Council, identify the visible difference between 20 and 40% and the emissions associated with each level. Be clear that even

the tighter opacity standard will not insure resolution of all cases, but it will make this tool more effective for resolving wood smoke complaints.

b) Certify a City employee to make opacity readings.

One of the limitations of the opacity restriction is that a County inspector may not be available to make a reading during the periods of highest opacity. In order to increase capability to make timely opacity readings, certify a City employee to read opacity. Having two certified opacity readers (one City, one County) is expected to substantially increase the response time for opacity reading requests. In addition, provide training to the certified City employee so they can educate residents about wood burning practices and impacts when making opacity readings.

c) Work with the City's Municipal Judge and Prosecutor so they understand the opacity restriction and measurement methods.

d) Collect more data with each opacity reading.

Institute a tracking system for Fort Collins opacity requests indicating when the request was made, when the reading was made, and the outcome. These data on opacity requests will supplement the enhanced complaint data collection recommended under Education, Item 3 (d).

e) Evaluate the opacity limitation for effectiveness two years after adoption.

2. Explore the use of nighttime opacity measurements.

Alaska, California, and Hawaii use a method to read chimney opacity during the nighttime. Evaluate whether this method would increase the practical effectiveness of the opacity restriction.

3. Evaluate mandatory removal of non-certified units when homes are sold. Provide an incentive program to aid buyers/sellers in achieving this mandate.

Committee members feel this is an option worth considering and support the Air Quality Advisory Board's intent to explore this measure. The Committee suggests instituting the program in a voluntary mode first, and providing an incentive program to aid buyers and sellers in removal of non-certified units. This mirrors the approach used by Utilities when requiring water meters at residences.

Pros

It is in direct support of City policy to "reduce the number of non-certified wood stoves."

Cons

Absent a subsidy, this will likely increase the cost of a housing transaction.

Information Needs

Cost of removal.

Details on how to handle fireplaces.

Better data on number of non-certified units associated with wood smoke complaints.

4. Review the general clause of City's Air Pollution Nuisance Ordinance and develop implementation guidelines.

Seek assistance from the City Attorney's staff to identify and review alternatives to the City's air pollution nuisance ordinance that could aid in increasing the ability to quantify "nuisance" so that it is defensible in court. (This pertains to all air pollution nuisances, not just wood smoke.)

Further, develop internal policy guidelines for interpretation and enforcement of this ordinance.

Actions Considered but not Recommended

1. Mandatory disclosure of wood-burning device type and/or maintenance at point of sale.

The Committee considered other actions at point-of-sale such as mandatory disclosure of type of wood-burning device and/or maintenance status, but felt stove maintenance would be more effectively promoted through the wood stove industry (retailers, chimney sweeps, etc.).

2. Restrict installation of wood stoves older than five years.

CDPHE staff reported that EPA data show emission control devices on wood stoves degrade with time, lessening their efficiency. CDPHE staff suggested a ban on the installation of wood stoves older than five years. The Committee was not able to obtain more information on this item in a timely manner, and therefore did not include it in this report.

3. Create a map of neighborhoods with high potential for wood smoke problems.

The Committee abandoned the idea of producing a map showing neighborhoods with older home because complete data on the presence or absence of wood burning devices in homes are not available, and the presence of a wood-burning device does not necessarily mean it will be used.

This section provides relevant information that was identified through the committee process and is used to support the findings and recommendations of the Committee.

A. OTHER EXISTING PROGRAMS IN COLORADO

State of Colorado

Education

The Colorado Department of Public Health and Environment has an extensive outreach program to notify citizens in the Denver-metro area about high-pollution (“Red”) advisory days and when associated woodburning restrictions are in effect. Citizens are notified through the Web and on TV Channel 9.

Incentives

CDPHE does not offer any incentive program to reduce wood smoke.

Regulation

The Colorado Air Quality Control Commission, a body appointed by the Governor, establishes State regulations governing air pollution in Colorado. Below is a brief summary of state regulations that relate to wood smoke.

Regulation 1: PM, Smoke, CO, Sox. – Regulation 1 limits emissions from stationary or intermittent sources to 20% opacity or less. Recreational or non-commercial (i.e., residential) fireplaces, fireplace inserts, and wood stoves are exempt.

Regulation 2: Odor. Regulation 2 limits detectable odors in residential and commercial areas. A violation occurs if the odor is detectable when the odorous air is diluted seven times with clean air.

Regulation 4: Wood Burning Devices. Regulation 4 requires mandatory woodburning restrictions during high pollution (“Red”) days for everyone in the entire six-county Denver metro area, which includes Boulder County. Exceptions from the restriction include citizens who live above 7,000 feet and citizen who use Colorado Phase III (EPA Phase II) certified woodburning stoves, Colorado approved pellet stoves, approved masonry heaters or those whose stoves or fireplaces are their primary source of heat.

Regulation 4 is enforced largely by local agencies that have adopted restrictions into their own municipal code. Currently, 19 local governments, including Boulder and Longmont, have local control ordinances. The Colorado Department of Public Health and Environment enforces Regulation 4 in the remaining areas that do not have local authority.

Larimer County

Department of Health and Environment Mission Statement

“To promote a healthy community and reduce unnecessary suffering caused by preventable disease, disability, or death. This mission is accomplished by providing community health and

environmental health services, communicable disease control, health education, vital records management, health data assessment, development of policies that advance the public's health, and advocacy for community-based services that provide needed health care.”

Policy

Larimer County Master Plan Section 7.3.1, Action Item 16, states the objective of reducing the use of non-certified wood stove and fireplaces.

Education

Larimer County uses education as the first approach to resolve wood smoke problems. A letter is sent to the probable offending property owner in unincorporated and rural areas of the county. Municipalities handle education within their own boundaries. County staff report problems ranging from wet wood to poor burning practices. Most complaints are from individuals with respiratory problems or other sensitivities to wood smoke. Resolution is sometimes achieved through education.

Incentive

Larimer County does not offer incentive-based programs to reduce wood smoke.

Regulation

Larimer County prohibits the installation of any new, non-certified wood stoves or wood stove inserts in the County. Larimer County restricts installation of non-certified masonry fireplaces in the A.I.R. program area only, but as of December 2001, allows installation of new non-certified masonry fireplaces outside the A.I.R. program area.

The County is the enforcement agency for State air emissions regulations as well as County regulations. County staff also enforce Fort Collins' chimney opacity restriction using EPA Method 9. This requires making 24 consecutive readings over a six-minute period. County staff must be recertified every 6 months. Recertification involves passing 100 reading tests and paying the twice-yearly recertification fee of \$100.

County staff are also certified to “read” odor levels for compliance with the State regulation, using a “scentometer”. This involves diluting the odor with a charcoal filter. It is extremely difficult for odors to violate the state odor standard. There are no known violations of the odor standard from wood smoke sources.

Poudre Fire Authority

Poudre Fire Authority issues more than 300 open burning permits for slash piles/open pit fires within its jurisdiction each year. This is up from ~ 100 permits a decade ago. They receive about five citizen complaints each year from these permitted open fires.

PFA 1997 Uniform Fire Code, Article 11, allows the Fire Chief (or his representative) the discretion to put out open fires if he determines that smoke emissions are causing a threat to an individual's health or property.

PFA does not receive many wood smoke complaints because most citizens complain about wood smoke after 5:00 p.m., when PFA's call-in number is closed. The option after 5:00 p.m. is to call 911. PFA refers the few wood smoke complaints they receive to the City of Fort Collins Natural Resources Department or Larimer County Health Department.

City and County of Denver

The City and County of Denver prohibit solid fuel burning in any solid-fuel-fired device during a "high pollution day" unless a permit has been granted by the Denver Department of Environmental Health. Permits are granted only for Environmental Protection Agency (EPA) Phase II certified wood stoves, fireplace inserts, approved pellet stoves, and for residential sole

source of heat and effective heating systems. This is enforced only when citizens complain. They try to resolve complaints through education first.

Weld County/Greeley

Currently, wood smoke issues are addressed through education and outreach. Staff makes a contact and talks to the source of the wood smoke. City and County Code allow only wood to be burned in wood burning devices. When Greeley was designated a carbon monoxide nonattainment area, they participated in the mandatory No Burn program under Colorado Regulation 4. The Weld County Health Department performed high-pollution day forecasting for Greeley, and notification was done through a telephone hot line. Greeley no longer participates in the mandatory No Burn program.

Loveland

Loveland is listed on the State Health Department's Web site as participating in a voluntary No Burn program. (<http://www.cdphe.state.co.us/ap/woodlocal.asp>)

Boulder

The City of Boulder participates in the mandatory No Burn program on "Red" days. Boulder's Code Enforcement staff, who are commissioned officers, enforce the program. They work in pairs during the night shift on high pollution days, and receive paid overtime. Boulder maintains a database of wood burning devices, by residence. If a complaint is reported, or if the Code Enforcement Officers notice visible chimney smoke, they will knock on the door, explain the situation, and ask about the type of device. When the mandatory No Burn program was initially adopted in the late 1990's, initial enforcement efforts were very high. Within six months, the community had largely accepted the program. Boulder does not have a chimney opacity restriction.

El Paso County / Colorado Springs

El Paso County's Clean Air Campaign administers a voluntary "No Burn" program asking residents to voluntarily refrain from using uncertified wood stoves and open wood-burning fireplaces when high pollution days are forecast or are in effect. However, citizens can burn if using an EPA Certified Phase II wood stove or fireplace insert, a Colorado-approved Phase III pellet stove, pellet fireplace insert or masonry heater, a gas stove, gas fireplace insert, or a gas fireplace.

"No Burn" announcements are made through the radio, television and newspapers, and through the Clean Air Campaign office.

Mesa County

The Mesa County Health Department asks residents to voluntarily refrain from burning on high pollution days. On those days, anyone not using an EPA Certified Phase II wood stove or fireplace insert, a Colorado Phase III pellet stove, pellet fireplace insert or masonry heaters, or a gas hearth product is asked not to burn a fire in their hearth. The Mesa County Health Department monitors air quality in the Grand Valley and issues "No Burn" advisories to the public through radio, television, and newspapers on high pollution days. The advisories are issued in the morning from November through February and are in effect for 24 hours.

Grand Junction

A new ordinance passed in March 1997 by Grand Junction's City Council requires that new hearth products (wood stoves, pellet stoves, masonry heaters) installed after this date meet current state standards for clean burning. Wood stoves must be EPA Certified Phase II products, and pellet stoves and masonry heaters must be Colorado Phase III products. The ordinance also

prohibits burning in non-clean stoves and fireplaces on high pollution days as declared by the Mesa County Health Department.

In addition, after September 1, 1997, residents who sell a house with a non-clean burning hearth product are required to either replace it with a gas stove, an EPA Certified Phase II wood stove or a Colorado Phase III pellet stove or masonry heater. Fireplaces are not subject to this ordinance.

Fruita

In Fruita, new dwellings and remodeled portions of existing structures cannot contain wood stoves, fireplaces, coal burning or similar heating devices, but gas fireplaces and pellet stoves may be installed.

Telluride

According to town code, all wood-burning devices must be permitted. Telluride has capped the number of available permits, so new wood burning devices can only be installed if an old device is removed, and that permit becomes available.

B. SCOPE OF WOOD SMOKE PROBLEM IN FORT COLLINS

Estimates of Local Wood Smoke Emissions

The major emissions from wood stoves are carbon monoxide, organic gases, particulate matter, and nitrogen oxides. Wood smoke contains small amounts of harmful organic compounds including formaldehyde, benzopyrene, and dioxins.

Figure 1. Survey-based Estimates of Local Wood Smoke Emissions

The above emissions estimates were based on responses to “amount of wood burned” questions in Fort Collins citizen surveys.

Figure 2. State Estimates of Local Wood Smoke Emissions

These wood smoke emission estimates were made by CDPHE when developing the carbon monoxide emission analysis for Fort Collins’ redesignation to attainment using the following assumptions:

* New stoves after 1992 were equal to population growth times existing stoves.

* The number of fireplaces was held constant at 1990 levels.

* The amount of fuel burned, by device type, was held at 1990 levels.

Source: Wood Smoke Emissions Inventory; Draft CO Redesignation Technical Support Document, Colorado Department of Public Health and Environment, March 2002.

...

C. HEALTH ASPECTS

Background Information

(Source: “Health Effects of Wood Smoke”, a brochure published by the Washington State Department of Ecology, Olympia, WA, 1997. This document can be found at <http://www.ecy.wa.gov/biblio/92046.html>.)

“Wood smoke is a complex mixture of substances produced during the burning of wood. The major emissions from wood stoves are carbon monoxide, organic gases (containing carbon or derived from living organisms), particulate matter, and nitrogen oxides. Wood smoke contains many organic compounds known to cause cancer (such as benzopyrenes, dibenzanthracenes, and dibenzocarbazoles), and other toxic compounds (such as aldehydes, phenols, or cresols). The

particulate fraction is composed of solid or liquid organic compounds, carbon char (elemental or soot carbon – similar to charcoal), and inorganic ash.

The particles in wood smoke are too small to be filtered by the nose and upper respiratory systems, so they wind up deep in the lungs. They can remain here for months causing structural damage and chemical changes. Poisonous and cancer-causing chemicals often enter the lungs by adhering to tiny particulate matter (such as wood smoke particles).

These tiny particles are emitted in neighborhoods, both indoors and out, where people spend most of their time. Unfortunately, wood smoke is not only in the outdoor air we breathe. The particulate matter in wood smoke leaving chimneys is so small that it is not stopped by closed door and windows, and often seeps into the neighboring houses. Even more smoke is released inside homes that heat with wood.

Wood smoke exposure causes a decrease in lung function and an increase in the severity of existing lung disease with increases in smoke concentrations or exposure time. It also aggravates heart conditions and carbon monoxide causes heart pain. The occurrence of respiratory illnesses in children has been shown to increase with increased exposure to wood smoke. This includes lower respiratory infections such as acute pneumonia, or bronchitis, which are major causes of disease and death in young children.”

Although wood smoke potentially affects everyone, children, people with respiratory diseases and the elderly are more likely to be affected.

...

Asthma-related hospital visits are less than one percent of all hospital visits over the past three years.

Recent Studies

Pollution May Cause Asthma

A study conducted by the University of Southern California and published in *The Lancet* (2002) has shown that exposure to elevated ozone levels ozone can *cause* asthma in children, not just exacerbate it. It has long been known that smog can trigger asthma attacks, but this is the first study indicating that children (especially active ones) can develop asthma in heavily polluted areas. Wood smoke contains ozone precursors including nitrogen oxides.

(McConnell, R., et.al. Asthma in exercising children exposed to ozone: A Cohort Study. *Lancet* 2002 Feb 2; 359 (9304): 386-91)

Pollutants Linked to Birth Defects

University of California Los Angeles School of Public Health and the California Birth Defects Monitoring Program researchers published a study in the *American Journal of Epidemiology* in 2002. This study showed that the greater the exposure to carbon monoxide (or ozone) during a woman’s critical second month of pregnancy, the greater the chance the child would have a serious cardiac birth defect. These conclusions were drawn after studying 9,000 babies born between 1987 and 1998. However, researchers cautioned that they are not certain that CO and ozone were directly causing the birth defects. They said those pollutants could be a “marker” for something associated with the real cause.

(Ritz, B., et. al. Ambient air pollution and risk of birth defects in Southern California. *American Journal of Epidemiology* 2002 Jan 1; 155(1): 17-25)

Study Finds Soot Particles Strongly Linked to Lung Cancer

Prolonged exposure to air tainted with tiny particles of soot significantly raises the risk of dying of lung cancer or other lung and heart diseases, according to a new study of 500,000 people in 116 American cities. In fact, the authors say, many city residents face a long-term risk of fatal lung cancer similar to that of someone living with a smoker.

Because lung cancer is so rare among nonsmokers, that translates into just two additional lung cancer fatalities per 100,000 people, said a leader of the research project, Dr. George D. Thurston, associate professor of environmental medicine at the New York University School of Medicine. But, Dr. Thurston added, the finding helps suggest a cause for many otherwise unexplained lung cancer deaths and adds urgency to efforts to reduce fine-particle pollution, which comes from power plants and motor vehicles.

Earlier studies had hinted at a link between fine soot particles and lung cancer. But this one was the first with sufficient breadth (involving the 500,000 subjects) and duration (16 years) to show a strong relationship.

(Pope, C.A., et. al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA: The Journal of the American Medical Association 2002 Mar 6; 287(9): 1132-41)

Studies Show Particulate Matter Impacts at Low Concentrations

Epidemiological studies have reported a linear relationship between exposure to particulate matter and effects. In other words, the higher the concentration of particles, the greater the effect on the health of populations. Effects have been demonstrated at levels well below the current National Ambient Air Quality Standards. Scientists have not been able to identify a threshold below which health effects from particulate matter do not occur.

(NRDC Internet site –<http://www.nrdc.org/air/pollution/qbreath.asp#level>)

D. OTHER EXAMPLES - INCENTIVES

Melville, Australia teams with gas company to offer upgrade incentives

(Source: http://lash.une.edu.au/~drobinso/woodheat_ban.htm)

The City of Melville's Health Services teamed up with the local gas company, AlintaGas, to offer incentives to citizens to replace existing wood heaters with gas appliances. Natural gas is the cleanest burning fossil fuel - it provides heat without smoke. It is also a reliable and economically viable heat alternative to burning wood. As an incentive, AlintaGas is offering local people discounts on gas heaters, free connections to the AlintaGas main supply, and special deals on heater installation.

Arizona Tax Deductions

Starting in 1993, Arizona taxpayers are allowed to take a personal tax deduction of up to \$500 for the cost of converting an existing wood fireplace to a qualifying wood stove. Qualifying wood stoves must meet the standards of performance for new wood heaters manufactured after July 1990, or sold after July 1992.

Idaho Tax Deductions

Idaho taxpayers can deduct 40% of the total cost (including purchase price and professional installation) of a certified wood stove, pellet stove, and natural gas or propane heating device in the year it was installed. They can deduct 20% of the total cost for the next three years. Total deductions may not exceed \$5,000.

Great Stove Change-Out Programs

EPA

(source: EPA – Feb 2001: <http://detnews.com/2001/metro/0102/08/d06d-185247.htm>)

Homeowners in 12 states were able to receive a discount on a new (certified) wood burning stove from an area retailer participating in the program until April 30, 2001.

Michigan (Source: http://www.epa.gov/bns/baphcb/BaP_Rdcn.html#Intro)

The Great Lakes Wood Stove Changeout program was co-sponsored by a consortium of public and private sector parties, with support from EPA Region 5. This program offered incentives for residents in northern Michigan to trade in their old wood-stoves for newer, cleaner burning hearth products. The newer technology stoves reduce wood smoke emissions by about 85 percent and generate less B(a)P and particulate matter emissions.

Minnesota

(Source: <http://www.woodstove-changeout.org/Lable.htm>)

The Hearth Products Association offers discounts of 10 to 15 percent on new stoves and inserts at participating dealers. Discounts ranging from \$100 to \$300 are provided when old equipment is returned and destroyed.

Nevada and California

Dealers and manufacturers have teamed up to offer cash rebates of up to 15% off the list price of certified units. Some air pollution control districts offer cash incentives on top of the point-of-sale discounts.

Eastern Ontario

Residential wood burning is a significant source of air pollution in Canada, estimated to emit about 25 % of fine particulates in Canada's air, 15 % of volatile organic compounds, and 10 % of carbon monoxide. More than 25 participating Eastern Ontario wood stove retailers offer special trade-in rebates to encourage people to replace older technology stoves or fireplaces with approved, cleaner wood-burning appliances.

E. OTHER EXAMPLES – REGULATION

Chimney Opacity Regulations

An Internet search of opacity regulations reveals that most regulations restrict residential chimney opacity to 20%.

Location Regulation Reference

State of Idaho 20% for wood smoke <http://www.nicon.org/sos/howmuchislegal.html>

Iowa, Linn County 20% opacity (40% for 6 minutes with each new fire)

<http://www.air.linn.ia.us/ordinance/ordinance4.html>

Nebraska, Lincoln/Lancaster Counties

20 % opacity w/ 6 min start up limited to 27%. (Exceptions = 30% for teepee wood waste burner, 40% for alfalfa dehydration)

<http://www.epa.gov/region07/programs/artd/air/rules/nebraska/llc2-20.pdf>

Oregon, Jackson County

During Green (clean) advisory periods, 50 % opacity, with 30 minute start-up exceptions in any four-hour period. (NO visible smoke during Red and Yellow advisory periods)

www.co.jackson.or.us/pdf/CodeOnline/Part18.pdf

And <http://www.co.jackson.or.us/Page.asp?NavID=338>

State of Washington

20% chimney opacity; future spot checks lead to escalating fines

<http://www.scapca.org/document/regs/r1a8.pdf>

The “industry standard” for efficient combustion (after the period of start-up) is 15% opacity, as stated in the Hearth, Patio, and Barbecue Association’s “Straight Answers to Burning Questions”

Web page at <http://hpba.org/communications/FactSheets/answers.shtml>.

State of Oregon

Mandatory removal of non-certified units at point of sale.

Starting in 1995, the State of Oregon requires removal of non-certified units at point of sale in PM₁₀ non-attainment areas, with some exemptions.

(See <http://www.leg.state.or.us/ors/468a.html>)

Two Stage Curtailment Program

State Statute requires that any programs adopted to curtail wood smoke emissions during periods of air stagnation must provide for two stages of curtailment based on the severity of the projected air quality conditions.

State of Washington

Local burn bans are called when wood smoke pollution is measured at unsafe levels. This is a two stage plan:

Stage I: The use of all uncertified wood heating devices, including fireplaces, is prohibited when pollution approaches unhealthful levels. Certain models of pellet stoves are exempt.

Stage 2. The use of all wood heating devices is prohibited, including pellet stoves.

APPENDIX A

CITY CODE Chapter 5 – Buildings and Building Regulations.

Section 5-110. Solid Fuel Burning Appliances

a) No person shall install or modify a solid fuel-burning appliance without first having obtained a building permit in accordance with this Chapter.

(b) Except as is otherwise provided in Subsections (d), (e) and (f) of this Section, no person shall install or modify a solid fuel-burning appliance (including, without limitation, any wood stove or any solid fuel cooking stove) unless, both prior and subsequent to installation or modification, it meets the most stringent emission standards set forth in Subparagraphs (1) and (2) of Federal Regulation 40 CFR Part 60, Subpart AAA, Subsection 60.532(b) as of the time of installation of the solid fuel-burning appliance. All such appliances shall be tested and certified to be in conformance with the preceding emission standards in accordance with the testing and certification methods and procedures in Federal Regulation 40 CFR Part 60, Subpart AAA.

(c) For the purposes of this Section, the following definitions shall apply:

(1) A *wood stove* shall be defined as any solid fuel-burning appliance designed for the purpose of burning wood for space heating or aesthetic purposes in either domestic or commercial buildings.

(2) A *solid fuel cooking stove* shall be defined as any solid fuel-burning appliance designed to burn wood or any other solid fuel for the purpose of cooking, flavoring, curing or preparing food for domestic or commercial purposes.

(d) No person shall install or modify any solid fuel-burning appliance for the purpose of burning coal.

(e) No person shall install or modify a pellet stove unless, both prior and subsequent to installation or modification, it meets all requirements for pellet stoves as set forth in Regulation No. 4, Section III, as established by the Colorado Air Quality Control Commission as of the time of installation of the pellet stove.

(f) No person shall install or modify any fireplace unless it is one of the following:

(1) A gas-burning appliance;

(2) An electric appliance; or

(3) A fireplace insert that, both prior and subsequent to installation or modification, meets the most stringent emission standards as set forth in Subparagraphs (1) and (2) of Federal Regulation 40 CFR Part 60, Subpart AAA, Subsection 60.532(b) as of the time of installation of the fireplace.

(g) Exemptions. The following solid fuel-burning appliances and processes are exempt from the provision of this Section:

(1) Portable household solid fuel-burning appliances such as camping stoves, barbecue grills and smokers.

(2) Commercial cooking processes which utilize small quantities of wood for food flavoring, provided that the following conditions are met:

a. The primary fuel source for any fuel-burning (nonelectric) commercial cooking and food preparation appliance must be either natural gas or liquefied petroleum gas, unless the appliance complies with the emissions standards set forth in Subsection (b) of this Section.

b. Only the minimum amount of wood sufficient to flavor the food may be used in this cooking process, and the wood must be cured and dry.

c. Operation of the appliance must comply with § 20-1(c) of this Code, which prohibits the emission of smoke exceeding forty (40) percent opacity.

(Ord. No. 25, 1991, § 1, 3-19-91; Ord. No. 32, 1997, 3-4-97)

CITY CODE – Chapter 20. Nuisance Ordinance.

Article 1 – In General

Sec. 20-1. Air pollution nuisances prohibited.

(a) The emission or escape into the open air from any source or sources of smoke, ashes, dust, dirt, grime, acids, fumes, gases, vapors, odors or any other substances or combination of substances in such manner or in such amounts as to endanger or tend to endanger the health, comfort, safety or welfare of the public or to cause unreasonable injury or damage to property or to interfere with the comfortable enjoyment of property or normal conduct of business is hereby found and declared to be a public nuisance. It is unlawful for any person to cause, permit or maintain any such public nuisance within the city.

(b) No person shall cause or allow the emission of smoke exceeding forty (40) percent opacity from any flue or chimney, except for a single fifteen-minute period for cold startup. Any emission in excess hereof is hereby declared to be a nuisance and is prohibited.

(c) After October 1, 1988, no person shall cause or allow, for the purpose of residential or commercial space heating, the burning of coal in a solid fuel-burning appliance, unless that appliance is designed to burn coal, and unless it is the sole source of heat for the building. No solid fuel-burning appliance shall be considered to be the sole source of heat if the building is equipped with a permanently installed furnace or heating system that is designed to use natural gas, fuel oil, electricity or propane, whether connected or disconnected from its energy source.

(d) Except as is provided in paragraph (c) hereof, no person shall cause or allow the burning of any solid fuel in a solid fuel-burning appliance other than clean, dry, untreated wood or wood products, or other solid fuel products specifically manufactured for the purpose of space heating.

(Ord. No. 184, 1986, § 4, 11-18-86; Ord. No. 180, 1987, § 2, 12-1-87; Ord. No. 89, 1994, § 1, 6-21-94; Ord. No. 130, 1996, 11-5-96)

PUBLIC NUISANCE ORDINANCE

(source <http://fcgov.com/cityattorney/pub-key-points.php>)

Fort Collins' Public Nuisance Ordinance was passed by the City Council on April 4, 2000, and went into effect April 14, 2000. Key points of the Nuisance Ordinance are discussed below.

1. Purpose

To remedy chronic problems at properties where City Code violations occur that annoy or disturb others. To hold property owners accountable for the use of their properties.

2. Definition of "Public Nuisance"

Three or more separate City Code violations at the same property within 12 months or 5 or more within 24 months. Written notice must have been sent to the property owner and tenants within 30 days of each violation, except the last one. The last violation must have occurred at least 45 days after the last notice. Each complaint about a separate violation must result in the issuance of a municipal court citation.

3. Commencement of Nuisance Action

Another notice must be posted at the property and mailed to the property owner at least 10 days before filing the action. After that ten-day period, the City may then file the action in municipal court and serve the summons and complaint on any person(s) that the City believes is responsible for the nuisance.

4. Voluntary Agreement

At any time after a notice has been sent out, a property owner can enter into a voluntary abatement plan with the City. If the property owner and the City reach such an agreement and the property owner does what he or she has agreed to do, no public nuisance action will be filed. Even without an agreement, a notice of violation will be stricken (not counted) if a landlord goes to court to evict a tenant that has caused the problem and does everything reasonably possible to avoid more of the same kinds of problems.

5. City's Remedies

If no voluntary abatement agreement is reached, the City can ask the Municipal Court to order the parties causing the nuisance to do whatever is necessary to put an end to the nuisance. Only in an emergency can the City get such an order without a court hearing. If the City gets such an order, the persons affected by the order can ask the Court to remove it at any time. At no time can the City seek or obtain a court order that would take away or close the property or place the property into "special receivership". A person who knowingly disobeys an abatement order issued by the court could be prosecuted for committing a misdemeanor criminal offense.

6. Effect of Sale of the Property

All previous notices of violations will be stricken (will not count) if the property is sold unless the property is sold simply to avoid the public nuisance ordinance.

Lincoln County

Lincoln County

SUBCHAPTER 2: SOLID FUEL BURNING DEVICE REGULATIONS

75.1.201 **INTENT:**

- (1) A regulation reducing the levels of particulate air pollutants to or below levels of the NAAQS/MAAQS.
- (2) This regulation is necessary to preserve, protect, improve, achieve and maintain such levels of air quality as will protect the health and welfare of the citizens of Lincoln County.

75.1.202 **SCOPE AND EFFECTIVE DATE:**

- (1) This regulation applies to all persons, agencies, institutions, businesses, industries or government entities living in or located within the Air Pollution Control District except for sources exempt from local regulation under 75-2-301(5), MCA.
- (2) The effective date of this sub-chapter is January 1, 2007.

75.1.203 **DEFINITIONS:** As used in this subchapter, unless indicated otherwise, the following definitions apply:

- (1) "Opacity" means a measurement of visible emissions defined as the degree expressed in percent to which emissions reduce the transmission of light and obscure the view of an object in the background.
- (2) "Operating Permit" means a permit issued by the Department that allows the use of a solid fuel burning device within the boundaries of the Air Pollution Control District.
- (3) "Pellet Fuel Burning Device" means a solid fuel burning device that burns only automatically fed biomass, pelletized fuels.
- (4) "Solid Fuel Burning Device" means any fireplace, fireplace insert, wood stove, pellet stove, pellet furnace, wood burning heater, wood-fired boiler, wood or coal-fired furnace, coal stove, or similar device burning any solid fuel used for aesthetic, cooking or heating purposes which has a rated capacity of less than 1,000,000 BTU's per hour.
- (5) "Standard Catalytic Device" means a solid fuel burning device with a catalytic emissions control system that has been certified by EPA test method as having emissions <4.1 grams/hour.
- (6) "Standard Non-Catalytic Device" means a solid fuel burning device with a non-catalytic emissions control system that has been certified by EPA test method as having emissions <7.5 grams/hour.

75.1.204 **OPERATING & EMISSION LIMITS:**

- (1) No person may install or operate any type of solid fuel burning device without a valid Operating Permit issued by the Department.
- (2) No person may burn any material in a solid fuel burning device except uncolored newspaper, untreated wood and lumber, and products manufactured for the sole purpose of use as a solid fuel. Products manufactured or processed for use as solid fuels must conform to any other applicable provisions of this subchapter.
- (3) In the absence of an Air Pollution Alert, no person operating a solid fuel burning device may cause or allow the discharge of visible emissions greater than twenty percent opacity. The provisions of this section do not apply to visible emissions during the building of a new fire, for a period or periods aggregating no more than twenty minutes in any four-hour period.
- (4) During an Air Pollution Alert, no person operating a solid fuel burning device that is permitted for use during an Alert may cause or allow the discharge of visible emissions greater than ten percent opacity. The provisions of this subsection shall not apply during the building of a new fire, for a period or periods aggregating no more than twenty minutes in any four-hour period. No person may operate a standard catalytic or non-catalytic solid fuel burning device during an Air Pollution Alert.

75.1.205 SOLID FUEL BURNING DEVICE PERMITS:

- (1) Prior to installing or operating a solid fuel burning device in any residential or commercial property, a person shall apply to the Department for a permit and provide the following information:
 - (a) the owner/operator of the device;
 - (b) contact information for the device owner/operator;
 - (c) location of the device;
 - (d) device manufacturer & model;
 - (e) type of device (rating); and
 - (f) any other relevant information for the Department to determine whether it satisfies the requirements of this regulation.
- (2) The Department may issue Operating Permits for the following types of solid fuel burning devices:
 - (a) **Standard catalytic devices.** The Department may issue an Operating Permit for a catalytic solid fuel burning device. Standard catalytic devices may not be operated during an Air Pollution Alert. Implementation of the contingency measure in 75.1.208 would automatically invalidate the operating permit for this type of device.
 - (b) **Standard non-catalytic devices.** The Department may issue an Operating Permit for a non-catalytic solid fuel burning device. Standard non-catalytic devices may not be operated during an Air Pollution Alert. Implementation of the contingency measure in 75.1.208 would automatically invalidate the operating permit for this type of device.
 - (c) **Pellet fuel burning devices.** The Department may issue an operating permit for a biomass pellet fuel burning device. Pellet fuel burning devices may be operated during an Air Pollution Alert. Implementation of the contingency measure in 75.1.208 would not invalidate the operating permit for this type of device.
- (3) Unless otherwise invalidated by implementation of a contingency measure or future changes in solid fuel burning device regulations, Operating Permits are valid until the named owner/operator changes or the device is removed or modified in any way. Permits may not be transferred from person to person or from place to place.
- (4) An Operating Permit for a solid fuel burning device may be revoked by the Department for non-compliance with these regulations or Operating Permit conditions.

75.1.206 AIR POLLUTION ALERTS:

- (1) The Department may declare an Air Pollution Alert to be in effect whenever ambient PM concentrations, as averaged over a four hour period, exceed a level 20 percent below any state or federal ambient 24-hour standard established for particulate matter; and when scientific and meteorological data indicate the average concentrations will remain at or above these levels over the next 24 hours.
- (2) The Department may also declare an Air Pollution Alert to be in effect whenever scientific and meteorological data indicate that the ambient PM concentrations over any four-hour period within the next twenty—four hours may reasonably be expected to exceed a level 20 percent below any state or federal ambient 24-hour standard established for particulate matter.
- (3) No person shall be subject to any violation of 75.1.204(4) for three hours after the Department declares an Air Pollution Alert and makes that information reasonably available to the public.

75.1.207 PENALTY ASSESSMENTS:

- (1) The Department shall issue a “Notice of Violation” for any documented violation. The first notice of violation issued is a warning to the violator and will include educational and compliance information on air pollution regulations.
- (2) For a second and any subsequent violations, the Department shall process each notice of violation for a Civil Penalty Assessment of \$25.00 per violation.
- (3) No person or entity may be cited for a violation more than once in any calendar day. However, the Department may issue a notice of violation for each calendar day of violation and each such notice is considered as a separate violation.

75.1.208 CONTINGENCY MEASURES:

- (1) If compliance with NAAQS/MAAQS are not achieved or compliance levels are not maintained, and the Department determines that solid fuel burning device emissions are a

contributor to non-compliance, the Department shall implement the following control measure:

- (a). No person may operate a solid fuel burning device except a biomass pellet fuel burning device with a valid operating permit issued by the Department.

Missoula County

CHAPTER 9 SOLID FUEL BURNING DEVICES

Rule 9.101 - Intent

The intent of this rule is to regulate and control the emissions of air pollutants from solid fuel burning devices in order to further the policy and purpose declared in Chapter 1.

Rule 9.102 - Definitions

For the purpose of this rule the following definitions apply:

- (1) "Burning season" means from the first day of July through the last day of June of the following year.
- (2) "Alert permit" means an emission permit issued by the department to operate a solid fuel burning device during an air pollution Alert and during periods when the air stagnation plan is not in effect. Solid fuel burning devices must meet Lowest Achievable Emission Rate to qualify for an Alert class emissions permit.
- (3) "Install" means to put in position for potential use, and includes bringing a manufactured home or recreational vehicle containing a solid fuel burning device into the Air Stagnation Zone.
- (4) "Installation permit" means an emissions permit issued by the department to install and operate a solid fuel burning device within the Air Stagnation Zone.
- (5) "EPA method" means 40 CFR Part 60, Subpart AAA, Sections 60.531, 60.534, and 60.535.
- (6) "Fireplace" means a solid fuel burning device with an air-to-fuel ratio of greater than thirty which is a permanent structural feature of a building. A fireplace is made up of a concealed masonry or metal flue, and a masonry or metal firebox enclosed in decorative masonry or other building materials.
- (7) "High Impact Zone" means the geographical area designated as such by a map adopted by the Control Board on August 25, 1983. Attached hereto and by this reference made a part hereof. (see Appendix A)
- (8) "New solid fuel burning device" means any solid fuel burning device installed, manufactured, or offered for sale after July 1, 1986.
- (9) "Oregon method" means Oregon Department of Environmental Quality "Standard Method for Measuring the Emissions and Efficiencies of Woodstoves", Sections 1 through 8 and O.A.R. Chapter 340. Division 21 Sections 100, 130, 140, 145, 160, 161, 163, 164, 165.
- (10) "Pellet stove" means a solid fuel burning device designed specifically to burn pellets or other nonfossil biomass pellets that is commercially produced, incorporates induced air flow, is installed with an automatic pellet feeder, and is a free standing room heater or fireplace insert.
- (11) "Solid fuel burning device" means any fireplace, fireplace insert, woodstove, wood burning heater, wood fired boiler, coal-fired furnace, coal stove, or similar device burning any solid fuel used for aesthetic, cooking, or heating purposes, that burns less than 1,000,000 BTU's per hour.
- (12) "Sole source of heat" means one or more solid fuel burning devices that:
 - (a) constitute the only source of heat in a private residence for purpose of space heating, or
 - (b) constitutes the main source of heat in a private residence where the residence is equipped with a heating system that is only minimally sufficient to keep the plumbing from freezing.
- (13) "Woodstove" means a wood fired appliance with a heat output of less than 40,000 BTU per hour with a closed fire chamber that maintains an air-to-fuel ratio of less than thirty during the burning of 90 percent or more of the fuel mass consumed in a low firing cycle. The low firing cycle means less than or equal to 25 percent of the maximum burn rate achieved with doors closed or the minimum burn achievable, whichever

is greater. Wood fired forced air combustion furnaces that primarily heat living space, through indirect heat transfer using forced air duct work or pressurized water systems are excluded from the definition of “woodstove”.

Rule 9.103 - Applicability

- (1) The regulations of this Chapter apply within the Air Stagnation Zone, except for Rule 9.104, which applies to the entire county.

Rule 9.104 - Fuels

- (1) Within Missoula County a person may not burn any material in a solid fuel burning device except uncolored newspaper, untreated wood and lumber, and products manufactured for the sole purpose of use as fuel. Products manufactured or processed for use as fuels must conform to any other applicable provision of this Program.

Rule 9.105 - Non-Alert Visible Emission Standards

- (1) Within the Air Stagnation Zone, a person owning or operating a solid fuel burning device may not cause, allow, or discharge emissions from such device that are of an opacity greater than forty (40) percent.
- (2) The provisions of this section do not apply to emissions during the building of a new fire, for a period or periods aggregating no more than ten (10) minutes in any four (4) hour period.

Rule 9.106 - Prohibition of Visible Emissions During Air Pollution Alerts and Warnings.

- (1) Within the High Impact Zone, a person owning, operating or in control of a solid fuel burning device may not cause, allow, or discharge any visible emission from such device during an air pollution Alert declared by the department pursuant to Rule 4.104 unless a sole source permit, a Temporary Sole Source permit, a special need permit, or an Alert permit has been issued for such device pursuant to this chapter.
- (2) Within the High Impact Zone, a person owning, operating or in control of a solid fuel burning device for which a sole source permit or special need permit has been issued may not cause, allow, or discharge any emissions from such device that are of an opacity greater than twenty (20) percent during an air pollution Alert declared by the department pursuant to Rule 4.104. The provisions of this paragraph do not apply to emissions during the building of a new fire or for refueling for a period or periods aggregating no more than ten (10) minutes in any four (4) hour period.
- (3) Within the High Impact Zone, a person owning, operating, or in control of a solid fuel burning device for which an Alert class permit has been issued may not cause, allow, or discharge any emissions from such device that are of an opacity greater than ten (10) percent during an air pollution Alert declared by the department pursuant to Rule 4.104. The provisions of this subsection do not apply to emissions during the building of a new fire, or for refueling for a period or periods aggregating no more than ten (10) minutes in any four (4) hour period.
- (4) When declaring a Stage 1 Air Alert, the department shall take reasonable steps to publicize that information and to make it reasonably available to the public at least three (3) hours before initiating any enforcement action for a violation of this section.
- (5) Every person operating or in control of a solid fuel burning device within the High Impact Zone has a duty to know when an air pollution Alert has been declared by the department.
- (6) Within the High Impact Zone, a person owning, operating, or in control of a solid fuel burning device may not cause, allow, or discharge any visible emissions from such device during an air pollution Warning declared by the department pursuant to Rule 4.104 unless such device has a sole source permit or a temporary sole source permit. Within the High Impact Zone, a person owning, operating or in control of a solid fuel burning device for which a sole source permit has been issued may not cause, allow, or discharge any emissions from such device that are of an opacity greater than twenty (20) percent during an air pollution Warning declared by the department pursuant to Rule 4.104. The provisions of this paragraph do

not apply to emissions during the building of a new fire, for a period or periods aggregating no more than ten (10) minutes in any four (4) hour period.

Rule 9.107 - Emissions Certification

- (1) The Control Board hereby adopts the Oregon method for the sole purpose of establishing an uniform procedure to evaluate the emissions and efficiencies of woodstoves for compliance with the emission limitation imposed in Rules 9.110 and 9.111. Beginning January 1, 1988 the department shall also use the EPA method for the purpose of establishing a uniform procedure to evaluate the emissions and efficiencies of woodstoves.
- (2) Devices exempted from the definition of “woodstove” listed in the Oregon method or “wood heater” listed in the EPA method may not be issued an Alert class or Installation class emissions certification unless tested to either method using modifications in the test procedure approved by the department.
- (3) The department shall accept as evidence of compliance with the emission limitation imposed in Rules 9.110, 9.111 and 9.118, labels affixed to the stove in compliance with OAR 340-21-150, 40 CFR Part 60, Subpart AAA, Section 60.536, or documentation that, in the opinion of the department, is sufficient to substantiate that the specific model, design, and specifications of the woodstove meet standards specified in Rules 9.110, 9.111 and 9.118.

Rule 9.108 - New Solid Fuel Burning Devices Prohibited

- (1) After July 1, 1986, a person or persons may not install or use any new solid fuel burning device in any structure within the Air Stagnation Zone without an Installation permit.

Rule 9.109 - Sale of New Solid Fuel Burning Devices

- (1) In the Air Stagnation Zone, a person may not sell or offer for sale a new solid fuel burning device that cannot be legally installed within the Air Stagnation Zone without labeling as follows:
 - (a) A clearly visible, legible label must be placed on each device offered for sale;
 - (b) The label must state, “It is illegal to install this device within the Air Stagnation Zone. Call the Missoula City-County Health Department (phone #) for more information”; and
 - (c) The lettering on the label must be in block letters no less than 20-point bold type, in a tone contrasting with the background.

Rule 9.110 - Installation Permits

- (1) The department may only issue installation permits for pellet stoves with emissions that do not exceed 1.0 gram per hour weighted average when tested in conformance with the EPA method.
- (2) An installation permit expires 180 days after issuance unless a final inspection is conducted or unless the department receives adequate documentation to insure the type of device, and installation are in compliance with the provisions of this Program.
- (3) New solid fuel burning devices may not be installed or used with a flue damper unless the device was so equipped when tested in accordance with Rule 9.107.

Rule 9.111 - Alert Permits

- (1) Those woodstoves that have a valid alert permit issued by the department may be operated during a Stage I Air Alert subject to the opacity limitations in Rule 9.106.
- (2) The department may issue a new alert permit for a pellet stove if the emissions do not exceed 1.0 gram per hour weighted average when tested in conformance with the EPA method.

- (3) The department may renew an alert permit for a woodstove that has emissions that do not exceed 6.0 grams per hour weighted average when tested using the Oregon method or 5.5 grams per hour weighted average when tested using the EPA method if the original application for an alert permit was received prior to June 30, 1988 and the permit has never lapsed.
- (4) The department may renew an alert permit for a woodstove that has emissions that do not exceed 4.0 grams per hour weighted average when tested using the Oregon Method or 4.1 grams per hour when tested using the EPA method if the original application for the Alert permit was received prior to October 1, 1994 and the permit has never lapsed.
- (5) Before renewing an alert permit, the department may require information to determine if the woodstove is capable of meeting emission requirements. If an inspection of the appliance during operation is not allowed by the applicant, the department shall require evidence that any non-durable parts (e.g. catalytic combustor, gaskets, by-pass mechanisms) have been replaced as necessary to meet applicable emission limitations.
- (6) To qualify for an alert permit or a renewal, catalyst-equipped woodstoves must be equipped with a permanent provision to accommodate a commercially available temperature sensor that can monitor combustor gas stream temperature within or immediately downstream (within 1.0 inch or 2.5 cm) of the combustor surface.
- (7) Alert permits is valid for two years for any woodstove that uses a catalyst or other nondurable part as an integral part, and five years for other devices.

Rule 9.112 - Sole Source Permits

- (1) A solid fuel burning device with a valid sole source permit issued by the department may be operated during Stage I Air Alerts and Stage II Warnings subject to the opacity limitations of Rule 9.106.
- (2) The department may only issue a new sole source permit for a pellet stove that:
 - (a) constitutes the sole source of heat in a private residence; and
 - (b) emits less than 1.0 gram per hour weighted average when tested using the EPA method.
- (3) The department may renew a sole source permit for a solid fuel burning device that constitutes the sole source of heat in a private residence if the solid fuel burning device is:
 - (a) a pellet stove that emits less than 1.0 gram per hour weighted average when tested using the EPA method; or
 - (b) a woodstove that has a continuously renewed sole source permit originally issued prior to July 1, 1985.
- (4) A sole source permit is not eligible for renewal when the ownership of the property is transferred from person to person.
- (5) A sole source permit is valid for one year beginning July 1st through the last day of June the following year.

Rule 9.113 - Special Need Permits

- (1) Woodstoves with a valid special need permit issued by the department may be used during an Alert subject to the opacity limitations of Rule 9.106.
- (2) A person who demonstrates an economic need to burn solid fuel for space heating purposes by qualifying for energy assistance according to economic guidelines established by the U.S. Office of Management and Budget under the Low Income Energy Assistance Program (L.I.E.A.P.), as administered in Missoula County by the District XI Human Resources Development Council, is eligible for a Special Need permit.

- (3) Special need permits may be renewed providing the applicant meets the applicable need and economic guidelines at the time of application for renewal.
- (4) Special need permits are issued at no cost to the applicant.
- (5) A special need permit is valid for up to one (1) year from the date it is issued.

Rule 9.114 - Temporary Sole Source Permit

- (1) Woodstoves with a valid temporary sole source permit may be used during Stage 1 Air Alerts and Stage 2 Warnings, subject to the opacity limitations of Rule 9.106.
- (2) A person may apply for a temporary sole source permit in an emergency situation if their solid fuel burning devices do not qualify for a permit under Rule 9.111. An emergency situation includes, but is not limited to, the following situations:
 - (a) where a person demonstrates his furnace or central heating system in inoperable other than through his own actions;
 - (b) where the furnace or central heating system is involuntarily disconnected from its energy source by a utility or fuel supplier; or
 - (c) where the normal fuel or energy source is unavailable for any reason.
- (3) The department may issue a temporary permit if it finds that:
 - (a) the emissions proposed to occur do not constitute a danger to public health or safety;
 - (b) compliance with the air stagnation plan and Rule 9.106(1) would produce hardship without equal or greater benefits to the public; and
 - (c) compliance with the air stagnation plan and Rule 9.106(1) would create unreasonable economic hardship to the applicant or render the residence as equipped severely uncomfortable for human habitation, or cause damage to the building or its mechanical or plumbing systems.
- (4) The department may place conditions on a temporary permit to insure that the permittee is in compliance with the Program when the permit expires.
- (5) The department shall arrange for an applicant interview to be conducted within five (5) working days of receipt of a written request for a temporary permit and shall render its decision within ten (10) working days of receipt of the written request.
- (6) Application to and denial by the department for a temporary permit does not prevent the applicant from applying to the Control Board for a variance under the appropriate provisions of this Program.
- (7) A temporary permits issued pursuant to this section is valid for a period determined by the department, but may not exceed one (1) year and is not renewable.

Rule 9.115 - Permit Application Requirements

- (1) The department shall issue a permit pursuant to the regulations of this chapter when the applicant has submitted information, on forms supplied by the department, that indicates compliance with this chapter, local building codes, and other applicable provisions of this Program.
- (2) The department shall decide whether to issue a permit or permit renewal within ten (10) working days after receiving an application.

Rule 9.116 – Revocation or Modification of Permit

- (1) A permit issued under this chapter may be revoked for a violation of:
 - (a) A condition of the permit;

- (b) A provision of this Program;
 - (c) An applicable regulation, rule or standard adopted pursuant to the FCAA; or
 - (d) A provision of the Clean Air Act of Montana.
- (2) A permit issued under this chapter may be modified for the following reasons:
- (a) Changes in an applicable provision of this Program adopted by the Control Board, or rules adopted under the Clean Air Act of Montana;
 - (b) When the department or Control Board determines modifications are necessary to insure compliance with the provisions of this Program or an implementation plan approved by the Control Board.
- (2) The department shall notify the permittee in writing of its intent to revoke or modify the permit. The department's decision to revoke or modify a permit becomes final unless the permittee requests, in writing, an administrative review within fifteen (15) days after receipt of the department's notice. Departmental receipt of a written request for a review initiates the department's appeal process outlined in Chapter 14 of this Program and postpones the effective date of the of the department's decision until the conclusion of the administrative appeals process.

Rule 9.117 - Transfer of Permit

- (1) A permit issued under this chapter may not be transferred from one location to another or from one solid fuel burning device to another. A permit may not be transferred from one person to another, unless re-issued by the department.

Rule 9.118 - Removal of Solid Fuel Burning Devices Upon Sale of the Property.

- (1) After October 1, 1994, in the Air Stagnation Zone, all solid fuel burning devices contained on property to be sold must be removed from the property or rendered permanently inoperable unless they meet the emissions requirements listed in Section (2) of this rule.
- (2) The following solid fuel burning devices may remain on a property in the Air Stagnation Zone to be sold:
- (a) Woodstoves if the emissions do not exceed:
 - (i) 6.0 grams per hour weighted average when tested in conformance with the Oregon Method; or
 - (ii) 5.5 grams per hour weighted average when tested in conformance with the EPA Method.
 - (b) Commercially manufactured pellet stoves that have not been tested, but were installed prior to October 1, 1994.
 - (c) Fireplaces meeting the definition of Rule 9.101(6).
 - (d) Wood-fired, forced-air combustion furnaces that primarily heat living space, through indirect heat transfer using forced air duct work or pressurized water systems.
- (3) Within the Air Stagnation Zone, it is unlawful for any person to complete, or allow the completion of the sale, transfer or conveyance of any real property unless a Certificate of Compliance is filed with the Missoula County Clerk and Recorders Office.
- (4) (a) Until July 1, 2001, a Certificate of Compliance is valid until the real property is transferred or conveyed to a new owner. At that time, another Certificate must be filed.
- (b) After July 1, 2001, once a Certificate of Compliance has been filed for a property, another certificate is not needed if the number and type of stoves on the real property matches what is on file at the department. The department shall list properties with Certificates of Compliance on the internet. A copy of the list must be available at the department for inspection.

- (5) The Certificate of Compliance must state that either:
 - (a) there are no solid fuel burning devices on the property; or
 - (b) any solid fuel burning devices on the property meet the requirements of Section (2) above.
- (6) The Certificate of Compliance must be in a format specified by the department and must be signed by the seller(s), the buyer(s), the real estate agent(s) of the seller(s), and if any stoves are staying on the property, a certified inspector.
- (7) City Building Department inspectors and persons certified by the department to inspect and certify that solid fuel burning devices on the real property meet the emissions limitations described by these regulations shall sign and submit a Certificate of Compliance to the Missoula County Clerk and Records Office.
- (8) The Certificate of Compliance does not constitute a warranty or guarantee by the department or certified inspectors that the Solid Fuel Burning Device on the property meets any other standards of operation, efficiency or safety, except the emission standards contained in these regulations.

Rule 9.119 - Contingency Measures

- (1) Rule 9.106(1) and 9.106(2) are modified to delete Alert class permitted devices, and Rules 9.106(3) and 9.111(1) are void. (See Chapter 3.)
- (2) All portions of this chapter that allow Alert permits to burn during alerts or warnings are hereby rescinded.

Clark County

CLARK COUNTY
AIR QUALITY REGULATIONS
SECTION 28 - FUEL BURNING EQUIPMENT

28.1 General Provisions

28.1.1 This regulation applies to installation in which FUEL is burned for the primary purpose of producing heat or power by indirect heat transfer in which the products of combustion do not come into direct contact with other materials. FUELS include those such as coke, coal, lignite, coke breeze, FUEL OIL, and wood, but do not include refuse. When any products or by-products of a manufacturing process are burned for the same purpose or in conjunction with any FUEL, the same maximum emission limitations shall apply.

28.1.2 The heat content of coal shall be determined according to ASTM method D-271-64 Laboratory Sampling and Analysis of Coal or Coke or ASTM method D2015-62T gross calorific value of solid fuel by the Adiabatic Bomb Calorimeter, which publications are made a part of this section by reference.

28.1.3 For purposes of this regulation the heat input shall be the aggregate heat content of all FUELS whose products of combustion pass through a stack or stacks. The heat input value used shall be the equipment manufacturer's or designer's guaranteed maximum input, whichever is greater. The total heat input of all FUEL-BURNING UNITS on a plant or premises shall be used for determining the maximum allowable amount of PARTICULATE MATTER which may be EMITTED.

28.1.4 The amount of PARTICULATE MATTER EMITTED shall be measured according to the American Society of Mechanical Engineers' Power Test Codes PTC-27, dated 1957 entitled, "Determining Dust Concentrations in a Gas Stream," which publication is made a part of this section by reference. The CONTROL OFFICER may modify this testing procedure or specify the use of more current procedures in accordance with good professional practice.

28.2 Emission Limitations

28.2.1 No PERSON shall cause or permit the EMISSION of PARTICULATE MATTER from any FUEL-BURNING EQUIPMENT in excess of the quantity set forth in the following table:

Amended 07/01/04 28-1 CC Air Quality Regulations

Maximum allowable rate of

EMISSION of PARTICULATE

Heat input, millions of MATTER, pounds per million

BRITISH THERMAL UNITS BRITISH THERMAL UNITS of per hour heat

10 0.600

50 0.412

100 0.352

500 0.242

1,000 0.207

4,000 0.150

8,000 0.102
10,000 0.0904
15,000 0.0717
20,000 0.0607
40,000 0.0409
50,000 0.0358
100,000 0.0243

28.2.2 Maximum allowable EMISSION rates of PARTICULATE MATTER for heat input greater than 10 million but less than 4000 million BTU per hour shall be determined by using the equation $Y = 1.02 X^{-0.231}$. Maximum allowable EMISSION rates of PARTICULATE MATTER for heat inputs equal to or greater than 4000 million BTU per hour shall be determined by using the equation $Y = 17.0 X^{-0.568}$ where Y = allowable rate of EMISSION in pounds per million BTU and X = maximum heat input in millions of BTU per hour.

- - - -History: Amended: April 23, 1987; April 24, 2001; June 3, 2003; July 1, 2004.
Amended 07/01/04 28-2 CC Air Quality Regulations

Washoe County

040.051 WOOD STOVE/FIREPLACE INSERT EMISSIONS

(Amended 9/23/98; Revised 6/19/02, Effective 1/1/03; Revised 2/23/06)

SECTION A – GENERAL

1. PURPOSE: To limit particulate matter emissions and other pollutants discharged into the ambient air from solid fuel burning devices by:

- a. Setting emission standards and certifying devices;
- b. Requiring removal of devices that are not certified;
- c. Restricting materials that can be burned; and
- d. Limiting the number devices that are not deemed low emitting.

2. APPLICABILITY: The provisions of this regulation apply to any:

- a. Person that advertises, except when restrictions are noted, sells, offers to sell, or installs any wood stove within the Health District;
- b. Person that completes, or allows the completion of any:
 - (1) escrow transaction; and/or
 - (2) title change on a residential property.

SECTION B – DEFINITIONS: For the purpose of this regulation, the following definitions shall apply.

1. Antique wood stove. Means a wood stove built before 1940 that has an ornate construction and a current market value substantially higher than a common wood stove manufactured in the same time period.
2. Certified. Means a solid fuel burning device has been certified in accordance with current standards adopted by the U.S. EPA, the State of Oregon, the State of Colorado and/or appears on the Washoe County District Health Department Official List of Certified Wood Stoves; Ref. 40 CFR, Part 60; Oregon Administrative Rules, Chapter 340, Division 21; Colorado Revised Statute, Regulation No. 4. (As noted also in Section 010.0255).
3. Certificate of Compliance. A permit issued for a specific location by the Control Officer for a solid fuel burning device deeming the device certified in accordance with this regulation.
4. Cook Stove. Means a wood stove installed in the kitchen, which is primarily designed for cooking and has a stovetop and an oven. It may also be equipped with gas burners. This wood stove is exempt from the emission standards and requirements of Section 040.051. (As noted also in Section 010.045).
5. Development. Is a group of multifamily dwelling structures built on a parcel of land with common amenities. Examples of a development include but are not limited to: condominiums, apartments, and townhouses. (Adopted 5/23/90). (As noted also in Section 010.047).
6. Fireplace. Means an open hearth or fire chamber or similarly prepared place in which a fire may be made and which is built in conjunction with a chimney. It may have doors, provided they are not designed with gaskets, air intake controls or other modifications, which create an air starved operating condition. Wood-burning devices initially classified, as a wood heater (Section 010.200) may not be modified to meet the fireplace definition. (Amended 11/16/94). (As noted also in Section 010.063).
7. Garbage. Means putrescible animal or vegetable waste. (As noted also in Section 010.072).
8. Low emitting. Devices that are considered low emitting include but are not limited to:
 - a. All propane or natural gas-fired devices;

b. Pellet stoves;

- c. Specific models of wood stoves or other solid fuel burning devices that meet a certified emission rate of 1 gram/hour or less of particulate matter; and
- d. Masonry Heaters that are certified by Colorado Revised Statute, Regulation 4.

9. Notice of Exemption (NOE). A form approved by the Control Officer, containing the notarized signatures of both the buyer and seller, attesting to the fact that the previously occupied residential property:
- a. Does not have any Solid Fuel Burning Device;
 - b. Has a fireplace only that does not have doors that are gasketed to make the device airtight; or
 - c. Had an uncertified wood stove removed from the residential property prior to sale.
10. Pellet Stove. Means a solid fuel burning device designed to heat the interior of a building. It is a forced draft heater with an automatic feed which supplies appropriately sized feed material or compressed pellets of wood, or other biomass material to the firebox. (As noted also in **Section 010.117**).
11. Removed or Removal. Means a solid fuel burning device is physically taken off the real property. Furthermore, the device must not be stored at any other location on the real property or elsewhere within the Health District without the approval of the Control Officer.
12. Residential Property. Means any structure used as a dwelling including mobile, manufactured, single and multifamily homes and/or land with outbuildings including but not limited to barns, sheds, and garages.
13. Seasoned Wood. Means firewood with a moisture content not exceeding 20%.
14. Smoke. Means small gas-borne particles resulting from incomplete combustion, consisting predominantly of carbon, ash, and other combustible material present in sufficient quantity to be observable or, as a suspension in gas of solid particles in sufficient quantity to be observable. (As noted also in **Section 010.136**).
15. Solid Fuel Burning Device (device). Means a device that burns wood, or any other nongaseous or non-liquid fuels, and includes any device burning any solid fuel used for aesthetic or space-heating purposes including but not limited to a fireplace, wood stove, or pellet stove.
16. Stack or Chimney. Means any flue, conduit, or duct arranged to conduct any smoke, air contaminant or emission to the atmosphere. (As noted also in **Section 010.140**).
17. Treated Wood. Means wood of any species that has been chemically impregnated, painted, or similarly modified.
18. Uncertified. Means a wood stove that cannot be verified as meeting the certified standards and/or does not appear on the Washoe County District Health Department Official List of Certified/Exempt Wood Stoves. (As noted also in **Section 010.145**).
19. Waste Petroleum Products. Means hydrocarbon based or contaminated materials.
20. Wood Heater. Means an enclosed wood burning appliance capable of, and intended for space heating, domestic water heating or indoor cooking and has an air-to-fuel ratio of less than 35 to 1 in the low burn cycle. It also must have a usable firebox volume less than twenty (20) cubic feet, weigh less than 800 kilograms and have a minimum burn rate less than five (5) kilograms per hour. Appliances that are described as prefabricated fireplaces and are designed to accommodate doors or other accessories that would create the air starved operating conditions of a wood heater, must meet the emission standards if they meet the criteria in the above definition with those accessories in place. (As noted also in **Section 010.200**).
21. Wood Stove. For purposes of this regulation may be a:
- a. wood heater;
 - b. pellet stove;
 - c. prefabricated zero clearance fireplace or a fireplace heat form with doors or other accessories which cause the fireplace to function as a wood heater; or
 - d. wood heater inserted in a fireplace.

Wood stoves do not include open masonry fireplaces, barbecue devices, portable firepits, gas-fired fireplaces or cook stoves. (Revised 9/23/98) (As noted also in Section 010.205).

SECTION C – STANDARDS:

1. **PARTICULATE MATTER EMISSION STANDARD:** The particulate matter emission standard is 7.5 grams or less of particulate matter per hour for a non-catalytic appliance or 4.1 grams or less of particulate matter per hour for a catalytic appliance. If the U.S. Environmental Protection Agency adopts a wood stove/fireplace emission standard, which is more stringent, that emission standard supersedes the standard in this section and becomes effective on the date that the U.S. Environmental Protection Agency standard becomes effective.

2. **CERTIFICATION:** A wood stove shall be considered certified for purposes of these regulations as defined in 040.051.B.2.

3. **EXISTING DEVICES:**

a. Upon the transfer or conveyance of any residential property, currently installed or existing wood stove(s) that are uncertified must be removed or replaced with certified or low emitting device(s), prior to the completion of any:

(1) escrow transaction; and/or

(2) title change on a residential property.

Rendering a device inoperable is not acceptable in lieu of removal.

b. The Control Officer on a case-by-case basis may approve an exemption from Section 040.051.C.3.a for an Antique wood stove. Persons requesting the exemption must provide proof of antiquity.

c. **RENOVATION/REMODEL:** If a residential property is undergoing a renovation/remodel, and not changing ownership, the existing wood stove(s) may be moved and re-installed, or the same type of fireplace(s) may be re-built. New or additional solid fuel burning devices are prohibited in accordance with the limitations set forth in 040.051.C.7 of this regulation.

4. **VISIBLE EMISSIONS:** No person may permit emissions from the stack or chimney of a solid fuel burning device to exceed an opacity greater than that shade designated as No. 2 on the Ringelmann Chart for a period or periods aggregating more than three (3) minutes in any one hour period. Emissions created during a fifteen (15) minute start-up period are exempt.

5. **PROHIBITED FUELS:** A person shall not cause or allow any of the following materials to be burned in a solid fuel burning device:

a. asphaltic products;

b. books and magazines;

c. garbage;

d. paints;

e. colored/wrapping paper;

f. plastic;

g. rubber products;

h. treated wood;

i. waste petroleum products;

j. fuel wood that is not seasoned;

k. coal; or

l. any other material not intended by a manufacturer for use as a fuel in a solid fuel burning device

6. CONDITIONS FOR SELLING WOOD: A person selling wood for use in a solid fuel burning device shall comply with the following:

- a. Seasoned wood (wood with a moisture content of 20 percent or less) may be sold for immediate use in a wood burning device.
- b. Wood with a moisture content of greater than 20 percent may be sold with a disclosure of the excessive moisture content and a recommended seasoning period to obtain a moisture content of 20 percent or less.

7. LIMITATION ON NUMBER OF SOLID FUEL BURNING DEVICES:

- a. New Installations: The number of certified wood stoves or fireplaces installed on any property for which a building or set-up permit is issued shall not exceed one per acre.
- b. Existing Property: In dwelling units or commercial/public facilities existing on the effective date of this regulation, installation of additional solid fuel burning devices is prohibited.
- c. The above limitations do not apply to devices that are defined as low emitting (Section B.8. of this regulation).

SECTION D – ADMINISTRATIVE REQUIREMENTS:

1. No local government authority within the Health District may issue a building permit to any person to install an uncertified, or U.S. EPA exempt wood stove.

2. **WOOD STOVE INSPECTORS:** A person may be approved by the Control Officer to inspect and certify that wood stoves are currently, or have been in the past, certified per Section 040.051.

a. To obtain approval, an application must be submitted to the Control Officer. Approval will be issued upon satisfactory completion of all requirements set forth by the Control Officer and payment of the fee established by the Board of Health. Annual approval may be renewed upon meeting all the requirements of the Control Officer and payment of the renewal fee.

b. An approved inspector shall report the result of each inspection on a form provided by the Control Officer after the fee established by the Board of Health is paid. The approved inspector must indicate:

- (1) Whether the residential property contains any solid fuel burning device;
- (2) The number of wood stoves which are certified;
- (3) The number of wood stoves which are not certified.

3. **EXISTING WOOD STOVES AND CHANGE OF OWNERSHIP:** In order to complete any escrow transaction, and/or title change on any residential property, the current property owner must obtain either a Certificate of Compliance or a Notice of Exemption:

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- a. The Control Officer shall issue a Certificate of Compliance if:
 - (1) An inspection report from an approved Wood Stove Inspector is submitted that demonstrates the residential property contains allowable wood burning devices.
 - i. If the report indicates that a wood stove is uncertified, the wood stove must be removed from the residential property and re-inspection by an approved inspector is required.
 - (2) The Control Officer shall issue a Certificate of Compliance not later than seven (7) working days after receipt of a completed inspection report from an approved Wood Stove Inspector.
 - i. If the Control Officer fails to act within the seven (7) working day period, any escrow transaction and/or title change that requires a Certificate of Compliance may be completed in lieu of issuance of said Certificate.
- b. A Notice of Emption shall be submitted to the Control Office within ten (10) working days of the close of escrow and/or title change, if:
 - (1) The residential property does not contain a wood stove.
 - (2) The residential property contains any solid fuel burning device that is to be removed before the close of escrow and/or title change, then the Notice of Exemption can not be submitted until the solid fuel burning device is removed from the property.

The buyer and seller of any residential property shall observe any disclosure statements supplied by the real estate agents relating to the requirement under this regulation for the inspection of any wood stove.

SECTION E – COMPLIANCE AND RECORDS

1. DEALERS AFFIDAVIT OF SALE

- a. A person who sells a wood stove within the Health District must report the sale to the Control Officer within thirty (30) days from the date of sale on the form provided by the Control Officer.
- b. The form shall be provided by the Control Officer after the person pays the fee established by the Board of Health for that form.
- c. Any person who fails to notify the Control Officer of the sale is subject to the penalties set forth in **Section 020.040**.

2. CERTIFICATE OF COMPLIANCE: A Certificate of Compliance issued pursuant to this section:

- a. Remains valid until the residential property is transferred or conveyed to a new owner or nine (9) months, whichever comes sooner.
- b. Does not constitute a warranty or guarantee by the approved inspector or the Control Officer that the wood stove meets any other standards of operation, efficiency or safety, except the emission standards contained in these regulations.

3. FALSIFICATION OF INFORMATION: Any person who falsifies any information associated with a:

- a. Wood Stove Inspection;
- b. Certificate of Compliance;
- c. Notice of Exemption; or
- d. Dealer's Affidavit of Sale

is subject to the penalties set forth in **Section 020.040**, and may be subjected to the applicable penalties prescribed by law for perjury. The revocation of the Control Officer's approval to conduct wood stove inspections or revocation of a Certificate of Compliance may also be a result.

4. VIOLATION OF VISIBLE EMISSIONS OR PROHIBITED FUELS STANDARDS: A person who violates Sections C.4, C.5 or C.6 of this regulation shall be issued a warning for the first violation, and shall be provided information on proper wood burning techniques. Subsequent violations would be subject to the penalties set forth in Section 020.040.

5. CURTAILMENT OF BURNING DURING POLLUTION ALERTS: If the concentrations of an air containment reach or are predicted to reach levels that constitute a Stage 1 alert as defined in

Section 050.005, operation of any Solid Fuel Burning Device shall be suspended in accordance with the requirements of Section 050.015.A.5.

040.0512 EXISTING WOOD STOVE/FIREPLACE INSERT - REPLACEMENT

(Amended 11/18/92, 11/16/94, 9/23/98; Text deleted in its entirety by DBOH 6/19/02)

040.0514 LIMITATION ON NUMBER OF SOLID FUEL BURNING DEVICES (Adopted 5/23/90,

Amended 11/16/94, 9/23/98; Text deleted in its entirety by DBOH 6/19/02)

040.055 ODOROUS OR GASEOUS CONTAMINANTS (Amended 1/89)

It is unlawful for any person to discharge, or cause to be discharged, from any source whatsoever, any quantity of odorous or gaseous emissions, materials, or air contaminants of any kind or description, which is, or tends to be, offensive to the senses, or injurious or detrimental to repose, health, and safety, or which in any way unduly interferes with or prevents the comfortable enjoyment of life or property by any property owners, residents or the general public.

The Control Officer may deem an odor complaint a confirmed violation if he is able to verify the odor episode by reliable methods including, but not limited to: 1) actual ambient measurements of a known substance at a level greater than its odor threshold; or 2) verification of odors on-site by the Control Officer; or 3) at least 75% of a group of eight or more people selected by the Control Officer, when exposed to the odor, find it objectionable to their senses at ambient levels in areas accessible to the public.

The Control Officer may require, by notice in writing, any source with two or more violations of this regulation within a one year period, to submit a plan to reduce odorous emissions. This plan must demonstrate how the source will reduce emissions to a level that will eliminate any odor episode occurrences in the future. The plan must be submitted within 60 days of the receipt of the Control Officer's notice, and must be implemented within a reasonable period of time thereafter, as determined by the Control Officer.

State of Oregon

The Oregon Administrative Rules contain OARs filed through June 15, 2006

DEPARTMENT OF ENVIRONMENTAL QUALITY

DIVISION 262

RESIDENTIAL WOODHEATING

340-262-0010

Purpose

The purpose of this Division is to establish rules to control, reduce and prevent air pollution caused by residential woodheating emissions.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.460

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0001

340-262-0020

Definitions

The definitions in OAR 340-200-0020, 340-204-0010 and this rule apply to this division. If the same term is defined in this rule and OAR 340-200-0020 or 340-204-0010, the definition in this rule applies to this division.

- (1) "Administrator" means the administrator of the Environmental Protection Agency or the administrator's authorized representative.
- (2) "Antique Woodstove" means a woodstove built before 1940 that has an ornate construction and a current market value substantially higher than a common woodstove manufactured in the same time period.
- (3) "Commission" means the Environmental Quality Commission.
- (4) "Consumer" means any person who buys a woodstove for personal use.
- (5) "Cookstove" means an indoor woodburning appliance the design and primary purpose of which is to cook food.

- (6) "Curtailement" means a period during which woodburning is prohibited due to the existence of an air stagnation condition.
- (7) "Dealer" means any person engaged in selling wood-stoves to retailers or other dealers for resale. A dealer which is also an Oregon retailer shall be considered to be only a retailer for purposes of this Division.
- (8) "Destroy" means to demolish to such an extent that restoration is impossible.
- (9) "Department" means the Oregon Department of Environmental Quality.
- (10) "Director" means the Director of the Department or the Director's authorized delegates.
- (11) "EPA" means the United States Environmental Protection Agency.
- (12) "Federal Regulations" means **Volume 40 CFR, Part 60, Subpart AAA, Sections 60.530 through 60.539b**, dated **July 1, 1993**.
- (13) "Fireplace" means a framed opening made in a chimney to hold an open fire.
- (14) "Manufacturer" means any person who imports a woodstove, constructs a woodstove or parts for woodstoves.
- (15) "New Woodstove" means any woodstove that has not been sold, bargained, exchanged, given away or has not had its ownership transferred from the person who first acquired the woodstove from the manufacturer's dealer or agency, and has not been so used to have become what is commonly known as "second hand" within the ordinary meaning of that term.
- (16) "Pelletstove" means a woodburning heating appliance which uses wood pellets as its primary source of fuel.
- (17) "Retailer" means any person engaged in the sale of woodstoves directly to consumers.
- (18) "Used Woodstove" means any woodstove that has been sold bargained, exchanged, given away, or has had its ownership transferred from a retailer, manufacturer's dealer or agent to a consumer.
- (19) "Woodstove" or "Woodheater" means an enclosed, woodburning appliance capable of and intended for space heating and domestic water heating that meets all of the following criteria:
- (a) An air-to-fuel ratio in the combustion chamber averaging less than 35-to-1 as determined by the test procedure prescribed in federal regulations, **40 CFR, Part 60, Subpart AAA, §60.534** performed at an accredited laboratory;
 - (b) A usable firebox volume of less than 20 cubic feet;

- (c) A minimum burn rate less than 5 kg/hr as determined by the test procedure prescribed in federal regulations, **40 CFR, Part 60, Subpart AAA, §60.534** performed at an accredited laboratory; and
- (d) A maximum weight of 800 kg. In determining the weight of an appliance for these purposes, fixtures and devices that are normally sold separately, such as flue pipe, chimney, heat distribution ducting, and masonry components that are not an integral part of the appliance or heat distribution ducting, shall not be included.

[Publications: The publication(s) referred to or incorporated by reference in this rule are available from the agency.]

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 11-1984, f. & ef. 6-26-84; DEQ 5-1990, f. 3-7-90, cert. ef. 7-1-90; DEQ 25-1991, f. & cert. ef. 11-13-91; Renumbered from 340-021-0100; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 1-1994, f. & cert. ef. 1-3-94; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0005

Woodstove Sales

340-262-0030

Requirements for Sale of Woodstoves

(1) Requirements applicable to the sale of new woodstoves:

- (a) No person shall advertise to sell, offer to sell, or sell a new woodstove in Oregon unless the woodstove has been labeled for heating efficiency and tested, certified and labeled for emission performance in accordance with criteria, emission standards, and procedures specified in the federal regulations, **40 CFR, Part 60, Subpart AAA**;
- (b) No manufacturer, dealer, retailer or individual shall alter the permanent certification label in any way from the label approved by the Administrator pursuant to federal regulations, **40 CFR, Part 60, Subpart AAA**;
- (c) No manufacturer, dealer or retailer shall alter the removable label in any way from the label approved by the Administrator pursuant to federal regulations, **40 CFR, Part 60, Subpart AAA**.

(2) Requirements applicable for the sale of used woodstoves. A person shall not advertise to sell, offer to sell, or sell a used woodstove unless:

- (a) The woodstove was certified by the Department or the Administrator on or after July 1, 1986, in accordance with emission performance and heating efficiency criteria applicable at the time of certification;

(b) The woodstove has permanently attached an emission performance label authorized by the Department or the EPA.

(3) Section (2) of this rule concerning used woodstoves that have not been certified shall not apply to the following:

(a) The selling by a consumer of a used woodstove that has not been certified by the Department to a person in the business of reusing, reclaiming or recycling scrap metal to be destroyed or used as scrap metal;

(b) The remittance of a used woodstove that has not been certified by the Department by a consumer to a retailer for the purpose of receiving a reduction in price on a new residential heating system.

[Publications: The publication(s) referred to or incorporated by reference in this rule are available from the agency.]

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.500

Hist.: DEQ 11-1984, f. & ef. 6-26-84; DEQ 5-1990, f. 3-7-90, cert. ef. 7-1-90; DEQ 25-1991, f. & cert. ef. 11-13-91; Renumbered from 340-021-0105; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 1-1994, f. & cert. ef. 1-3-94; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0010

340-262-0040

Exemptions

(1) A pelletstove is exempt from the following requirements:

(a) OAR 340-262-0110 through 340-262-0130, woodstove certification, and OAR 340-262-0030, requirements applicable to the sale of woodstoves;

(b) OAR 340-262-0030(2), requirements applicable to the sale of used woodstoves;

(c) OAR 340-262-0200 through 340-262-0250, woodburning curtailment; and

(d) OAR 340-262-0300 through 340-262-0330, woodstove requirements.

(2) An enclosed woodheating appliance capable of and intended for residential space heating or domestic water heating is exempt from OAR 340-262-0030, requirements applicable to the sale of woodstoves, and OAR 340-262-0110 through 340-262-0130, woodstove certification, provided the manufacturer holds a valid letter of exemption from the Administrator which verifies that the appliance is not a woodstove or woodheater as defined in OAR 340-262-0020(19).

(3) An antique stove is exempt from the requirements of:

(a) OAR 340-262-0030(2), requirements applicable to the sale of used woodstoves; and

(b) OAR 340-262-0300 through 340-262-0330, woodstove requirements.

(4) A cookstove is exempt from the requirements of OAR Chapter 340, Division 262, except for OAR 340-262-0200 through 340-262-0250, woodburning curtailment.

(5) A woodburning fireplace, woodstove or appliance operated within a household classified to be at less than or equal to 125 percent of the federal poverty level is exempt from the requirement of OAR 340-262-0200 through 340-262-0250, woodburning curtailment. The federal poverty level is published in the **Federal Register, Volume 56, Number 34, February 20, 1990, page 6859**, Department of Health and Human Services.

(6) A woodstove operated in a residence that is equipped solely with woodheat is exempt from the requirements of OAR 340-262-0200 through 340-262-0250, woodburning curtailment.

[Publications: The publication(s) referred to or incorporated by reference in this rule are available from the agency.]

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 11-1984, f. & ef. 6-26-84; DEQ 5-1990, f. 3-7-90, cert. ef. 7-1-90; DEQ 25-1991, f. & cert. ef. 11-13-91; Renumbered from 340-021-0110; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 1-1994, f. & cert. ef. 1-3-94; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0015

340-262-0050

Civil Penalties

Violations of OAR Chapter 340, Division 262 are subject to OAR Chapter 340, Division 12, Enforcement Procedures and Civil Penalties.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0020

Woodstove Certification Program

340-262-0100

Applicability

(1) OAR 340-262-0100 through 340-262-0130 shall apply to any woodstove or woodheater.

(2) The following woodheating appliances are not subject to OAR 340-262-0100 through 340-262-0130:

(a) Open masonry fireplaces;

(b) Boilers;

(c) Furnaces; and

(d) Cookstoves.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 1-1994, f. & cert. ef. 1-3-94; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0045

340-262-0110

Emissions Performance Standards and Certification

(1) Unless exempted by the Department under OAR 340-262-0040, new woodstoves advertised for sale, offered for sale or sold in Oregon between July 1, 1990 and June 30, 1992 shall be certified by the Administrator pursuant to federal regulation as complying with the particulate matter emission limits specified in the federal regulations, **40 CFR, Part 60, Subpart AAA, §60.532(a)**.

(2) Unless exempted by the Department under OAR 340-262-0040, new woodstoves advertised for sale, offered for sale, or sold in Oregon on or after July 1, 1992 shall be certified by the Administrator pursuant to federal regulation as complying with the particulate matter emission limits specified in the federal regulations, **40 CFR, Part 40, Subpart AAA, §60.532(b)**.

[Publications: The publication(s) referred to or incorporated by reference in this rule are available from the agency.]

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 11-1984, f. & ef. 6-26-84; DEQ 5-1990, f. 3-7-90, cert. ef. 7-1-90; DEQ 25-1991, f. & cert. ef. 11-13-91; Renumbered from 340-021-0115; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 1-1994, f. & cert. ef. 1-3-94; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0050

340-262-0120

General Certification Procedures

Any new woodstove sold in Oregon shall be considered to be in full compliance with Oregon emission performance standards and rated heating efficiency requirements if the manufacturer holds a valid Certificate of Compliance issued by the Administrator, pursuant to federal regulations, **40 CFR, Part 60, Subpart AAA**. Such a stove shall be considered Oregon certified without any further action by the Department.

[Publications: The publication(s) referred to or incorporated by reference in this rule are available from the agency.]

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 11-1984, f. & ef. 6-26-84; DEQ 5-1990, f. 3-7-90, cert. ef. 7-1-90; DEQ 25-1991, f. & cert. ef. 11-13-91; Renumbered from 340-021-0125; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 1-1994, f. & cert. ef. 1-3-94; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0060

340-262-0130

Labeling Requirements

New woodstoves sold in Oregon shall have affixed to them:

(1) A permanent label, in accordance with federal regulations, **40 CFR, Part 60, Subpart AAA, §60.536**.

(2) A point-of-sale removable label in accordance with federal regulations, **40 CFR, Part 60, Subpart AAA, §60.536**.

[Publications: The publication(s) referred to or incorporated by reference in this rule are available from the agency.]

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 11-1984, f. & ef. 6-26-84; DEQ 5-1990, f. 3-7-90, cert. ef. 7-1-90; DEQ 25-1991, f. & cert. ef. 11-13-91; Renumbered from 340-021-0135; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 1-1994, f. & cert. ef. 1-3-94; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0070

Woodburning Curtailment

340-262-0200

Applicability

OAR 340-262-0200 through 340-262-0250 shall apply to any portion of the state:

(1) Where the Department has determined that, under the requirements of the Clean Air Act, an enforceable woodburning curtailment program is required as an emission reduction control strategy for a PM₁₀ nonattainment area and the Department has determined that the local government or regional authority has failed to adopt or adequately implement the required woodburning curtailment program. In determining whether a local government or regional authority has failed to adequately adopt or implement a curtailment program, the Department shall determine if a local government or regional authority:

- (a) Has adopted an ordinance that requires the curtailment of residential woodheating at forecasted air pollution levels which are consistent with the curtailment conditions and requirements specified in OAR 340-262-0210(1) and 340-262-0220(1) and (2);
- (b) Is issuing on a daily basis curtailment advisories to the public consistent with OAR 340-262-0230; and
- (c) Is conducting surveillance for compliance and is taking adequate enforcement actions consistent with OAR 340-262-0240.

(2) Where the Department has determined that, under the requirements of the Clean Air Act, an enforceable woodburning curtailment program is required as an emission abatement strategy to respond to an air pollution emergency.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.515

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 10-1995, f. & cert. ef. 5-1-95; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0150

340-262-0210

Determination of Air Stagnation Conditions

The Department shall utilize appropriate data and technology to develop methodology criteria for a curtailment program that:

(1) For use as an emission reduction control strategy or contingency plan for PM₁₀ nonattainment areas:

- (a) Calls a Stage I advisory when the PM₁₀ standard is being approached; and
- (b) Calls a Stage II advisory, when an exceedance of the PM₁₀ standard is forecasted to be imminent.

(2) For use as an emission abatement strategy in order to respond to an air pollution emergency:

- (a) Calls an Alert when PM₁₀ alert levels have been reached and are forecasted to continued; and

(b) Calls a Warning when PM₁₀ warning levels have been reached and are forecasted to continue;

(c) Alert and Warning levels are specified in OAR Chapter 340, Division 206.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.515

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0155

340-262-0220

Prohibition on Woodburning During Periods of Air Stagnation

(1) During any designated Stage I advisory, the operation of any uncertified woodstove, fireplace, or woodburning appliance shall be prohibited unless exempted under the provisions of OAR 340-262-0040.

(2) During any designated Stage II advisory, the operation of any woodstove, fireplace, or woodburning appliance shall be prohibited unless exempted under the provisions of OAR 340-262-0040.

(3) During any designated PM₁₀ Alert, the operation of any uncertified woodstove, fireplace, or woodburning appliance shall be prohibited unless exempted under the provisions of OAR 340-262-0040.

(4) During any designated PM₁₀ Warning, the operation of any woodstove, fireplace, or woodburning appliance shall be prohibited unless exempted under the provisions of OAR 340-262-0040.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.515

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0160

340-262-0230

Public Information Program

The Department or its designated representative shall implement a public information program to disseminate the daily air pollution advisory to the local community. The public information program shall include but may not be limited to the utilization of applicable local media including television, radio, and newspapers.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.025

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0165

340-262-0240

Enforcement

(1) The Department or its designated representative shall monitor the level of compliance with curtailment requirements during designated periods of air stagnation.

(2) A rebuttable presumption of a violation shall arise if smoke is being emitted through a flue or chimney during a curtailment period unless the household from which smoke is being emitted has provided the Department or designated representative with information indicating that the household or its woodburning appliance is exempt from curtailment requirements in accordance with OAR 340-262-0040.

(3) Any person claiming an exemption to OAR 340-262-0200 through 340-262-0250 in accordance with OAR 340-262-0040 in response to a Notice of Noncompliance shall provide the Department with documentation which establishes eligibility for the exemption. The Department shall review the documentation and make a determination regarding the exemption status of the household, or woodheating appliance. The following documentation shall be submitted to the Department for review in order to establish exemption status under the criteria of OAR 340-262-0040:

- (a) For households desiring low income exemption status a copy of the previous year tax returns. The tax return should reflect the total combined household income for the past year;
- (b) A signed affidavit attesting to the sole source status of a home (see note);
- (c) A signed affidavit attesting to the certification status of the home heating appliance (see note).

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.025

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0170

340-262-0250

Suspension of Department Program

(1) The Department shall suspend the operation and enforcement of OAR 340-262-0200 through 340-262-0240 in any area upon determination by the Department that the local government or regional air quality authority has adopted and is adequately implementing a woodburning curtailment program that is at least as stringent as the program outlined in OAR 340-262-0200 through 340-262-0240.

(2) In making a determination concerning the adequacy of a local or regional woodburning curtailment program, the Department shall consider whether or not the local government or regional authority:

- (a) Has adopted an ordinance that requires the curtailment of residential woodheating at forecasted air pollution levels which are consistent with curtailment conditions specified in OAR 340-262-0210;
- (b) Is issuing curtailment advisories to the public on a daily basis;
- (c) Is conducting surveillance for compliance and is taking adequate enforcement actions;
- (d) Any other information the Department determines is necessary to determine the adequacy of the curtailment program.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.515

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0175

Woodstove Removal Contingency Program

340-262-0300

Applicability

OAR 340-262-0300 though 340-262-0330 shall apply to any area classified as a nonattainment area for PM₁₀ that does not achieve attainment by the applicable Clean Air Act deadline.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 10-1995, f. & cert. ef. 5-1-95; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0200

340-262-0310

Removal and Destruction of Uncertified Stove Upon Sale of Home

Except as provided for by OAR 340-262-0040, any uncertified woodstove shall be removed and destroyed by the seller upon the sale of a home.

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0205

340-262-0320

Home Seller's Responsibility to Verify Stove Destruction

Any person selling a home which contains an uncertified woodstove shall provide to the Department or the Department's designated representative prior to the sale of the home, a copy of a receipt from a scrap metal dealer verifying that the stove has been destroyed.

[NOTE: This rule is included in the State of Oregon Clean Air Act Implementation Plan as adopted by the Environmental Quality Commission under OAR 340-200-0040.]

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 10-1995, f. & cert. ef. 5-1-95; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0210

340-262-0330

Home Seller's Responsibility to Disclose

Any person selling a home in which an uncertified woodstove is present shall disclose to any potential buyer, buyer's agent or buyer's representative that the woodstove is uncertified, and must be removed and destroyed upon sale of the home.

[NOTE: This rule is included in the State of Oregon Clean Air Act Implementation Plan as adopted by the Environmental Quality Commission under OAR 340-200-0040.]

Stat. Auth.: ORS 468 & ORS 468A

Stats. Implemented: ORS 468A.480

Hist.: DEQ 25-1991, f. & cert. ef. 11-13-91; DEQ 4-1993, f. & cert. ef. 3-10-93; DEQ 14-1999, f. & cert. ef. 10-14-99, Renumbered from 340-034-0215

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State of Washington

70.94.450

Wood stoves — Policy.

In the interest of the public health and welfare and in keeping with the objectives of RCW [70.94.011](#), the legislature declares it to be the public policy of the state to control, reduce, and prevent air pollution caused by wood stove emissions. It is the state's policy to reduce wood stove emissions by encouraging the department of ecology to continue efforts to educate the public about the effects of wood stove emissions, other heating alternatives, and the desirability of achieving better emission performance and heating efficiency from wood stoves. The legislature further declares that: (1) The purchase of certified wood stoves will not solve the problem of pollution caused by wood stove emissions; and (2) the reduction of air pollution caused by wood stove emissions will only occur when wood stove users adopt proper methods of wood burning.

[1987 c 405 § 1.]

70.94.453

Wood stoves — Definitions.

Unless the context clearly requires otherwise, the definitions in this section apply throughout RCW [70.94.453](#) through [*70.94.487](#):

- (1) "Department" means the department of ecology.
- (2) "Wood stove" means a solid fuel burning device other than a fireplace not meeting the requirements of RCW [70.94.457](#), including any fireplace insert, wood stove, wood burning heater, wood stick boiler, coal-fired furnace, coal stove, or similar device burning any solid fuel used for aesthetic or space-heating purposes in a private residence or commercial establishment, which has a heat input less than one million British thermal units per hour. The term "wood stove" does not include wood cook stoves.
- (3) "Fireplace" means: (a) Any permanently installed masonry fireplace; or (b) any factory-built metal solid fuel burning device designed to be used with an open combustion chamber and without features to control the air to fuel ratio.
- (4) "New wood stove" means: (a) A wood stove that is sold at retail, bargained, exchanged, or given away for the first time by the manufacturer, the manufacturer's dealer or agency, or a retailer; and (b) has not been so used to have become what is commonly known as "second hand" within the ordinary meaning of that term.
- (5) "Solid fuel burning device" means any device for burning wood, coal, or any other nongaseous and nonliquid fuel, including a wood stove and fireplace.
- (6) "Authority" means any air pollution control agency whose jurisdictional boundaries are coextensive with the boundaries of one or more counties.

(7) "Opacity" means the degree to which an object seen through a plume is obscured, stated as a percentage. The methods approved by the department in accordance with RCW [70.94.331](#) shall be used to establish opacity for the purposes of this chapter.

[1987 c 405 § 2.]

70.94.455

Residential and commercial construction — Burning and heating device standards.

After January 1, 1992, no used solid fuel burning device shall be installed in new or existing buildings unless such device is either Oregon department of environmental quality phase II or United States environmental protection agency certified or a pellet stove either certified or exempt from certification by the United States environmental protection agency.

(1) By July 1, 1992, the state building code council shall adopt rules requiring an adequate source of heat other than wood stoves in all new and substantially remodeled residential and commercial construction. This rule shall apply (a) to areas designated by a county to be an urban growth area under chapter 36.70A RCW; and (b) to areas designated by the environmental protection agency as being in nonattainment for particulate matter.

(2) For purposes of this section, "substantially remodeled" means any alteration or restoration of a building exceeding sixty percent of the appraised value of such building within a twelve-month period.

[1991 c 199 § 503.]

70.94.457

Solid fuel burning devices — Emission performance standards.

The department of ecology shall establish by rule under chapter 34.05 RCW:

(1) Statewide emission performance standards for new solid fuel burning devices. Notwithstanding any other provision of this chapter which allows an authority to adopt more stringent emission standards, no authority shall adopt any emission standard for new solid fuel burning devices other than the statewide standard adopted by the department under this section.

(a) After January 1, 1995, no solid fuel burning device shall be offered for sale in this state to residents of this state that does not meet the following particulate air contaminant emission standards under the test methodology of the United States environmental protection agency in effect on January 1, 1991, or an equivalent standard under any test methodology adopted by the United States environmental protection agency subsequent to such date: (i) Two and one-half grams per hour for catalytic wood stoves; and (ii) four and one-half grams per hour for all other solid fuel burning devices. For purposes of this subsection, "equivalent" shall mean the emissions limits specified in this subsection multiplied by a statistically reliable conversion factor determined by the department that compares the difference between the emission test

methodology established by the United States environmental protection agency prior to May 15, 1991, with the test methodology adopted subsequently by the agency. Subsection (a) of this subsection does not apply to fireplaces.

(b) After January 1, 1997, no fireplace, except masonry fireplaces, shall be offered for sale unless such fireplace meets the 1990 United States environmental protection agency standards for wood stoves or equivalent standard that may be established by the state building code council by rule. Prior to January 1, 1997, the state building code council shall establish by rule a methodology for the testing of factory-built fireplaces. The methodology shall be designed to achieve a particulate air emission standard equivalent to the 1990 United States environmental protection agency standard for wood stoves. In developing the rules, the council shall include on the technical advisory committee at least one representative from the masonry fireplace builders and at least one representative of the factory-built fireplace manufacturers.

(c) Prior to January 1, 1997, the state building code council shall establish by rule design standards for the construction of new masonry fireplaces in Washington state. In developing the rules, the council shall include on the technical advisory committee at least one representative from the masonry fireplace builders and at least one representative of the factory-built fireplace manufacturers. It shall be the goal of the council to develop design standards that generally achieve reductions in particulate air contaminant emissions commensurate with the reductions being achieved by factory-built fireplaces at the time the standard is established.

(d) Actions of the department and local air pollution control authorities under this section shall preempt actions of other state agencies and local governments for the purposes of controlling air pollution from solid fuel burning devices, except where authorized by chapter 199, Laws of 1991.

(e) Subsection (1)(a) of this section shall not apply to fireplaces.

(f) Notwithstanding (a) of this subsection, the department is authorized to adopt, by rule, emission standards adopted by the United States environmental protection agency for new wood stoves sold at retail. For solid fuel burning devices for which the United States environmental protection agency has not established emission standards, the department may exempt or establish, by rule, statewide standards including emission levels and test procedures for such devices and such emission levels and test procedures shall be equivalent to emission levels per pound per hour burned for other new wood stoves and fireplaces regulated under this subsection.

(2) A program to:

(a) Determine whether a new solid fuel burning device complies with the statewide emission performance standards established in subsection (1) of this section; and

(b) Approve the sale of devices that comply with the statewide emission performance standards.

[1995 c 205 § 3; 1991 c 199 § 501; 1987 c 405 § 4.]

70.94.460

Sale of unapproved wood stoves — Prohibited.

After July 1, 1988, no person shall sell, offer to sell, or knowingly advertise to sell a new wood stove in this state to a resident of this state unless the wood stove has been approved by the department under the program established under RCW [70.94.457](#).

[1995 c 205 § 4; 1987 c 405 § 7.]

70.94.463

Sale of unapproved wood stoves — Penalty.

After July 1, 1988, any person who sells, offers to sell, or knowingly advertises to sell a new wood stove in this state in violation of RCW [70.94.460](#) shall be subject to the penalties and enforcement actions under this chapter.

70.94.467

Sale of unapproved wood stoves — Application of law to advertising media.

Nothing in RCW [70.94.460](#) or [70.94.463](#) shall apply to a radio station, television station, publisher, printer, or distributor of a newspaper, magazine, billboard, or other advertising medium that accepts advertising in good faith and without knowledge of its violation of RCW [70.94.453](#) through [*70.94.487](#).

[1987 c 405 § 12.]

70.94.470

Residential solid fuel burning devices — Opacity levels — Enforcement and public education.

(1) The department shall establish, by rule under chapter 34.05 RCW, (a) a statewide opacity level of twenty percent for residential solid fuel burning devices for the purpose of enforcement on a complaint basis and (b) a statewide opacity of ten percent for purposes of public education.

(2) Notwithstanding any other provision of this chapter which may allow an authority to adopt a more stringent opacity level, no authority shall adopt or enforce an opacity level for solid fuel burning devices other than established in this section.

(3) Actions of the department and local air pollution control authorities under this section shall preempt actions of other state agencies and local governments for the purposes of controlling air pollution from solid fuel burning devices, except where authorized by chapter 199, Laws of 1991.

[1991 c 199 § 502; 1987 c 405 § 5.]

70.94.473

Limitations on burning wood for heat.

(1) Any person in a residence or commercial establishment which has an adequate source of heat without burning wood shall:

(a) Not burn wood in any solid fuel burning device whenever the department has determined under RCW [70.94.715](#) that any air pollution episode exists in that area;

(b) Not burn wood in any solid fuel burning device except those which are either Oregon department of environmental quality phase II or United States environmental protection agency certified or certified by the department under RCW [70.94.457](#)(1) or a pellet stove either certified or issued an exemption by the United States environmental protection agency in accordance with Title 40, Part 60 of the code of federal regulations, in the geographical area and for the period of time that a first stage of impaired air quality has been determined, by the department or any authority, for that area. A first stage of impaired air quality is reached when:

(i) Fine particulates are at an ambient level of thirty-five micrograms per cubic meter measured on a twenty-four hour average; and

(ii) Forecasted meteorological conditions are not expected to allow levels of fine particulates to decline below thirty-five micrograms per cubic meter for a period of forty-eight hours or more from the time that the fine particulates are measured at the trigger level; and

(c) Not burn wood in any solid fuel burning device in a geographical area and for the period of time that a second stage of impaired air quality has been determined by the department or any authority, for that area. A second stage of impaired air quality is reached when:

(i) A first stage of impaired air quality has been in force and not been sufficient to reduce the increasing fine particle [particulate] pollution trend;

(ii) Fine particulates are at an ambient level of sixty micrograms per cubic meter measured on a twenty-four hour average; and

(iii) Forecasted meteorological conditions are not expected to allow levels of fine particulates to decline below sixty micrograms per cubic meter for a period of forty-eight hours or more from the time that the fine particulates are measured at the trigger level.

(2) Actions of the department and local air pollution control authorities under this section shall preempt actions of other state agencies and local governments for the purposes of controlling air pollution from solid fuel burning devices, except where authorized by chapter 199, Laws of 1991.

[2005 c 197 § 1; 1998 c 342 § 8; 1995 c 205 § 1; 1991 c 199 § 504; 1990 c 128 § 2; 1987 c 405 § 6.]

70.94.475

Liability of condominium owners' association or resident association.

A condominium owners' association or an association formed by residents of a multiple-family dwelling are not liable for violations of RCW [70.94.473](#) by a resident of a condominium or multiple-family dwelling. The associations shall cooperate with local air pollution control authorities to acquaint residents with the provisions of this section.

[1990 c 157 § 2.]

70.94.477

Limitations on use of solid fuel burning devices.

(1) Unless allowed by rule, under chapter 34.05 RCW, a person shall not cause or allow any of the following materials to be burned in any residential solid fuel burning device:

- (a) Garbage;
- (b) Treated wood;
- (c) Plastics;
- (d) Rubber products;
- (e) Animals;
- (f) Asphaltic products;
- (g) Waste petroleum products;
- (h) Paints; or
- (i) Any substance, other than properly seasoned fuel wood, which normally emits dense smoke or obnoxious odors.

(2) For the sole purpose of a contingency measure to meet the requirements of section 172(c)(9) of the federal clean air act, a local authority or the department may prohibit the use of solid fuel burning devices, except fireplaces as defined in RCW [70.94.453](#)(3), wood stoves meeting the standards set forth in RCW [70.94.457](#) or pellet stoves either certified or issued an exemption by the United States environmental protection agency in accordance with Title 40, Part 60 of the code of federal regulations, if the United States environmental protection agency, in consultation with the department and the local authority makes written findings that:

(a) The area has failed to make reasonable further progress or attain or maintain a national ambient air quality standard; and

(b) Emissions from solid fuel burning devices from a particular geographic area are a contributing factor to such failure to make reasonable further progress or attain or maintain a national ambient air quality standard.

A prohibition issued by a local authority or the department under this subsection shall not apply to a person in a residence or commercial establishment that does not have an adequate source of heat without burning wood.

[1995 c 205 § 2; 1990 c 128 § 3; 1987 c 405 § 9.]

70.94.480

Wood stove education program.

(1) The department of ecology shall establish a program to educate wood stove dealers and the public about:

- (a) The effects of wood stove emissions on health and air quality;
- (b) Methods of achieving better efficiency and emission performance from wood stoves;
- (c) Wood stoves that have been approved by the department;
- (d) The benefits of replacing inefficient wood stoves with stoves approved under RCW [70.94.457](#).

(2) Persons selling new wood stoves shall distribute and verbally explain educational materials describing when a stove can and cannot be legally used to customers purchasing new wood stoves.

[1990 c 128 § 6; 1987 c 405 § 3.]

70.94.483

Wood stove education and enforcement account created — Fee imposed on solid fuel burning device sales.

(1) The wood stove education and enforcement account is hereby created in the state treasury. Money placed in the account shall include all money received under subsection (2) of this section and any other money appropriated by the legislature. Money in the account shall be spent for the purposes of the wood stove education program established under RCW [70.94.480](#) and for enforcement of the wood stove program, and shall be subject to legislative appropriation. However, during the 2003-05 fiscal biennium, the legislature may transfer from the wood stove education and enforcement account to the air pollution control account such amounts as specified in the omnibus operating budget bill.

(2) The department of ecology, with the advice of the advisory committee, shall set a flat fee of thirty dollars, on the retail sale, as defined in RCW 82.04.050, of each solid fuel burning device after January 1, 1992. The fee shall be imposed upon the consumer and shall not be subject to the retail sales tax provisions of chapters 82.08 and 82.12 RCW. The fee may be adjusted annually above thirty dollars to account for inflation as determined by the state office of the economic and revenue forecast council. The fee shall be collected by the department of revenue in conjunction with the retail sales tax under chapter 82.08 RCW. If the seller fails to collect the fee herein imposed or fails to remit the fee to the department of revenue in the manner prescribed in chapter 82.08 RCW, the seller shall be personally liable to the state for the amount of the fee. The collection provisions of chapter 82.32 RCW shall apply. The department of revenue shall deposit fees collected under this section in the wood stove education and enforcement account.

[2003 1st sp.s. c 25 § 932; 1991 sp.s. c 13 §§ 64, 65; 1991 c 199 § 505; 1990 c 128 § 5; 1987 c 405 § 10.]

Chapter 173-433 WAC

SOLID FUEL BURNING DEVICES

WAC

173-433-010 Purpose.

173-433-020 Applicability.

173-433-030 Definitions.

173-433-100 Emission performance standards.

173-433-110 Opacity standards.

173-433-120 Prohibited fuel types.

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173-433-140 Impaired air quality criteria.
173-433-150 Curtailment.
173-433-170 Retail sales fee.
173-433-200 Regulatory actions and penalties.

WAC 173-433-010 Purpose.

This chapter, promulgated under chapters 43.21A and 70.94 RCW, establishes emission standards, certification standards and procedures, curtailment rules, and fuel restrictions for solid fuel burning devices.

[Statutory Authority: Chapters 70.94 and 43.21A RCW. 88-01-056 (Order 87-44), § 173-433-010, filed 12/16/87.]

WAC 173-433-020 Applicability.

The provisions of this chapter apply to solid fuel burning devices in all areas of the state of Washington.

[Statutory Authority: Chapters 70.94 and 43.21A RCW. 88-01-056 (Order 87-44), § 173-433-020, filed 12/16/87.]

WAC 173-433-030 Definitions.

The definitions of terms contained in chapter 173-400 WAC are incorporated by reference.

Unless a different meaning is clearly required by context, the following words and phrases as used in this chapter, shall have the following meanings:

- (1) "Adequate source of heat" means the ability to maintain seventy degrees Fahrenheit at a point three feet above the floor in all normally inhabited areas of a dwelling.
- (2) "Certified" means that a woodstove meets emission performance standards when tested by an accredited independent laboratory and labeled according to procedures specified by the EPA in "40 CFR 60 Subpart AAA - Standards of Performance for Residential Wood Heaters" as amended through July 1, 1990.
- (3) "Coal-only heater" means an enclosed, coal burning appliance capable of and intended for residential space heating, domestic water heating, or indoor cooking, which has all of the following characteristics:
 - (a) An opening for emptying ash which is located near the bottom or the side of the appliance;
 - (b) A system which admits air primarily up and through the fuel bed;
 - (c) A grate or other similar device for shaking or disturbing the fuel bed or power driven mechanical stoker; and
 - (d) The model is listed by a nationally recognized safety testing laboratory for use of coal only, except for coal ignition purposes.
- (4) "EPA" means United States Environmental Protection Agency.
- (5) "New woodstove" means a woodstove that has not been sold at retail, bargained, exchanged, or given away for the first time by the manufacturer, the manufacturer's dealer or agency, or a retailer, and has not been so used as to become what is commonly known as "second hand" within the ordinary meaning of that term.
- (6) "Nonaffected pellet stove" means that a pellet stove has an air-to-fuel ratio equal to or greater than 35.0 when tested by an accredited laboratory in accordance with methods and procedures specified by the EPA in "40 CFR 60 Appendix A, REFERENCE METHOD 28A - MEASUREMENT OF AIR TO FUEL RATIO AND MINIMUM ACHIEVABLE BURN RATES FOR WOOD-FIRED APPLIANCES" as amended through July 1, 1990.
- (7) "Retailer" means any person engaged in the sale of solid fuel burning devices directly to the public. A contractor who sells dwellings with solid fuel burning devices installed or a mail order

outlet which sells solid fuel burning devices directly to the public is considered to be a solid fuel burning device retailer.

(8) "Seasoned wood" means wood of any species that has been sufficiently dried so as to contain twenty percent or less moisture by weight.

(9) "Solid fuel burning device" (same as solid fuel heating device) means a device that burns wood, coal, or any other nongaseous or nonliquid fuels, and includes any device burning any solid fuel except those prohibited by WAC 173-433-120. This also includes devices used for aesthetic or space-heating purposes in a private residence or commercial establishment, which has a heat input less than one million British thermal units per hour.

(10) "Treated wood" means wood of any species that has been chemically impregnated, painted, or similarly modified to prevent weathering and deterioration.

(11) "Woodstove" (same as "wood heater") means an enclosed solid fuel burning device capable of and intended for residential space heating and domestic water heating that meets the following criteria contained in "40 CFR 60 Subpart AAA - Standards of Performance for Residential Wood Heaters" as amended through July 1, 1990:

(a) An air-to-fuel ratio in the combustion chamber averaging less than 35.0, as determined by EPA Reference Method 28A;

(b) A useable firebox volume of less than twenty cubic feet;

(c) A minimum burn rate less than 5 kg/hr as determined by EPA Reference Method 28;

(d) A maximum weight of 800 kg, excluding fixtures and devices that are normally sold separately, such as flue pipe, chimney, and masonry components not integral to the appliance.

Any combination of parts, typically consisting of but not limited to: Doors, legs, flue pipe collars, brackets, bolts and other hardware, when manufactured for the purpose of being assembled, with or without additional owner supplied parts, into a woodstove, is considered a woodstove. [Statutory Authority: Chapter 70.94 RCW. 91-07-066 (Order 90-58), § 173-433-030, filed 3/20/91, effective 4/20/91. Statutory

Authority: RCW 70.94.331. 90-19-062 (Order 90-10), § 173-433-030, filed 9/17/90, effective 10/18/90. Statutory Authority:

Chapters 70.94 and 43.21A RCW. 89-02-054 (Order 88-38), § 173-433-030, filed 1/3/89; 88-01-056 (Order 87-44), § 173-433-

030, filed 12/16/87.]

WAC 173-433-100 Emission performance standards.

(1) Woodstoves. On or before January 1, 1995, a person shall not advertise to sell, offer to sell, sell, bargain, exchange, or give away a new woodstove in Washington unless it has been tested to determine its emission performance and heating efficiency and certified and labeled in accordance with procedures and criteria specified in "40 CFR 60 Subpart AAA- Standards of Performance for Residential Wood Heaters" as amended through July 1, 1990. After January 1, 1995, woodstove sales shall comply with the requirements of subsection (3) of this section, Solid fuel burning devices.

(2) Fireplaces. After January 1, 1997, a person shall not advertise to sell, offer to sell, sell, bargain,

exchange, or give away a factory built fireplace unless it meets the 1990 United States Environmental Protection Agency standards for woodstoves or equivalent standard that may be established by the state building code council by rule. Subsection (3) of this section shall not apply to fireplaces, including factory built fireplaces, and masonry fireplaces.

(3) Solid fuel burning devices. After January 1, 1995, a person shall not advertise to sell, offer to sell, sell, bargain, exchange, or give away a solid fuel burning device in Washington unless it has

been certified and labeled in accordance with procedures and criteria specified in "40 CFR 60 Subpart AAA – Standards of Performance for Residential Wood Heaters" as amended through July 1, 1990, and meets the following particulate air contaminant emission standards and the test methodology of the United States Environmental Protection Agency in effect on January 1, 1991, or an equivalent standard under any test methodology adopted by the United States Environmental Protection Agency subsequent to such date:

- (a) Two and one-half grams per hour for catalytic woodstoves; and
- (b) Four and one-half grams per hour for all other solid fuel burning devices.
- (c) For purposes of this subsection, "equivalent" shall mean the emissions limits specified in this subsection multiplied by a statistically reliable conversion factor determined by ecology that relates the emission test results from the methodology established by the United States Environmental Protection Agency prior to May 15, 1991, to the test results from the methodology subsequently adopted by that agency.

[Statutory Authority: Chapter 70.94 RCW and 501-506 ESHB 1028, 1991. 93-04-105 (Order 91-55), § 173-433-100, filed 2/3/93, effective 3/6/93. Statutory Authority: Chapter 70.94 RCW. 91-07-066 (Order 90-58), § 173-433-100, filed 3/20/91, effective 4/20/91. Statutory Authority: RCW 70.94.331. 90-19-062 (Order 90-10), § 173-433-100, filed 9/17/90, effective 10/18/90. Statutory Authority: Chapters 70.94 and 43.21A RCW. 89-02-054 (Order 88-38), § 173-433-100, filed 1/3/89; 88-01-056 (Order 87-44), § 173-433-100, filed 12/16/87.]

WAC 173-433-110 Opacity standards.

- (1) A person shall not cause or allow emission of a smoke plume from any solid fuel burning device to exceed an average of twenty percent opacity for six consecutive minutes in any one-hour period.
- (2) State-wide opacity standard. An authority shall not adopt or enforce an opacity level for solid fuel burning devices that is more stringent than the state-wide standard.
- (3) Test method and procedures. Methods and procedures specified by the EPA in "40 CFR 60 Appendix A reference method 9 - VISUAL DETERMINATION OF THE OPACITY OF EMISSIONS FROM STATIONARY SOURCES" as amended through July 1, 1990, shall be used to determine compliance with subsection (1) of this section.
- (4) Enforcement. Smoke visible from a chimney, flue or exhaust duct in excess of the opacity standard shall constitute prima facie evidence of unlawful operation of an applicable solid fuel burning device. This presumption may be refuted by demonstration that the smoke was not caused by an applicable solid fuel burning device. The provisions of this requirement shall:
 - (a) Be enforceable on a complaint basis.
 - (b) Not apply during the starting of a new fire for a period not to exceed twenty minutes in any fourhour period.
- (5) Education. Any person or retailer providing information on the operation of solid fuel burning devices, such as brochures, demonstrations, and public education programs, should include information that opacity levels of ten percent or less are attainable through proper operation.

[Statutory Authority: Chapter 70.94 RCW and 501-506 ESHB 1028, 1991. 93-04-105 (Order 91-55), § 173-433-110, filed 2/3/93, effective 3/6/93. Statutory Authority: Chapter 70.94 RCW. 91-07-066 (Order 90-58), § 173-433-110, filed 3/20/91, effective 4/20/91. Statutory Authority: RCW 70.94.331. 90-19-062 (Order 90-10), § 173-433-110, filed 9/17/90, effective 10/18/90. Statutory Authority: Chapters 70.94 and 43.21A RCW. 88-01-056 (Order 87-44), § 173-433-110, filed 12/16/87.]

WAC 173-433-120 Prohibited fuel types.

A person shall not cause or allow any of the following materials to be burned in a solid fuel burning device:

- (1) Garbage;
- (2) Treated wood;
- (3) Plastic and plastic products;
- (4) Rubber products;
- (5) Animal carcasses;
- (6) Asphaltic products;
- (7) Waste petroleum products;
- (8) Paints and chemicals; or
- (9) Any substance which normally emits dense smoke or obnoxious odors other than paper to start the fire, properly seasoned fuel wood, or coal with sulfur content less than 1.0% by weight burned in a coal only heater.

[Statutory Authority: Chapter 70.94 RCW. 91-07-066 (Order 90-58), § 173-433-120, filed 3/20/91, effective 4/20/91. Statutory

Authority: RCW 70.94.331. 90-19-062 (Order 90-10), § 173-433-120, filed 9/17/90, effective 10/18/90. Statutory Authority:

Chapters 70.94 and 43.21A RCW. 89-02-054 (Order 88-38), § 173-433-120, filed 1/3/89; 88-01-056 (Order 87-44), § 173-433-120, filed 12/16/87.]

WAC 173-433-130 General emission standards.

In addition to the general applicability of chapter 173-400 WAC to all emission sources;

- (1) Emissions detrimental to persons or property. No person shall cause or permit the emission of any air contaminant from an identifiable solid fuel burning device, including any air contaminant whose emission is not otherwise prohibited by this chapter, if the air contaminant emission causes detriment to the health, safety, or welfare of a person, plant or animal, or causes damage to property or business.
- (2) Odors. Any person who shall cause or allow the generation of any odor from any solid fuel burning device which may interfere with any other property owner's use or enjoyment of his property must use recognized good practice and procedures to reduce these odors to a reasonable minimum.

[Statutory Authority: Chapter 70.94 RCW. 91-07-066 (Order 90-58), § 173-433-130, filed 3/20/91, effective 4/20/91. Statutory Authority: RCW 70.94.331. 90-19-062 (Order 90-10), § 173-433-130, filed 9/17/90, effective 10/18/90. Statutory Authority: Chapters 70.94 and 43.21A RCW. 89-02-054 (Order 88-38), § 173-433-130, filed 1/3/89.]

WAC 173-433-140 Impaired air quality criteria.

Impaired air quality shall be determined by ecology or an authority in accordance with the following criteria:

- (1) "First stage impaired air quality" - the first stage indicates the presence of:
 - (a) Particulate matter ten microns and smaller in diameter (PM_{10}) at or above an ambient level of seventy-five micrograms per cubic meter; or
 - (b) Carbon monoxide at or above an ambient level of eight parts of contaminant per million parts of air by volume (ppm).
- (2) "Second stage impaired air quality" - the second stage indicates the presence of particulate matter ten microns and smaller in diameter (PM_{10}) at or above an ambient level of one hundred five micrograms per cubic meter.

(3) On or after July 1, 1995, if an authority has geographically limited the use of solid fuel burning devices as specified under WAC 173-433-150(6), a single stage of impaired air quality will apply within the geographical area defined by the authority. A single stage of impaired air quality indicates the presence of:

- (a) Particulate matter ten microns and smaller in diameter (PM₁₀) at or above an ambient level of ninety micrograms per cubic meter; or
- (b) Carbon monoxide at or above an ambient level of eight parts of contaminant ppm.

(4) Acceptable ambient air quality measurement methods.

(a) Particulate matter ten microns and smaller in diameter (PM₁₀).

(i) Procedures specified by the EPA in "40 CFR 50, APPENDIX J - REFERENCE METHOD FOR THE DETERMINATION OF PARTICULATE MATTER AS PM₁₀ IN THE ATMOSPHERE" as amended through July 1, 1990, shall be used to gather reference ambient PM₁₀ data on a twenty-four-hour average.

(ii) More timely ambient PM₁₀ measurement methods may be utilized to evaluate air quality impairment if accepted and approved by ecology. Any alternative method for evaluating air quality impairment for the purpose of curtailing solid fuel burning device use must be done at the same location and in parallel to the reference method, and must be related to the reference method by a mathematical relationship with a correlation coefficient of no less than 0.85.

(b) Carbon monoxide (CO) must be measured on an eight-hour average in accordance with procedures specified by the EPA in "40 CFR 50, APPENDIX C - REFERENCE METHOD FOR THE DETERMINATION OF CARBON MONOXIDE IN THE ATMOSPHERE (NON-DISPURSIVE INFRARED PHOTOMETRY)" as amended through July 1, 1990.

(c) All monitors used to measure PM₁₀ for evaluation of air quality impairment due to solid fuel burning device use must be sited in accordance with EPA siting criteria in or near affected residential areas.

[Statutory Authority: Chapter 70.94 RCW. 91-07-066 (Order 90-58), § 173-433-140, filed 3/20/91, effective 4/20/91.]

WAC 173-433-150 Curtailment.

(1) Whenever ecology or an authority has declared the first stage of impaired air quality for a geographical area a person in a residence or commercial establishment within that geographical area with an adequate source of heat other than a solid fuel burning device shall not operate any solid fuel burning device, unless the solid fuel burning device is one of the following:

(a) A nonaffected pellet stove; or

(b) A woodstove certified and labeled by the EPA under "40 CFR 60 Subpart AAA - Standards of Performance for Residential Wood Heaters" as amended through July 1, 1990; or

(c) A woodstove meeting the "Oregon Department of Environmental Quality Phase 2" emissions standards

contained in Subsections (2) and (3) of Section 340-21-115, and certified in accordance with "Oregon Administrative Rules, Chapter 340, Division 21 - Woodstove Certification" dated November 1984.

(2) Whenever ecology or an authority has declared the second stage of impaired air quality for a geographical area a person in a residence or commercial establishment within that geographical area with an adequate source of heat other than a solid fuel burning device shall not operate any solid fuel burning device.

(3) Whenever ecology has declared an air pollution episode at a level above forecast a person in a residence or commercial establishment within that geographical area with an adequate source of heat other than a solid fuel burning device shall not operate any solid fuel burning device.

(4) The following matrix graphically illustrates the applicability of different types of solid fuel burning devices to the provisions of subsections (1) through (3) of this section:

(5) On or after July 1, 1995, an authority may prohibit use of solid fuel burning devices within specific geographical areas:

(a) The following factors shall be considered in the exercise of this limitation:

(i) The contribution of solid fuel devices that do not meet the standards set forth in "40 CFR 60 Subpart AAA - Standards of Performance for Residential Wood Heaters" as amended through July 1, 1990, to nonattainment of national ambient air quality standards;

(ii) The population density of the applicable geographical area; and

(iii) The public health effects of the use of solid fuel devices which do not meet the standards set forth in "40 CFR 60 Subpart AAA - Standards of Performance for Residential Wood Heaters" as amended through July 1, 1990.

(b) The following solid fuel devices are exempted from this limitation:

(i) Fireplaces;

(ii) Woodstoves certified and labeled by the EPA under "40 CFR 60 Subpart AAA - Standards of Performance for Residential Wood Heaters" as amended through July 1, 1990; or

(iii) Nonaffected pellet stoves.

(c) An authority shall allow an exemption from this subsection for low-income persons who reside in the geographical area affected by this subsection.

(6) On or after July 1, 1995, whenever an authority has declared impaired air quality in accordance with criteria contained in WAC 173-433-140(3) for a geographical area defined under subsection (5) of this section, a person in a residence or commercial establishment within that geographical area shall not operate any solid fuel burning device.

(7) A person responsible for an applicable solid fuel burning device already in operation at the time an episode is declared shall withhold new solid fuel for the duration of the episode. A person responsible for an applicable solid fuel burning device already in operation at the time impaired air quality is declared shall withhold new solid fuel for the duration of the impaired air quality. Smoke visible from a chimney, flue or exhaust duct after three hours has elapsed from the declaration of the episode or impaired air quality shall constitute prima facie evidence of unlawful operation of an applicable solid fuel burning device. This presumption may be refuted by demonstration that the smoke was not caused by a solid fuel burning device.

(8) Ecology, authorities, health departments, fire departments, or local police forces having jurisdiction in the area may enforce compliance with the above solid fuel burning device curtailment rules after three hours has elapsed from the declaration of the episode or impaired air quality.

[Statutory Authority: Chapter 70.94 RCW. 91-07-066 (Order 90-58), § 173-433-150, filed 3/20/91, effective 4/20/91. Statutory Authority: RCW 70.94.331. 90-19-062 (Order 90-10), § 173-433-150, filed 9/17/90, effective 10/18/90. Statutory Authority: Chapters 70.94 and 43.21A RCW. 88-01-056 (Order 87-44), § 173-433-150, filed 12/16/87.]

WAC 173-433-170 Retail sales fee.

(1) A person selling a solid fuel burning device at retail shall collect a fee from the buyer, pursuant to RCW 70.94.483.

- (2) The fee shall be:
- (a) Set at a minimum of thirty dollars on January 1, 1992. Thereafter, ecology may annually adjust the fee to account for inflation as determined by the office of the state economic and revenue forecast council. Adjustments in the fee should be rounded down to the nearest dollar.
 - (b) Applicable to all new and used solid fuel burning devices.
 - (c) Procedures for masonry fireplaces. Generally, contractors will collect, pay, and report the fee to the department of revenue on the combined excise tax return for the tax reporting period during which the retail sales tax is billed to the customer for the construction of the masonry fireplace. (See WAC 458-20-170 for a detailed explanation.) Collection and payment of the fee by contractors shall be in accordance with the following:
 - (i) A masonry contractor or other subcontractor who builds a masonry fireplace. The retail sale occurs at the time the general or prime contractor or customer is billed for the work. The masonry contractor or other subcontractor must collect the fee and pay it to the department of revenue, unless the masonry contractor or other subcontractor has received a resale certificate from the general or prime contractor. The fee shall be reported on the combined excise tax return.
 - (ii) A general or prime contractor building a custom building. The retail sale occurs at the time the customer is billed for the construction. The fee is charged and reported with the first progress payment after the masonry fireplace has been substantially completed. If a general or prime contractor subcontracts the work on a custom building to a masonry or other contractor, the general or prime contractor may give the masonry or other subcontractor a resale certificate. The general or prime contractor is responsible to collect the fee and pay it to the department of revenue. The fee is reported on the combined excise tax return.
 - (iii) A general or prime contractor building a speculation building. The fee is required to be paid at the time the fireplace is complete. The fee must be reported to the department of revenue on a combined excise tax return and paid to the department of revenue. If the prime or general contractor subcontracts the building of the masonry fireplace to a masonry contractor or other subcontractor, the general or prime contractor may not give a resale certificate to the masonry or other subcontractor. The masonry or other subcontractor must collect and pay the fee to the department of revenue as provided in (c)(i) of this subsection.
 - (d) Procedures for all other solid fuel burning devices. Collected by the retailer at the time of sale and remitted to the department of revenue in conjunction with the retail sales tax under chapter 82.08 RCW.
- (3) If the retailer or contractor fails to collect and remit the fee to the department of revenue as prescribed in chapter 82.08 RCW, the retailer or contractor shall be personally liable to the state for the amount of the fee, with subsequent actions taken in accordance with the collection provisions of chapter 82.32 RCW.
- (4) Beginning July 1, 1990, and each calendar quarter thereafter, the funds collected under RCW 70.94.483 shall be used solely for the purposes of public education and enforcement of the solid fuel burning device program. The department shall distribute the funds from the woodstove education and enforcement account as follows:
- (a) Sixty-six percent of the funds shall be distributed to those local air authorities with enforcement programs, based upon the fraction of the total state population residing in the

counties within their respective jurisdictions. Population figures used to establish this fraction shall be determined by the office of financial management. Where an activated local air authority does not exist or does not implement an enforcement program, or elects not to receive the funds, ecology shall retain the funds that would otherwise be distributed under this subsection; and

(b) Thirty-four percent of the funds shall be distributed to ecology for the purposes of enforcement and educating the public about:

- (i) The effects of solid fuel burning device emissions upon health and air quality; and
- (ii) Methods of achieving better efficiency and emission performance from solid fuel burning devices.

[Statutory Authority: Chapter 70.94 RCW and 501-506 ESHB 1028, 1991. 93-04-105 (Order 91-55), § 173-433-170, filed 2/3/93, effective 3/6/93. Statutory Authority: Chapter 70.94 RCW. 91-07-066 (Order 90-58), § 173-433-170, filed 3/20/91, effective 4/20/91. Statutory Authority: Chapters 70.94 and 43.21A RCW. 89-02-054 (Order 88-38), § 173-433-170, filed 1/3/89.]

WAC 173-433-200 Regulatory actions and penalties.

A person in violation of this chapter may be subject to the provisions of WAC 173-400-230 Regulatory actions and WAC 173-400-240 Criminal penalties.

[Statutory Authority: RCW 70.94.331. 90-19-062 (Order 90-10), § 173-433-200, filed 9/17/90, effective 10/18/90. Statutory Authority: Chapters 70.94 and 43.21A RCW. 88-01-056 (Order 87-44), § 173-433-200, filed 12/16/87.]

Appendix B
Supporting Data

Supporting Data

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Table B.01
Cost Calculations for the Replacement of an Existing Uncertified Freestanding Cordwood Stove

Scenario	Replacement of an Existing Uncertified Freestanding Cordwood Stove									
Heating Device	Uncertified Freestanding Cordwood Stove	Certified NSPS Non-Catalytic Cordwood Stove	Certified NSPS Catalytic Cordwood Stove	Pellet Stove	Gas Stove-Natural Gas, B Vent	Gas Stove-Natural Gas, Direct Vent	Gas Stove-Natural Gas, Vent Free	Gas Stove-LPG, B Vent	Gas Stove-LPG, Direct Vent	Gas Stove-LPG, Vent Free
Install/ Replacement Cost (\$)	-	3367	4150	3850	3400	3400	3400	3367	3367	3367
Lifetime (yrs)	-	19.3	19.3	15.0	17.7	17.7	17.7	17.7	17.7	17.7
Annualized Install/ Replacement (\$/yr)	-	174.1	214.7	256.7	192.5	192.5	192.5	190.6	190.6	190.6
Chimney Cleaning (\$/ cleaning)	150	150	150	125	-	-	-	-	-	-
Frequency (cleaning/ year)	1.5	1	1	1	-	-	-	-	-	-
Annualized (\$/yr)	225	150	150	125	-	-	-	-	-	-
Cat replace (\$/yr)	-	-	43.00	-	-	-	-	-	-	-
Electricity (\$/yr)	-	-	-	66.28	25.12	25.12	25.12	25.12	25.12	25.12
Ancillary Cost (\$/yr)	225	150.00	193.00	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Install/Ancillary Cost (\$/yr)	225.00	324.14	407.66	447.94	217.57	217.57	217.57	215.68	215.68	215.68

Table B.02
Cost Calculations for the Replacement of an Existing Uncertified Cordwood Fireplace Insert

Scenario	Replacement of an Existing Uncertified Cordwood Fireplace Insert									
Heating Device	Uncertified Cordwood Fireplace Insert	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free
Install/ Replacement Cost (\$)	-	3767	3700	3667	3350	3350	3350	3300	3300	3300
Lifetime (yrs)	-	19.3	19.3	15.0	17.7	17.7	17.7	17.7	17.7	17.7
Annualized Install/ Replacement (\$/yr)	-	194.8	191.4	244.4	189.6	189.6	189.6	186.8	186.8	186.8
Chimney Cleaning (\$/ cleaning)	175	150	150	125	-	-	-	-	-	-
Frequency (cleaning/ year)	2	1	1	1	-	-	-	-	-	-
Annualized (\$/yr)	350	150	150	125	-	-	-	-	-	-
Cat replace (\$/yr)	-	-	43.00	-	-	-	-	-	-	-
Electricity (\$/yr)	25.12	25.12	25.12	66.28	25.12	25.12	25.12	25.12	25.12	25.12
Ancillary Cost (\$/yr)	375.12	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12
Install/Ancillary Cost (\$/yr)	375.12	369.94	409.50	435.72	214.74	214.74	214.74	211.91	211.91	211.91

Table B.03

Cost Calculations for the Addition of an Insert or Gas Log Set to an Existing Cordwood Fireplace without Insert Used for Heating

Scenario	Addition of an Insert or Gas Log-Set to an Existing Cordwood Fireplace without Insert Used for Heating											
Heating Device	Cordwood Fireplace Used for Heating	Certified NSPS Non-Catalytic Cordwood Insert	Certified NSPS Catalytic Cordwood Insert	Pellet Insert	Gas Insert-Natural Gas, B Vent	Gas Insert-Natural Gas, Direct Vent	Gas Insert-Natural Gas, Vent Free	Gas Insert-LPG, B Vent	Gas Insert-LPG, Direct Vent	Gas Insert-LPG, Vent Free	Vent-Free Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG
Install/ Replacement Cost (\$)	-	3600	3500	3500	3233	3233	3233	3200	3200	3200	1493	1477
Lifetime (yrs)	-	19.3	19.3	15.0	17.7	17.7	17.7	17.7	17.7	17.7	12.7	12.7
Annualized Install/ Replacement (\$/yr)	-	186.2	181.0	233.3	183.0	183.0	183.0	181.1	181.1	181.1	117.9	116.6
Chimney Cleaning (\$/ cleaning)	150	150	150	125	-	-	-	-	-	-	-	-
Frequency (cleaning/ year)	1	1	1	1	-	-	-	-	-	-	-	-
Annualized (\$/yr)	150	150	150	125	-	-	-	-	-	-	-	-
Cat replace (\$/yr)	-	-	43.00	-	-	-	-	-	-	-	-	-
Electricity (\$/yr)	-	25.12	25.12	66.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Ancillary Cost (\$/yr)	150	175.12	218.12	191.28	25.12	25.12	25.12	25.12	25.12	25.12	25.12	25.12
Install/Ancillary Cost (\$/yr)	150.00	361.32	399.15	424.61	208.13	208.13	208.13	206.25	206.25	206.25	143.01	141.69

Table B.04

Cost Calculations for the Replacement of an Existing Centralized Cordwood Heating System

Scenario	Replacement of an Existing Cordwood Furnace or Boiler			
Heating Device	Centralized Cordwood Heating System	Pellet Furnace or Boiler	Gas Furnace or Boiler-Natural Gas	Gas Furnace or Boiler-LPG
Install/ Replacement Cost (\$)	-	4575	3675	3675
Lifetime (yrs)	-	16.0	16.0	16.0
Annualized Install/ Replacement (\$/yr)	-	285.9	229.7	229.7
Chimney Cleaning (\$/ cleaning)	150	150	-	-
Frequency (cleaning/ year)	1	1	-	-
Annualized (\$/yr)	150	150	-	-
Cat replace (\$/yr)	-	-	-	-
Electricity (\$/yr)	158.69	239.91	158.69	158.69
Ancillary Cost (\$/yr)	308.69	389.91	158.69	158.69
Install/Ancillary Cost (\$/yr)	308.69	675.85	388.38	388.38

Table B.05

Cost Calculations for the Addition of a Gas Log Set or Use of Wax/Fiber Firelogs with an Existing Fireplace

Scenario	Addition of a Gas Log Set or Use of Wax/Fiber Firelogs with an Existing Fireplace					
Heating Device	Cordwood Fireplace Used for Aesthetic Purposes	Vent-Free Gas Log Set-Natural Gas	Vented Gas Log Set-Natural Gas	Vent-Free Gas Log Set-LPG	Vented Gas Log Set-LPG	Wax/Fiber Firelog Fuel
Install/ Replacement Cost (\$)	-	1493	1483	1477	1467	NA
Lifetime (yrs)	-	12.7	12.7	12.7	12.7	-
Annualized Install/ Replacement (\$/yr)	-	117.9	116.8	116.6	115.5	-
Chimney Cleaning (\$/ cleaning)	150	-	-	-	-	150
Frequency (cleaning/ year)	0.5	-	-	-	-	0.5
Annualized (\$/yr)	75	-	-	-	-	75
Cat replace (\$/yr)	-	-	-	-	-	-
Electricity (\$/yr)	-	0.39	0.39	0.39	0.39	-
Ancillary Cost (\$/yr)	75.00	0.39	0.39	0.39	0.39	75.00
Install/Ancillary Cost (\$/yr)	75.00	118.28	117.18	116.96	115.87	75.00

NA = Not Applicable

Table B.06
Fuel Cost and Heat Content by Tree Species

Species	Average Cost of Wood (\$/kg) [*]	LHV (MJ/kg) ^{**}	Cost of Available Heat (\$/MJ)
Douglas fir	0.15	19.6	0.0077
Atlantic white cedar	0.15	18.1	0.0083
Pitch pine	0.15	24.7	0.0061
Eastern white pine	0.15	19.5	0.0077
Bald cypress	0.15	21.5	0.0070
Eastern hemlock	0.15	18.7	0.0080
Maple spp	0.15	18.6	0.0081
Birch spp.	0.15	18.7	0.0080
Hickory spp.	0.15	18.7	0.0080
American beech	0.15	19.0	0.0079
White ash	0.15	19.1	0.0079
Yellow poplar	0.15	19.3	0.0078
White oak	0.15	19.0	0.0079
Northern red oak	0.15	18.7	0.0080
Black oak	0.15	17.6	0.0085
Elm spp.	0.15	19.0	0.0079
Average	0.15	19.36	0.0078
Standard Deviation	0.00	1.65	0.0006

^{*}Average of cost per cord by state⁴³ / Average of mass per cord by state⁵¹⁻⁵⁷ = \$0.15/kg

^{**}Reference 42

Cordwood Cost for MANE-VU region

The firewood suppliers were identified by online yellow pages or local newspaper classified ads. If a supplier's website provided pricing of a cord of seasoned hardwood, split and delivered, that price was recorded. If the supplier's classified ad listed the price for a cord of seasoned hardwood, split and delivered, that price was recorded. Otherwise, the supplier was telephoned and asked for the price of a cord of seasoned hardwood, split and delivered.

The pellet suppliers were identified by online yellow pages. Each supplier was telephoned and asked for the price of a ton of pellets delivered. If delivery was not available, \$25 was added to the price to cover delivery cost.

COMPANY	CITY	STATE	FIREWOOD	PELLETS
Phelps & Sons Inc.	Vernon Rockville	CT		\$320
Thompson G Merrit & Sons	Mansfield Depot	CT		\$249
Academy Farm	Stafford Springs	CT		\$259
Manville & Sons Firewood	Mansfield Center	CT	\$165	
James Gillespie	Sharon	CT	\$175	
Al's Affordable Tree	Laurel	DE	\$140	
Leo Friel	Wilmington	DE	\$200	
Tri State Tree Service	Milton	DE	\$180	
Robert Gallo	New Castle	DE	\$175	
Fireplace Specialties	Selbyville	DE		\$260
Island Firewood	Levittown	NY	\$160	
AAA Northern Firewood	Central Square	NY	\$215	
Adirondack Firewood	Bright Waters	NY	\$170	
Alpine Firewood	Buffalo	NY	\$98	
Trees Plus II	Garnerville	NY	\$175	
Cornerstone Stoves & Accessories	Falconer	NY		\$235
Hearthshop at Universal Building Supply Inc	Utica	NY		\$254
Curtis Lumber	Queenbury	NY		\$260
Agway	Clinton Corners	NY		\$300
Buzzell Trucking & Firewood	Kingston	NH	\$285	
Treehugger Farms	Westmoreland	NH	\$211	
All Basics Stove Shop	Merrimack	NH		\$275
Chop Chop Firewood	Hardwick	VT	\$170	
Colton Enterprises	Pittsfield	VT	\$250	
Montpelier Stove Works	Montpelier	VT		\$260
Friends of the Sun	Brattleboro	VT		\$290
Cut-Rite Tree	Coventry	RI	\$200	

COMPANY	CITY	STATE	FIREWOOD	PELLETS
Verrier Tree Service	West Greenwich	RI	\$200	
Stove Pipe Fireplace Shop	Warwick	RI		\$269
Benton Lloyd Firewood & Mulch	Fork	MD	\$200	
Frederick Wood Products	Frederick	MD	\$185	
A-1 Firewood	Bel Air	MD	\$150	
The Shade House	Baltimore	MD	\$215	
Tomczak Louis	Germantown	MD	\$180	
Mace Energy Supply	Smithsburg	MD		\$247
Survival Products	Salisbury	MD		\$255
Ace Hardware & Hearth	Pasadena	MD		\$265
GTL Forest Products	Westminster	MA	\$200	
Beech Hill Firewood	Newton	MA	\$295	
Harrington Hardwood	Holden	MA	\$170	
Ice House Inc.	Brockton	MA		\$310
Pellets Direct	Oxford	MA		\$275
Turnpike Acres Pellet Stove Shop	Ludlow	MA		\$285
Fireplace Showcase	Seekunk	MA		\$275
Aaron's Custom Firewood	Middletown	NJ	\$185	
Countryside Landscaping & Tree Experts	Whitehouse Station	NJ	\$170	
Dion's Tree Service & Firewood	Howell	NJ	\$200	
Dujets Tree Service	Little Falls	NJ	\$150	
SOS Woodstoves	Hackettstown	NJ		\$305
Agway	New Egypt	NJ		\$300
A H Reiff Firewood	Carlisle	PA	\$150	
Helverson Bros Firewood	Kintnersville	PA	\$175	
Randy Piper	Green Castle	PA	\$100	
D & S Logging	Thompson	PA	\$110	
Firewood Industries	Harrisburg	PA	\$130	
Flameworks LLC	Roxbury	PA		\$205
Logland Forest Products	Showhegan	ME	\$155	
LR Liberty Firewood	Showhegan	ME	\$130	
Southern Maine Firewood	Gorham	ME	\$210	
RC McLucas	Portland	ME	\$175	
Mark Eastman Firewood	Bangor	ME	\$200	
Finest Hearth & Home	Yarmouth	ME		\$375
Fireside Stove Shop	Auburn	ME		\$294



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To: Dr. James Houck, OMNI

From: John Crouch, Director of Public Affairs, HPBA

Date: June 28, 2006

Re: Cost estimate Surveys of various Hearth Products on an Installed Basis

At your request we attempted to quickly survey representative retailers in some of the MANE-VU states, in order to ascertain the total installed costs of various woodstove Changeout options.

Given the short turnaround time, we were only able to obtain a few responses, covering 3 of the MANE-VU states, Pennsylvania, New York, and Massachusetts. While we made an effort to contact leading retailers, the response we received is thin. On the other hand, these respondents sell these products every day, on an installed basis, and operate in a very competitive environment, so their opinions clearly outweigh those of national manufacturers.

The one area in which some of them may not be qualified to answer, is the question regarding the useful life of a catalytic converter, since some of them do not sell catalytic stoves. On this subject I checked with the technical department of a major North East Stove manufacturer who has some history with catalytic converters, and his response was:

... in general I'd say an average replacement time (the range can be quite wide depending on use of the stove) would be after 4 seasons. This is when I feel they 'should' be replaced for good performance rather than 'must be' replaced, the later being very hard to determine by the end user. What I have seen over the years is that even catalysts that appear crumbled and degraded can still be effective.

Based on this informed response, and the bulk of the retailers responses, I would say that 4 years is a reasonable and appropriate time frame for a catalytic element. I would also add, from my own experience, that other components of a catalytic appliance, including the seal on the by-pass system, need to be inspected, and may need to be serviced at this same interval, as well.

There are a number of general caveats to the responses:

1) Our retailers, by and large, do not sell gas furnaces, and may not be accurate on the installed price of this product, consequently most did not answer this question.

2) Virtually none of our member retailers, in any state, carry all of these products. The prices reported here are the 'best guess' of a very limited subset of stores. Some stores clearly gave opinions on items they do not carry, particularly the "Lifetime" questions.

3) It is not clear from the responses that all the dealers understood the difference implied between the Question on Replacement of an existing conventional stove, and, Installation of a new unit into a fireplace. I report the numbers as given, but in my opinion, there should be a minimum of \$100 added to the cost of all the replacement options to cover the cost of removal and disposal of the old stove.

4) Labor rates & overhead costs differ from Rural to Urban areas. The two dealers from New York state differed, sometimes substantially. Their answers are averaged here for that state.

Cost Estimates

Typical or average costs, including appliance costs, labor, ancillary hardware, such as, chimney and chimney connector pipe, carpentry and masonry work, disposal of old appliance, gas plumbing (for gas appliances assume home has natural gas or LPG).

Bottom line – if a customer calls and you have never seen their house, on the average, what will their total cost be? Again on the average. Please provide one number not a range.

**Numbers given are all in whole dollars, and are from:
Pennsylvania – N.Y. - Mass**

Category	Cost
Replace a conventional pre-EPA certification cordwood stove with:	
Certified non-catalytic cordwood stove	4000---3400---2400
Certified catalytic cordwood stove	4000---4100--- NA
Pellet stove	4000---3900---3550
Gas stove – natural gas	3100---3200---3600
Gas stove – LPG	3100---3200---3500
Replace an existing conventional pre-EPA certification fireplace insert with:	
Certified non-catalytic cordwood insert	4000---3500---3500
Certified catalytic cordwood insert	4200---3000---NA
Pellet insert	3700---3400---3600
Gas insert – natural gas	2900---3300---3550
Gas insert –LPG	2900---3200---3500
Installation of a new device into an existing fireplace	
Certified non-catalytic cordwood insert	3800---3500---3500
Certified catalytic cordwood insert	4000---3000---NA
Pellet insert	3400---3400---3700
Gas insert – natural gas	2900---3300---3500
Gas insert –LPG	2900---3200---3500
Gas log set – natural gas	900---- 1250---2300 (includes glass doors)
Gas log set – LPG	900---- 1200---2300 “ “ “
Replacement of an older cordwood furnace or boiler with:	
Pellet furnace or boiler	4300---4250
Gas furnace	NA
Fuel Costs	
cord of split wood delivered	210---240---225
ton of pellets delivered	260---282---250
wax/fiber firelog (per 5 or 6 lb log)	2.75---NA---NA

Misc. questions:

Length of time that a catalyst lasts in a stove or insert. _____4_____yrs.

Cost of replacing a catalyst __100 ----275---140__

Lifetime of a cordwood stove or insert _____yrs,	20—18---20
of a pellet stove or insert _____ yrs,	12---18---15
of a gas stove or insert _____yrs,	20---18---15
of a gas log set _____yrs,	18—10---10
of a cordwood furnace _____yrs,	18—10---15
of an inside cordwood boiler _____yrs,	18---10---15
of an outside cordwood boiler _____yrs,	15---7--- 15
of a pellet furnace _____yrs	18---15---15

July 11, 2006

Mark McSweeney
Executive Director
National Chimney Sweep Guild
2155 Commercial Drive
Plainfield, IN 46168

Dear Mark

As we discussed over the phone, OMNI Environmental Services has been contracted by the Mid-Atlantic Regional Air Management Association to perform a cost-benefit analysis for the reduction of air pollutants from residential wood combustion in the MANE-VU region (Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont). The reduction in air pollutants would be accomplished by replacing old technology appliances with newer ones, or with the use of different fuels.

An estimate of the typical cost and frequency of chimney sweeping in the MANE-VU region is needed in the cost-benefit analysis as the frequency of chimney sweeping would, of course, change with the change in heating appliances or fuels used. For the calculations a single number, not a range, will be used.

The attached table lists the parameters. Probably many of the costs are the same for the different categories but the frequency changes. I know there are many variables but OMNI is charged to put together the most common or typical scenario.

Thank you for your assistance.

Sincerely,

James E. Houck, Ph.D.

Category	¹ Frequency of Chimney Sweepings That Is Appropriate (number/yr)	** ¹ Typical Cost to Home Resident (\$ per sweeping)
Older Conventional Pre-EPA Certification Freestanding Cordwood Stove	Minimum recommendation is once per year. 2 times or more may be required due to additional deposit buildup (1/4" deposit is an indicator of need for sweeping).	General range of \$100-\$200.
EPA-Certified Non-Catalytic Freestanding Cordwood Stove	Annually	General range of \$100-\$200.
EPA-Certified Catalytic Freestanding Cordwood Stove	Annually	General range of \$100-\$200.
Older Conventional Pre-EPA Certification Cordwood Fireplace Insert	1 to 3 times annually may be required. Few owners have it done often enough.	This varies greatly depending on the type of installation (ie. full reline, "slammer", direct connect, etc), which may cause the cost to exceed the general range.
EPA-Certified Non-Catalytic Cordwood Fireplace Insert	Annually	This varies greatly depending on the type of installation. Proper installation of an EPA Certified unit is assumed and could likely better control these costs.
EPA-Certified Catalytic Fireplace Insert	Annually	This varies greatly depending on the type of installation. Proper installation of an EPA Certified unit is assumed and could likely better control these costs.
Pellet Stove	Annually – However, note that maintaining the efficiency of these units generally requires more frequent appliance service than that of a wood burner.	Approximately \$100+. Cleaning these vents is typically easier than that of a wood burner. However, a greater familiarity with the specific product in generally required.
Pellet Fireplace Insert	Annually – However, note that maintaining the efficiency of these units generally requires more frequent appliance service than that of a wood burner.	Approximately \$100+. Cleaning these vents is typically easier than that of a wood burner. However, a greater familiarity with the specific product in generally required.
Fireplace without an insert used for secondary heating (used frequently by resident)	Annually if good design. Note that quality of fuel used, frequency of use, and quality of design all greatly impact deposit buildup.	General range of \$100-\$200.
Fireplace without an insert used for aesthetics (used infrequently by resident). <i>Aka "Open Fireplace"</i>	Sweep every 2 years on average. However, annual inspection is recommended to account for non-creosote buildup issues that can impact performance. Note that quality of fuel used, frequency of use, and quality of design all greatly impact deposit buildup.	General range of \$100-\$200.

Category	¹ Frequency of Chimney Sweepings That Is Appropriate (number/yr)	** ¹ Typical Cost to Home Resident (\$ per sweeping)
Cordwood Furnace	This is a unique arrangement as the appliance is used outside, which tends to impact the mindset of the consumer. Required service is typically related more to appliance performance than chimney safety. Comparatively, these appliances create the highest level of emissions.	General range of \$100-\$200.
Cordwood Boiler	This is a unique arrangement as the appliance is used outside, which tends to impact the mindset of the consumer. Required service is typically related more to appliance performance than chimney safety. Comparatively, these appliances create the highest level of emissions.	General range of \$100-\$200.

**These costs merely represent an observed range and in no way constitute a recommendation of the National Chimney Sweep Guild or the Chimney Safety Institute of America. These costs do assume a Level I inspection as part of a standard sweeping service. A Level II inspection will affect these prices and, at minimum, is generally called for under the following conditions:

- Point of sale of real estate
- Replacement of equipment with differing BTU input or fuel type
- Prior to a reline
- Any event that could have caused damage to the chimney

It should also be noted that the presence of a chimney cap can impact deposit buildup in the flue. That is, rain can rinse the flue to cause it to appear “clean.” However, rain will not affect deposit buildup in the smoke chamber below the flue. The Chimney Safety Institute of America recommends use of a chimney cap to prolong the life of the chimney and prevent intrusion (animals, leaves, etc) from creating blockage in the chimney.

¹Information provided by:

Mark McSweeney, Executive Director, Chimney Safety Institute of America and the National Chimney Sweep Guild
Ashley Eldridge, Director of Education, Chimney Safety Institute of America