

**SACRAMENTO METROPOLITAN  
AIR QUALITY MANAGEMENT DISTRICT**

**STAFF REPORT**

**Rule 421, Mandatory Episodic Curtailment of Wood and Other Solid Fuel Burning**

**Proposed Amendments  
August 24, 2009**

**Prepared by:** Marc Cooley  
Assistant Air Quality Engineer

**Reviewed by:** Kevin J. Williams, Ph.D.  
Program Coordinator

Aleta Kennard  
Program Supervisor

**Approved by:** Brigette Tollstrup  
Division Manager

## **BACKGROUND**

Particulate matter (PM) is a mixture of very small liquid droplets and solid particles. Adverse health effects are linked to particles that are less than 10 microns in diameter (PM10), and fine particles that are less than 2.5 microns in diameter (PM2.5).

Sacramento does not meet state or federal health standards for fine particle air pollution (PM2.5). Sacramento will be formally designated nonattainment for the federal health standards later this year. Fine particulate matter is linked to serious adverse health effects, including aggravated asthma, heart attacks, and premature death in people with heart or lung disease. The largest single source of Sacramento's wintertime PM2.5 emissions is wood and other solid fuel burning in fireplaces, wood inserts, wood stoves and pellet stoves. New health studies have increased the concern about wood smoke health impacts, including the impact to children.

The District has implemented three control measures to reduce emissions from wood burning: 1) provide financial incentives to remove or replace fireplaces and dirty stoves with cleaner burning options, 2) prohibit installation of new fireplaces and dirty wood stoves, and 3) prohibit burning on days when weather conditions cause wood smoke to be trapped near the ground and build up to unhealthy levels.

Rule 421, Mandatory Episodic Curtailment of Wood and Other Solid Fuel Burning, prohibits wood and other solid fuel burning when PM2.5 concentrations are forecast to exceed the federal health standard. Rule 421 is in effect from November 1<sup>st</sup> through the end of February. When PM2.5 concentrations are forecast to exceed the federal health standard of 35  $\mu\text{g}/\text{m}^3$  but will not exceed 40  $\mu\text{g}/\text{m}^3$ , burning is prohibited, except in EPA certified wood stoves or pellet stoves. This is called a Stage 1 No Burn day. When PM2.5 concentrations are forecast to exceed 40  $\mu\text{g}/\text{m}^3$ , all burning is prohibited. This is called a Stage 2 No Burn day. The rule does not apply to fireplaces and stoves that burn gaseous fuels (natural gas and propane), and exempts burning that is the sole source of heat, or in situations when not burning would be a financial hardship to a resident.

Staff commissioned two studies of the effectiveness of our wood burning control efforts, specifically Rule 421. The first study, conducted by Sonoma Technology, Inc. (STI) examined the air quality benefits on forecast No Burn days in the last two seasons. The second study, conducted by Aurora Research Group, examined the public awareness and response to the rule. These studies showed significant improvements in air quality. The Aurora survey showed that 92% of the respondents were aware of burning restrictions and from their actions Sacramento County saw up to a 23% reduction in PM2.5 concentrations. The studies showed significant reductions and when curtailment days are called the largest air quality improvement occurred in the PM2.5 concentrations in the early evenings.

Although the public response to the rule and air quality improvements were significant, they are not sufficient to meet the health standards. There were 20 unhealthy days during the winter 2008/2009 season. The study also showed that two contributing factors to the unhealthy air quality days are the underprediction in the forecasts and lower air quality benefit on Stage 1 days. Therefore, Staff is proposing to amend Rule 421 to:

- Maintain the two stage program but reduce the concentration thresholds for prohibiting burning.

Other options for modifying the rule that are included for Board consideration are:

- Maintain the two-stage curtailment program but further reduce the concentration thresholds for prohibiting burning than the Staff recommendation; and/or
- Eliminate the two-stage curtailment program and replace it with a single-stage curtailment program with a reduced concentration threshold; and/or
- Incorporate a provision that automatically drops the threshold to 20 ug/m<sup>3</sup> if the District does not meet our federal air quality deadline (2015 or 2019).

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## HEALTH IMPACTS

Particulate matter (PM) is a mixture of very small liquid droplets and solid particles. Adverse health effects are linked to particles that are less than 10 microns in diameter (PM10), and fine particles that are less than 2.5 microns in diameter (PM2.5). The District is currently designated as a nonattainment area for the state and federal<sup>1</sup> health standards for PM10 and for the state health standard for PM2.5. In addition, the District will be nonattainment for the federal PM2.5 health standard when formal designations are published later this year.

Wood smoke also emits other air contaminants including volatile organic compounds (VOCs) and nitrogen oxides (NOx) which are precursors to aerosol forms of PM2.5, and toxic and/or cancer-causing substances, such as benzene, formaldehyde and benzo-a-pyrene, a polycyclic aromatic hydrocarbon (PAH). In addition, wood smoke is a component of black carbon.

According to the U.S. Environmental Protection Agency (EPA), health studies have linked exposure to particulate matter, especially fine particles, to several significant health problems, including:

- increased respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing;
- decreased lung function;
- aggravated asthma;
- development of chronic bronchitis;
- irregular heartbeat;
- nonfatal heart attacks,
- premature death in people with heart or lung disease; and
- increased risk of cardiovascular and cerebrovascular events in post-menopausal women.

Exposure to particulate matter pollution can cause coughing, wheezing, and decreased lung function even in otherwise healthy children and adults. EPA estimates that thousands of elderly people die prematurely each year from exposure to fine particles. In addition, a recent study (Dominici et al., 2006) of the correlation between PM2.5 concentrations and hospital admission rates concluded that short-term exposure to PM2.5 increases the risk of hospitalization for cardiovascular and respiratory diseases.

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<sup>1</sup> Based on 1998-2000 monitoring data, EPA made a finding (February 15, 2002 Federal Register, Volume 67, Number 32, Page 7082 et seq.) that Sacramento County attained the federal ambient PM10 standard by the applicable December 31, 2000 attainment deadline. Note that this EPA finding did not redesignate the Sacramento District to attainment.

The California Air Resources Board (CARB) heard the results of several studies<sup>2</sup> that showed smoke from wood fires aggravates lung and heart disease and increases the number of hospital admissions. The research results indicate exposure to wood smoke may reduce lung function and reduce the blood's ability to clot properly. In addition, wood smoke exposure may also increase substances in the body that lead to cardiovascular and pulmonary inflammation. The studies also found that up to 70 percent of smoke from chimneys can re-enter a home or neighboring residences.

The research further found that children are more likely to be harmed by PM2.5 and wood smoke than adults because their respiratory systems are still developing, they breathe more air per pound of body weight, and they are more active outdoors. Recent studies have concluded that children breathing PM2.5 and wood smoke are likely to experience:

- more coughing and wheezing,
- reduced lung function if they have asthma<sup>3</sup>,
- permanent reduction in lung air capacity<sup>4</sup>,
- ten percent increased hospital admissions from respiratory problems<sup>5</sup>, and
- decreases in memory function and scores on intelligence tests<sup>6</sup>.

In 2008, CARB updated their studies of mortality effects from elevated PM2.5 concentrations. They now estimate that in the Sacramento Metropolitan Area, up to 600 premature deaths would be avoided at an economic benefit of over \$0.9 billion per year if the region met the state and federal annual PM2.5 standards.

In addition, studies have shown that with less air pollution, people will walk and bicycle more for recreation and transportation<sup>7</sup>. People who live in an area more conducive to walking have been shown to walk more, weigh less, and have lower blood pressure<sup>8,9</sup>. Rule 421 has the potential to increase walking of residents by decreasing wood burning emissions. Furthermore, the analysis of Rule 421 effectiveness has shown the largest air quality improvement occurred in the early evening, when people are more likely to be active or commuting home from work or school. Staff has received feedback from some members of the public that the reduction in wood smoke has made it nicer to walk and has reduced health concerns from breathing wood smoke.

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<sup>2</sup> California Air Resources Board, The potential health impacts of residential wood burning, Jan. 2009, <http://www.arb.ca.gov/research/health/healthup/Jan09.pdf>

<sup>3</sup> Allen R et al 2008, Changes in lung function and airway inflammation among asthmatic children residing in wood smoke-impacted urban area. *Inhal Toxicol.* 20(4):423-433

<sup>4</sup> Gauderman WJ et al, The Effect of Air Pollution on Lung Development from 10 to 18 Years of Age. *N Engl J Med* 351;11:1057-1063, Sept 2004

<sup>5</sup> Anderson ZJ et al, Ambient particle source apportionment and daily hospital admissions among children and elderly in Copenhagen. *J Expos Sci Environ Epidemiol.* 17(7):625-636.

<sup>6</sup> Suglia F et al, Association of Black Carbon with Cognition among Children in a Prospective Birth Cohort Study. *American Journal of Epidemiology.* 2008:167:280-286

<sup>7</sup> Pikora T et al, Developing a framework for assessment of the environmental determinants of walking and cycling. *Social Science & Medicine.* 56 (2003): 1693-1703

<sup>8</sup> Frank LD et al, Many Pathways from Land Use to Health. *Journal of the American Planning Association.* 72 (2006): 75-87

<sup>9</sup> Fuzhong L et al, Built environment and changes in blood pressure in middle aged and older adults. *Preventive medicine.* 48(2009)237-241.

**LEGAL MANDATES**

**Federal Mandates:** The District is currently designated as a nonattainment area for the federal PM10 standards. Sacramento does not meet federal health standards for fine particle air pollution (PM2.5). On December 22, 2008, the EPA Administrator signed rules designating the Sacramento area as nonattainment for the federal 24-hour PM2.5 health standard of 35 µg/m<sup>3</sup>. The designations are under review by the new administration and are expected to be published in the coming months. Attainment plans are expected to be due in late 2012 and the attainment deadline will be 2014, but may be extended to 2019 if properly justified to EPA.

The plan must include transportation conformity budgets and control measures. Transportation conformity budgets will require that future transportation projects stay within the specified emission levels to meet attainment and progress goals. Failure to submit a plan can result in withholding of federal transportation project approvals and funding.

Attainment of the federal health standards is determined using the design value (three-year average of the 98<sup>th</sup> percentile PM2.5 concentrations). When Rule 421 was adopted, our design value was based on 2004-2006 data. Since that time, PM2.5 concentrations have increased, likely due to weather influences. Sacramento will likely need more reductions than previously estimated to attain. It is likely that the current Rule 421 alone will not be enough to attain before the plan is due. Strengthening Rule 421 by lowering the concentration thresholds will help to further reduce PM2.5 concentrations during winter months, potentially reducing the need for other, more costly regulatory measures.

<b>PM2.5 Design Value<sup>10</sup></b>	
<b>Monitoring Station</b>	<b>µg/m<sup>3</sup></b>
Del Paso Manor, Years 2004-2006	48.7
Del Paso Manor, Years 2006-2008	51.8 <sup>11</sup>
<b>Federal Health Standard</b>	<b>35</b>

**State Mandates:** The District is currently designated as a nonattainment area for the state PM10 and PM2.5 standards. Senate Bill (SB) 656 required CARB to adopt a list of the most feasible and cost effective control measures to make progress towards state and federal PM10 and PM2.5 standards. The following table lists the District's PM control measures for wood burning fireplaces and wood burning heaters.

	<b>PM Control Measure</b>	<b>Status</b>
1	Require use of USEPA-Certified Phase II or equivalent devices	Implemented in Rule 417
2	Public Awareness Program with either a voluntary curtailment or mandatory curtailment	Implemented in Rule 421

<sup>10</sup> This data was acquired at Del Paso Manor station located in Sacramento County that has a federal reference method monitor. The average value is calculated according to procedures specified in Appendix N of Title 40, Code of Federal Regulations Part 50. The procedures require selection of the 98<sup>th</sup> percentile monitored concentration. For example, in 2006 the 98<sup>th</sup> percentile was the eighth highest reading.

<sup>11</sup> Design value calculated with exceptional event data from 2008 forest fires removed.

	PM Control Measure	Status
3	Require replacement of non-certified units upon sale of property	Not implemented
4	Restrict number of wood burning fireplaces and wood stoves allowed in new residential developments	Partially implemented in Rule 417
5	Control of wood moisture content. Prohibit burning materials that are not intended for use in fireplace/heater.	Implemented in Rule 417

Rule 417, adopted on October 26, 2006, implemented control measures 1 and 5, and partially implemented control measure 4. Although Rule 417 exceeds the control measures by prohibiting the installation of any wood burning fireplaces in new residential developments, it doesn't limit the number of certified wood burning stoves in a residence. Rule 421 implemented control measure 2. Control measure 3, which addresses replacement of noncertified units upon sale of property, has not yet been implemented. Staff recommended postponing the implementation of the control measures that have not been fully implemented until the benefits could be assessed from the original adoption of Rule 421. Staff is still considering postponement of these measures to assess the benefits of amendments to Rule 421. All of the PM2.5 measures will be reconsidered during development of the federal PM2.5 attainment plan.

The District's strategy to improve particulate matter air quality includes a three-pronged approach to reducing emissions from wood burning: providing financial incentives, regulating new wood burning installations, and reducing burning from existing fireplaces and wood stoves. The program to provide financial incentives to remove or replace existing fireplaces and dirty wood stoves was established in June 2006. On October 26, 2006 the Board of Directors approved Rule 417 to prohibit installing new fireplaces and dirty wood burning devices. The last prong was adopted on October 25, 2007, as Rule 421, Mandatory Episodic Curtailment of Wood and Other Solid Fuel Burning. Residents and businesses that take advantage of the financial incentives to install gaseous fuel burning devices are exempt from our wood burning regulations.

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## 2009 WOOD BURNING SURVEY

Aurora Research Group conducted a telephone survey of Sacramento County residents in April 2009. This survey was similar to the telephone survey Aurora previously conducted in April 2007. The purpose of this study was to gauge public awareness of mandatory No Burn restrictions and to gauge the effectiveness and compliance rates of Rule 421 on Burning Discouraged, Stage 1 and Stage 2 No Burn days.

The 2009 Aurora phone survey received responses from 400 random digit dial telephone surveys from county residents, including a subset of 6% who would be classified as low-income residents based on federal guidelines. Only those who have the capability to burn wood or pellets were included in the 400 surveys. To get an accurate compliance rate only the respondents who burned last season were focused on. Of the burners, 57% complied with all the Stage 1 restriction days (this accounts for certified device owners who are allowed to burn) and 70% complied with all the Stage 2 restriction days.

Other key findings are:

- 50% of all respondents who had the capability to burn wood or pellets did not burn at all last winter.
- 50% of all respondents burned sometime during the last winter season. 30% of all respondents burned wood less than once per week. 11% indicated burning more than once a week.
- No respondents indicated wood burning as their sole source of heat.
- Among the 45% of those who reduced their burning of wood last winter, 35% of those who burned less did so because of air quality or health concerns, or because they heard a request not to burn.
- 71% of all respondents know that it is their obligation to check to see if burning is permitted.
- 85% of those respondents aware of the mandatory curtailment restrictions saw or heard about a mandatory curtailment episode on TV and radio.
- 59% of all respondents rated residential wood burning fireplaces as a serious part of wintertime air pollution. However, 82% rated traffic as a serious part of wintertime air pollution with 20% more rating traffic as very serious compared to wood burning as very serious.

The final Aurora report is included in Appendix C.

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### **Rule 421 Effectiveness Analysis and Results**

The District contracted with STI to study the air quality benefits from Rule 421. They conducted three different analyses; a cluster analysis, Chemical Mass Balance (CMB) modeling, and numerical modeling.

- Cluster Analysis  
Cluster analysis involves grouping days with similar meteorology. For each group, the analysis then compares the PM<sub>2.5</sub> concentrations on days prior to the adoption of Rule 421 to days after Rule 421 was in effect. The difference in PM<sub>2.5</sub> concentrations can be largely attributed to the benefits achieved by Rule 421.

A total of 11 day-pairs (22 days) with similar meteorological conditions was compared. Half of the 22 days occurred prior to adoption of Rule 421 and the other half of the days were either Stage 1 or Stage 2 No Burn days. The results of the cluster analysis showed an average reduction in 24-hour average PM<sub>2.5</sub> concentration on a Stage 1 day of 4 µg/m<sup>3</sup> (10% reduction) and on a Stage 2 day of 12 µg/m<sup>3</sup> (23% reduction.) The greatest reduction of PM<sub>2.5</sub> concentrations occurred during the evening hours.

- Chemical Mass Balance (CMB) model  
A CMB model uses analysis of the chemical species contained in particulate matter collected on filters to determine which emissions sources contribute to the PM<sub>2.5</sub> problem. Studies have established a "fingerprint" of chemical species that are

associated with different emissions sources. The CMB model then uses this information to quantify the contribution from each source type.

The results of the CMB modeling indicate the average wood smoke contribution on days when PM<sub>2.5</sub> concentrations were high was at least 11 µg/m<sup>3</sup> (27%) and as high as 19 µg/m<sup>3</sup> of the total PM<sub>2.5</sub> concentration<sup>12</sup>. These results indicate that it is possible to achieve a PM<sub>2.5</sub> reduction on the order of 10 to 20 µg/m<sup>3</sup> on a Rule 421 No Burn day. This percentage is consistent with emissions inventory<sup>13</sup>.

- Numerical Modeling

STI runs a gridded air quality modeling system called BlueSky Gateway<sup>14</sup>. This model system provides hourly predictions of PM<sub>2.5</sub> concentrations for the entire United States, including Sacramento, using weather information, emissions data, and an air quality model to represent the chemical reactions that occur in the atmosphere. BlueSky Gateway's sub-components include the weather model, called MM5, an emissions model, called Sparse Matrix Operator Kernel Emissions (SMOKE), and the Community Multiscale Air Quality model (CMAQ). STI estimated PM<sub>2.5</sub> concentrations assuming 100% curtailment. Because the model represents the entire United States, and consequently has a fairly coarse resolution, peak concentrations may be under-predicted by the model.

The initial results of the modeling analysis show that the average PM<sub>2.5</sub> reduction with complete curtailment was 5.2 µg/m<sup>3</sup> or 21%.

STI updated the modeling for this analysis on August 20<sup>th</sup> to account for less than 100% compliance. The analysis was modified by applying the 57% emission reduction for Stage 1 No Burn days and the 70% emission reduction for Stage 2 No Burn days. The updated results of the modeling analysis show that the average PM<sub>2.5</sub> reduction on a Stage 1 No Burn day was 5.2 µg/m<sup>3</sup> or 13% and on a Stage 2 No Burn day was 6.4 µg/m<sup>3</sup> or 17%.

- Other data analysis

STI also determined how many days during the 2008/2009 season that benefits from Rule 421 avoided an exceedance of the federal health standard. A total of 20 days exceeding the NAAQS violations were observed, and had Rule 421 not been in effect there would have been about 13 additional days on which the NAAQS was exceeded.

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<sup>12</sup> Along with PM<sub>2.5</sub>, burning wood emits nitrogen oxides and organic compounds. Nitrogen oxides and organic compounds then react in the atmosphere to form secondary PM<sub>2.5</sub>. However, because there are many other sources of organic compounds and nitrogen oxides, it is not possible to specifically quantify the amount of this secondary PM<sub>2.5</sub> that is from wood burning. Therefore, 11 µg/m<sup>3</sup>, is a conservative estimate of the wood smoke contribution to total PM<sub>2.5</sub> concentrations.

<sup>13</sup> If all secondary PM<sub>2.5</sub> compounds were excluded, the percentage of PM<sub>2.5</sub> associated with wood smoke would be 58%, similar to the percentage estimated using emissions inventory methods.

<sup>14</sup> The model grid resolution is 36 kilometers.



Finally, STI evaluated the potential for underpredictions in the air quality forecast. No Burn forecasts are made based on the air quality and weather forecasts for each day. To provide greater certainty in avoiding federal health standard violations, STI recommends the thresholds be reduced to account for the potential underprediction.

The STI report is included in Appendix D.

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## **SUMMARY OF PROPOSED AMENDMENTS**

When Rule 421 was first adopted, forecasting error had not been quantified nor considered when determining the thresholds. The recent STI studies analyzed the current program, including the forecasting error. With this additional information and consideration of actual Rule 421 air quality benefits and comments received at public workshop, concentration thresholds can now be re-examined. Staff evaluated lowering the thresholds to strengthen the rule for three reasons; 1) the studies indicate that although the public awareness and air quality benefits are very good, we are still not meeting state or federal health standards, 2) when the thresholds were established Staff did not have information to consider the potential for underpredicting air quality forecasts or actual air quality benefit information, and 3) recent health studies indicate that serious health consequences can be specifically attributed to wood smoke and that updated CARB health information estimates higher mortality rates in Sacramento from high PM2.5 concentrations.

Four amendment options are being evaluated:

Recommended Change - Reduce the Stage 1 threshold from 35 to 31  $\mu\text{g}/\text{m}^3$  to account for the potential underprediction in air quality forecasts. Reduce the Stage 2 threshold from 40 to 35  $\mu\text{g}/\text{m}^3$  to account for the actual benefits that occur on Stage 1 No Burn days.

This is the Recommended Change because, as noted, an adjustment is needed to account for the potential underprediction in air quality forecasts and the actual Stage 1 benefit of 4  $\mu\text{g}/\text{m}^3$ . Staff originally estimated the Stage 1 benefit at 5  $\mu\text{g}/\text{m}^3$  during the adoption of Rule 421.

Option A – Change to a single-stage program, thereby eliminating the exemption for EPA certified wood stoves and pellet stoves. Set the No Burn threshold to 30  $\mu\text{g}/\text{m}^3$  and either maintain the voluntary threshold at 25  $\mu\text{g}/\text{m}^3$  or reduce it to 20  $\mu\text{g}/\text{m}^3$ . These thresholds are consistent with the San Joaquin Valley APCD program, and are more likely to meet Clean Air Act requirements for reasonably available control measures. Option A is expected to result in 8 more No Burn days.

This was the recommended change that was presented at the public workshops. However, many comments at the workshops expressed concern that eliminating a two-stage program, with its exemption for EPA certified devices and pellet stoves on Stage 1 days, would reduce the incentive for people to switch to cleaner devices and also be unfair to those who have already invested in cleaner devices.

Option B - Reduce the Stage 1 threshold to 25  $\mu\text{g}/\text{m}^3$  and the Stage 2 threshold to 30  $\mu\text{g}/\text{m}^3$  to be consistent with the San Joaquin Valley No Burn threshold. Reduce the voluntary threshold to 20  $\mu\text{g}/\text{m}^3$ . Option B is expected to result in 21 additional No Burn days.

Contingency Option - Include a provision to automatically change to a single-stage (if not already) program with a reduced threshold of 20  $\mu\text{g}/\text{m}^3$  if Sacramento does not meet the federal health standards by the required deadlines, either 2014 or 2019. Using the past 5 years of data, this would result in up to approximately 41 No Burn days. However, due to uncertainty in the effectiveness of future control measures to improve air quality the actual numbered days would likely be lower.

In addition, Staff recommends adopting the administrative change that clarifies the intent that first-time violators must complete and pass (i.e. a test or other method) the smoke awareness course.

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## IMPACTS AND BENEFITS FROM POTENTIAL RULE CHANGES

Staff used PM2.5 concentration data collected over the last 5 seasons to estimate the number of No Burn days that might be called each winter if the new potential thresholds were established.

Every additional No Burn day would be expected to have a 10% improvement in air quality for Stage 1 days, and 23% improvement in air quality for Stage 2 days.

- Staff recommendation – 5 more No Burn days than the current rule
- Option A – 8 more No Burn days than the current rule
- Option B – 21 more No Burn days than the current rule

Staff estimated the number of additional exceedances of the federal health standard that might be avoided by applying the STI estimated benefit. The estimation of the number of days avoided over the federal health standard was based on the 2007/2008 and 2008/2009 season daily forecasts.

The method was:

- 1) If the actual forecast concentration would have resulted in a change in No Burn status; e.g. from a Stage 1 day to a Stage 2 day, then
- 2) The observed concentration was adjusted downward by STI's estimate of the average benefit on Stage 1 and Stage 2 No Burn days.
- 3) The adjusted concentration for each day was compared to the federal health standard. If the adjusted concentration was below the 35  $\mu\text{g}/\text{m}^3$  health standard it was counted as an avoided exceedance.

The table below shows the number of avoided exceedance days. The primary reason that the number of avoided exceedance days doesn't vary between the options is because the analysis relies on historic observed air quality data and actual forecasts for 2007-2009, rather than a theoretical benefit that reflects the different projected emissions under each option. If there were no days where the air quality levels and forecasts fit into the boundaries that define the differences in the thresholds, then it was not counted as an avoided exceedance. There were only ten days (five per season) historically where the actual exceedance could have been avoided. The future could see different air quality levels, possibly more preventable days.

The number of avoided exceedance days will likely be higher in the future because, unfortunately, on our very worst days, a 23% air quality improvement hasn't been enough to attain the standards. But as air quality improves, 23% may be enough and the actual number of days avoided will be higher.

Optional threshold changes ( $\mu\text{g}/\text{m}^3$ )							
	Current rule		Recommended Change		Option A	Option B	
Voluntary threshold	25		25		20 or 25	20	
Stage 1 threshold	35		31		Eliminated	25	
Stage 2 threshold	40		35		30	30	
Impacts and Benefits							
	Stage 1	Stage 2	Stage 1	Stage 2	Single Stage	Stage 1	Stage 2
# of days in 2004/2005	7	9	9	16	29	17	29
# of days in 2005/2006	7	14	1	21	27	15	27
# of days in 2006/2007	5	24	4	29	37	10	37
# of days in 2007/2008	7	8	4	15	20	14	20
# of days in 2008/2009	7	26	6	33	43	10	43
Average # of No Burn days	7	16	5	23	31	13	31
Average total no. of <u>mandatory</u> No Burn days	23		28		31	44	
Average additional # of No Burn days	-		5		8	21	
Average # of voluntary No Burn days	22		17 <sup>15</sup>		33 @ 20 $\mu\text{g}/\text{m}^3$ 13 @ 25 $\mu\text{g}/\text{m}^3$	20	
# of avoided days over the federal health standard	13		16		17	18	
# of additional avoided days over the federal health standard	-		3		4	5	

## EMISSIONS INVENTORY

The California Air Resources Board is responsible for preparing the wood burning emission inventory for Sacramento County. Wood smoke is the single largest directly emitted PM2.5 emissions source, 49% as reported by the CARB's 2005 California Emission Forecast System

<sup>15</sup> The number of days is lower than the current rule, even though the threshold has not changed, because some of the previous voluntary days would become mandatory No Burn days.

(CEFS) wintertime PM<sub>2.5</sub> emissions inventory for Sacramento County. The 2005 emissions inventory is 8.30 tons on an average winter day from wood burning in Sacramento County. CARB estimates are based on a 1987 survey conducted in Healdsburg, California that suggested that 0.28 cords of wood is burned per household per year<sup>16</sup>. This wood usage amount was assumed statewide. The inventory using this methodology was calculated using heating degree days.

The residential wood smoke combustion emissions inventory is being re-evaluated by CARB in preparation for upcoming federal PM<sub>2.5</sub> plans. CARB is evaluating Staff's 2007 rule development work which suggests the inventory is significantly underestimated. Additionally, several relevant surveys have been conducted since CARB last modified the methodology. The revised methodology relies on breakdown of device types, wood usage per device type per year, updated emission fireplace factor and wood cord weight. The methodology will use regional information when appropriate for device breakdowns to further refine a region's inventory.

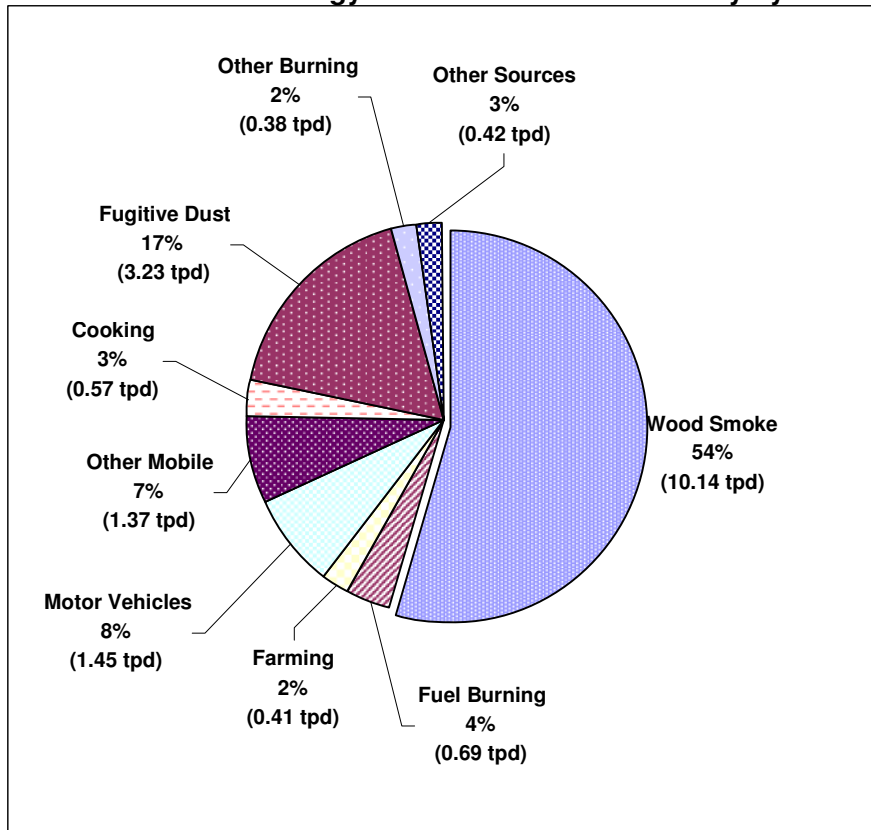
This revised CARB methodology estimates PM<sub>2.5</sub> emissions from wood burning in Sacramento County of 2,036 tons per year and 10.14 tons on an average<sup>17</sup> winter day. Since not all wood burning occurs during the winter months (November through April), the methodology uses a temporal profile to estimate wood usage for the entire year. The amount of wood burned during the 120 days of the CBYB program accounts for 69.1% of all wood fuel burned in a year and 90.9% of the fuel is burned in the months of November through April.

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<sup>16</sup>California Air Resources Board, Area Source Methodology, Section 7.1, Residential Wood Combustion, Revised July 1997

<sup>17</sup>Based on a 120-day winter with 90.9% of wood burned in the winter period

**2005 Revised Methodology Wintertime PM2.5 Inventory by Source**

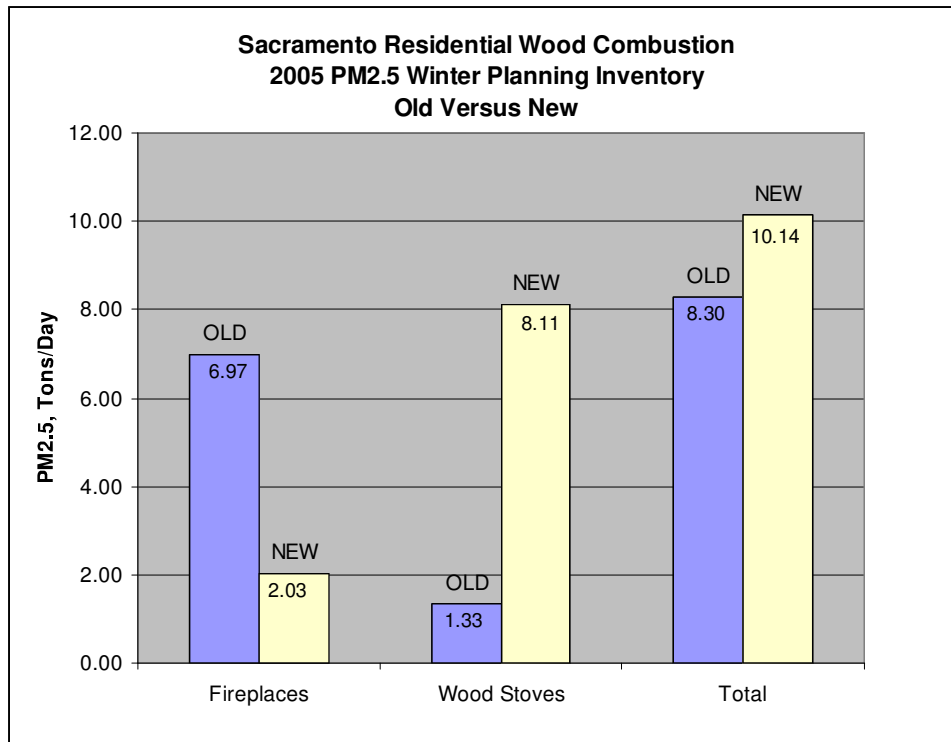


The changes represent a reduction in the Fireplace PM2.5 Emission Factor, use of cord weight, total number of devices, changes in the usage characteristics for the various wood devices into conventional (non-certified), Phase II certified non-catalytic, Phase II certified catalytic, and pellet device. In Sacramento County the largest source of wintertime PM2.5 emissions is wood smoke.

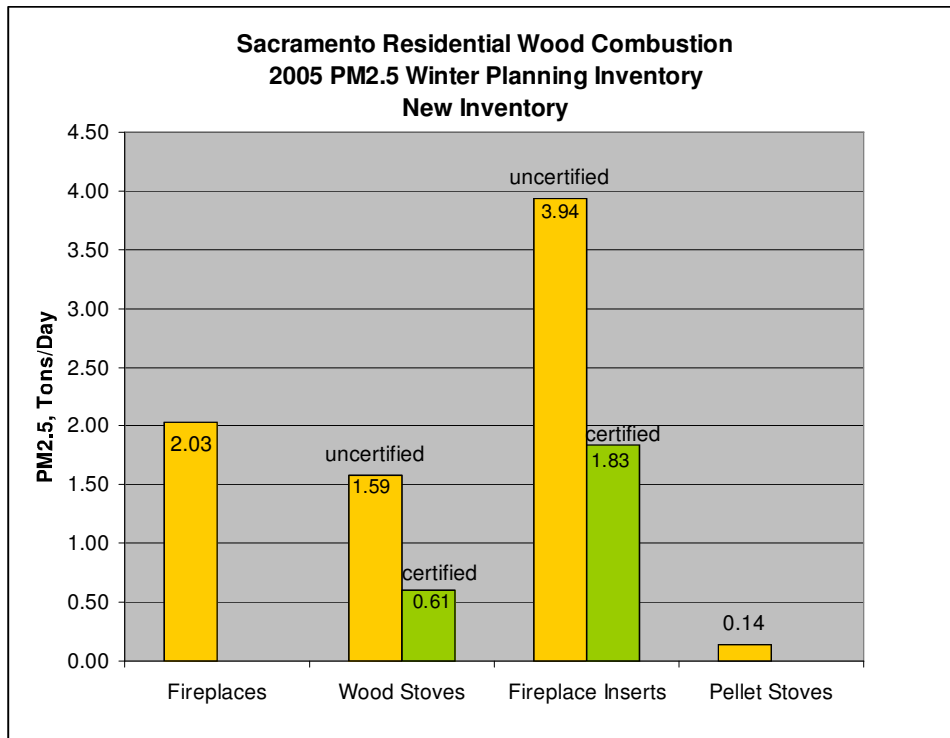
For detailed calculations see Appendix E, Emissions Calculations.

The changes between the CARB CEFS inventory and the revised methodology are graphical shown below:

The overall increase in emissions are due to a variety of factors, some increase emissions, others decrease emissions relative to the old methodology. Overall there is a significant reduction in projected fireplace emissions and increase in wood stove and fireplace insert emissions as shown below.



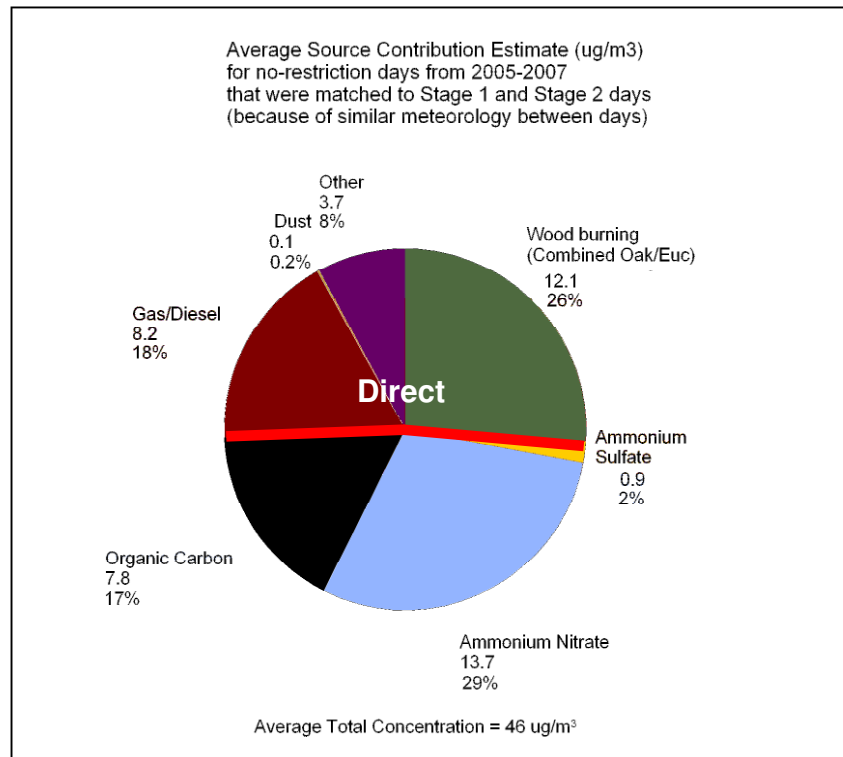
The graph below shows the revised methodology inventory by device type which shows the largest portion of the wood smoke inventory is from uncertified wood stoves and inserts. In Sacramento County the devices that contribute most to PM2.5 emissions are wood inserts. Contribution for fireplaces has significantly decreased based on a revised fireplace emission factor, percent of fireplaces used, amount of wood used and accounting for supplemental heating or aesthetic fireplace use.



The new CARB information shows that replacing fireplaces with EPA certified wood stoves or wood inserts and generally pellet stoves does not reduce overall emissions.

Device Type	Emission Factor (lbs PM2.5/ton fuel burned)	PM2.5 per device per year (lbs/year)
Fireplace – Aesthetic Heating	23.6	3
Uncertified wood stove	30.6	71
Catalytic wood stove	20.4	47
Non-Catalytic wood stove	14.6	34
Uncertified wood insert	30.6	57
Catalytic wood insert	20.4	38
Non-Catalytic wood insert	14.6	27
Pellet stove	3.06	6

### Average Wintertime Observed PM2.5 Contributions



The PM2.5 emission inventory shown above only tells part of the story. As noted previously, PM2.5 includes both directly emitted particles characterized in the emission inventory above, and PM2.5 aerosols formed by chemical reactions between gaseous pollutants, called precursors, in the atmosphere, in particular VOC, NO<sub>x</sub> and ammonia. Studies use chemical analyses of filters that have collected PM2.5 from Sacramento's air to ascribe collected PM2.5 concentrations to precursor and directly emitted PM2.5 emissions sources. These studies are generally referred to as chemical mass balances. The results from STI's recent chemical mass balance are shown below.

Along with PM2.5, burning wood emits nitrogen oxides and organic compounds. Nitrogen oxides and organic compounds then react in the atmosphere to form secondary PM2.5. However, because there are many other sources of organic compounds and nitrogen oxides, it is not possible to specifically quantify the amount of this secondary PM2.5 that is from wood burning. Therefore, 11 µg/m<sup>3</sup> is a conservative estimate of the wood smoke contribution to total PM2.5 concentrations.

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### EMISSION REDUCTIONS

The primary effect of the proposed amendments will be to reduce the PM2.5 concentrations on additional peak days, reduce adverse health effects, particularly for those in sensitive groups, and make additional progress to attain the state and federal annual and 24-hour health standards.



The emissions reductions were calculated using results from the 2009 Aurora Survey of burning behavior during the Rule 421 No Burn program. That survey reported 90% of those who burn were aware of the burning restrictions. The study results were used to determine that there was a 57% reduction in the number of people burning on Stage 1 No Burn days (EPA certified and pellet stoves are allowed to burn), and a 70% reduction in burning on Stage 2 No Burn days<sup>18</sup>. The Stage 1 No Burn reduction is assumed to be only on those who are not allowed to burn. All certified wood stoves, wood inserts and all pellet stoves are assumed to be burning on Stage 1. The emissions reduction for Stage 1 when accounting for all devices is 43%.

The emission reductions are based on the revised methodology and use the Sacramento specific data from the Houck and 2007 Aurora survey, the methodology estimates that wood burning devices in Sacramento County:

- 155,649 residence have open hearth fireplaces
- 25,105 residences have wood stoves
- 80,335 residences have wood burning inserts
- 15,063 residences have pellet stoves

Of the homes with wood burning equipment:

- 98,059 residences with fireplaces burn wood or manufactured logs
- 15,816 residences with wood stoves burn wood
- 50,611 residences with wood burning inserts burn wood
- 9,490 residences with pellet stoves burn pellets
- 69% use wood burning fireplaces more for aesthetics
- 31% use wood burning fireplaces more for supplemental heating
- 20% residences with wood burning fireplaces burn manufactured logs
- 43% of wood stoves are Phase II certified
- 45% of wood inserts are Phase II certified

The average wood usage per residence:

- Aesthetic Fireplace Users – 0.069 cords per year<sup>19</sup>
- Supplemental Heating Fireplace Users – 0.656<sup>19</sup>
- Pellet Stove Users – 4,000 pounds per year<sup>20</sup>
- Wood Stove Users – 1.5 cords per year<sup>20</sup>
- Wood Insert Users – 1.2 cords per year<sup>20</sup>

Based on the temporal profile used in the revised CARB methodology for Residential Wood Combustion, 69.1% of the annual emissions from wood burning occur in the months of November through February, when Rule 421 is in effect. The table below summarizes the daily average emissions during November – February and the estimated emission reductions from Stage 1 and Stage 2 days. Each option has the same emission reduction per No Burn day;

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<sup>18</sup> Cooley memo to Morley Chavero, "Burner Only Compliance/Emission Reduction Rates", July 1, 2009.

<sup>19</sup> Houck, James E., Mangino Joseph, Brooks, Garry and Huntley, Roy, "Recommended Procedure for Compiling Emission Inventory National, Regional and County Level Activity Data for Residential Wood Combustion Source Category", U.S. EPA Emission Inventory Conference, 2001.

<sup>20</sup> Broderick, D. and Houck, J., OMNI Consulting Services, Inc, "Results of Wood Burning Survey – Sacramento, San Joaquin, and San Francisco Areas, University of California Berkeley/CARB – GIS Study", January 15, 2003.

however, the options differ in the additional number of No Burn days that would occur. Detailed calculations and data sources are presented in Appendix E.

The table below summarizes the average winter day inventory for the wintertime season and potential emission reductions. Detailed calculations and data sources are presented in Appendix E.

Pollutant	Nov. – Feb. Daily Average Emissions (tons/day)	Reductions (tons/day)	
		Stage 1 Day	Stage 2 Day
PM10	11.95	5.17	8.37
PM2.5	11.47	4.97	8.03
NOx	1.39	0.59	0.76
CO	78.5	22.3	54.8
VOC	35.2	18.9	24.6

Note: Each option has the same reduction per No Burn day but the number of No Burn days differs in each option.

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## OTHER DISTRICTS

Since Rule 421 was adopted, three other California air districts have adopted or amended similar measures.

San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) adopted its rule prohibiting wood burning on forecast poor air quality days on July 17, 2003. The threshold for prohibiting burning was set to the federal PM2.5 health standard at the time, 65  $\mu\text{g}/\text{m}^3$  or greater. On October 16, 2008 they lowered their threshold to 30  $\mu\text{g}/\text{m}^3$  and will automatically lower that threshold to 20  $\mu\text{g}/\text{m}^3$  if they fail to attain the federal health standard of 65, by April 2015. The 20  $\mu\text{g}/\text{m}^3$  threshold would be implemented 60 days after the effective date of EPA's published finding of failure to attain for PM2.5.

Bay Area Air Quality Management District (BAAQMD) and South Coast Air Quality Management District (SCAQMD) also recently adopted similar mandatory No Burn rules. The BAAQMD threshold is 35  $\mu\text{g}/\text{m}^3$  and became effective on November 1, 2008. The SCAQMD rule becomes effective November 1, 2011, with a threshold of 35  $\mu\text{g}/\text{m}^3$ . None of these three districts exempt EPA certified devices or pellet stoves from mandatory No Burn restrictions.

Feather River Air Quality Management District (FRAQMD) has proposed amendments to Rule 3.17 – Wood Burning Appliances. A workshop is scheduled for the end of August. FRAQMD has proposed to allow the APCO issued voluntary advisory to curtail emissions to an advisory with specific recommended actions such as allow, reduce, curtail, limit specific areas, or a request to cease. The advisory would continue to be voluntary.

Additionally, Butte County AQMD is considering adopting mandatory No Burn restrictions. The Chico City Council recommended Butte County AQMD adopt a No Burn regulation with a threshold of 25  $\mu\text{g}/\text{m}^3$ . They propose to exempt EPA certified stoves.

Other areas with wood burning restrictions include the state of Oregon as well as specific counties and agencies in Oregon; the state of Washington and specific jurisdictions; numerous areas of Idaho: Denver, Colorado; Mammoth Lakes, California; several counties in Utah; Maricopa County, Arizona; and Albuquerque, New Mexico. Many other areas have voluntary restrictions or are considering adopting mandatory restrictions.

The restrictions in Oregon are based on PM10 and have not yet been updated for PM2.5 standards. The state of Washington has a two stage curtailment with exemptions for certified devices and pellet stoves on Stage 1, with a Stage 1 threshold of 35 µg/m<sup>3</sup>. Several clean air agencies in Washington have adopted the state regulation that includes exemptions for sole source, financial hardship and startup period.

## COST IMPACT

Section 40703 of the California Health and Safety code requires that the District consider and make public its findings relating to the cost effectiveness of implementing an emission control measure.

**Cost to Businesses:** Businesses with solid fuel burning devices other than for cooking would have a cost savings from reduced wood use, because they generally burn wood for aesthetic purposes. An increase in the number of No Burn days will increase the cost savings. Staff does not have information to quantify the impact, if any, to these businesses due to the loss of ambience. There will be an additional impact to wood retailers, because mandatory curtailment will reduce the amount of wood burned by the public, and therefore, the amount of wood sold by retailers. Using the current average number of No Burn days in the winter season (7 Stage 1 days and 16 Stage 2 days) as a baseline, the impact to wood retailers varies for each option. The estimated value of the wood products not purchased due to reduced burning on the additional mandatory curtailment days is shown in the following table:

	Average number of additional No Burn days for each option compared to current Rule 421 averages	Value of wood products not purchased (\$ per season)
Recommended Change	5	\$577,781
Option A	8	\$1,137,064
Option B	21	\$1,620,987
Contingency Option	41	\$4,211,867

Note:

1. Rule 421 average number of No Burn days is 23.
2. Percent of all wood burned that is purchased is 51.4% (Houck 2003).

**Cost to Public:** The majority of the people affected by the rule burn wood for ambience and would have cost savings from reduced wood use. For people who use wood as their primary or supplemental heat source, there will be a shift in costs from wood to an alternate source for

heat. Anecdotal information from comments during public workshops suggests that some consumers may have reduced heating costs from using wood or pellets as a supplemental heat source. The data below shows that it costs less per unit of heat delivered to use natural gas or electricity than to use wood<sup>21</sup>. Reported cost savings may result from personal comfort choices and/or because supplemental sources heat main living areas while other rooms remain cooler than the home's alternative heat source would provide, resulting in a net reduction in heat delivered. Staff cannot rely on anecdotal information to estimate community scale impacts of the additional No Burn days.

Heating Device	Thermal Efficiency	Fuel Cost per MMbtu
Fireplace	7%	\$206.23
Certified Wood Stove	63%	\$22.91
Pellet Stove	76%	\$28.29
Propane Fireplace	75%	\$34.24
Natural Gas Fireplace	75%	\$14.54
Electric Fireplace	>99%	\$25.23
Gas Central Heat & Air	80%	\$13.63
Electric Central Heat & Air	100%	\$25.23
Propane Central Heat & Air	80%	\$32.10
Note: 1. Used as primary source of heat 2. PG&E rates for natural gas (Winter 2009) 3. SMUD rates for electricity (Winter 2009) 4. Average cost of cord of wood <sup>22</sup> = \$269, average cost of pellets <sup>22</sup> = \$344/ton, and Cost of propane = \$2.31/gallon		

The average cost of heating a home with a wood stove for 30 days is \$236 and a pellet stove is \$172 while the cost is \$153 for electricity and \$88 for natural gas.

**Overall Rule Amendment Cost Effectiveness:** The cost effectiveness of the amendments can be calculated by using the cost (lost sales for wood suppliers). In this case the recommended option cost effectiveness is estimated to be \$3.14-\$5.32 per pound of PM2.5. To put these costs into perspective, it is useful to compare the cost effectiveness for other District rules. District Rule 417, Wood Burning Appliances, cost \$4.19/lb of PM2.5 in today's dollar. It should be noted that most of the District's existing rules are for controlling ozone precursors, usually VOC or NOx. Rule 421 also achieves NOx reductions. The cost effectiveness of this rule is \$2.80 - \$4.86 per pound of NOx + PM2.5. The 2005 amendments to District Rule 411, NOx from Boilers, Process Heaters and Steam Generators cost \$13.90/lb of NOx. The cost effectiveness of the gasoline dispensing regulations (Rule 449, Transfer of Gasoline into Vehicle Fuel Tanks; 12/17/1991 rule amendments) is at the higher end of the cost effectiveness range, costing \$17/lb of VOC in today's dollars. Rule 452, Can Coating (8/21/1990 rule amendments), is at the low end of the range at a cost of \$1/lb of VOC in today's dollars.

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<sup>21</sup> In the case that free wood is delivered to the residence at no cost, there would be an increase in fuel cost.

<sup>22</sup> Socioeconomic Impact Analysis for SMAQMD Rule 421 Amendments, ERG, 2009

## **DISTRICT IMPACT**

The amendments and costs to the District for Rule 421 fall into three general areas: 1) forecasting PM2.5 air quality, 2) public outreach to continue to educate and inform individuals, and 3) enforcement/compliance.

Daily forecasting will continue. If amendments are adopted, the additional number of No Burn days will not cause an increase in forecasting costs. Additionally, the Staff time and media outreach efforts that are utilized to educate the public about the health effects of particulate matter pollution and the Check Before You Burn program will continue without increased costs.

Compliance and enforcement will continue in the same manner. The original estimate of Staff resources when Rule 421 was adopted was 0.3 FTE compared to the actual 1.2 FTE to administer the 10 Stage 1 days and 28 Stage 2 days experienced in the 2008/2009 season. Using a ratio of the options to last season, and keeping in mind that last season was an above average year for the number of No Burn days, the estimated Staff resources for the additional No Burn days for the enforcement/compliance effort are 0.16 FTE, 0.25 FTE, or 0.66 FTE for the Recommended Change, Option A, or Option B respectively, specifically for the following:

- 1) Surveillance by inspection Staff on the additional No Burn days for at least 1 hour per day per inspection Staff member (including weekends).
- 2) Responding to the increase in reported burning or smoke complaints from the public due to the additional No Burn days.
- 3) Handling of the increase in Notice of Violations (NOVs) from the additional No Burn days.

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## **SOCIOECONOMIC IMPACT ANALYSIS**

CHSC Section 40728.5 requires a district to perform an assessment of the socioeconomic impacts before adopting, amending, or repealing a rule that will significantly affect air quality or emission limitations. The District Board is required to actively consider the socioeconomic impacts of the proposal and make a good faith effort to minimize adverse socioeconomic impacts.

CHSC Section 40728.5 requires discussion of:

1. The type of industry or business, including small business, affected by the proposed rule or rule amendments.
2. The impact of the proposed rule or rule amendments on employment and the economy of the region.
3. The range of probable costs, including costs to industry or business, including small business.
4. The availability and cost-effectiveness of alternatives to the proposed rule or rule amendments.
5. The emission reduction potential of the rule or regulation.
6. The necessity of adopting, amending, or repealing the rule or regulation to attain state and federal ambient air standards.

Eastern Research Group (ERG) prepared a report for the District that contains a detailed socioeconomic analysis of the proposed rule amendments. This report is included as Appendix G. The paragraphs below summarize the socioeconomic findings.

Type of industry or business, including small business, affected by the proposed rule: Rule 421 applies to the use of solid fuel burning appliances and fires. The rule has the potential to affect fuel suppliers as well as businesses (e.g., restaurants, drinking establishments) and residents who burn wood for ambience or as a source of heat. Fuel suppliers include large retail stores (e.g., supermarkets and hardware stores) in addition to small independent dealers that sell wood as either a primary source of income (wood lots) or a secondary source of income (e.g., tree service or landscape companies). Companies that produce manufactured logs are also potentially affected. For a more detailed description of the businesses affected, refer to Appendix G.

Impact on employment and economy in the District of the proposed rule: The fuel suppliers, particularly the small independent dealers, are the group with the potential to be most affected by the proposed amendments, due to lost sales. Two scenarios were analyzed to determine worst case impacts on either suppliers or buyers of wood. Under the first scenario (the worst case for suppliers), it was assumed that the suppliers would absorb the entire cost of the lost sales volume without the ability to raise prices to compensate. To estimate the impacts, it was assumed (again, worst case) that the total loss in sales for Sacramento County would be borne either entirely by the independent wood dealers or entirely by the large retail stores. Under this scenario, the lost revenue, percentage of total revenue and the potential loss of jobs were determined, as presented in the following tables.

	<b>Small Independent Wood Dealers</b>			
	Recommended Option	Option A	Option B	Contingency Option
<b>Total Revenue</b>	\$7,683,905	\$7,683,905	\$7,683,905	\$7,683,905
<b>Lost Revenue</b>	\$352,025	\$669,899	\$1,074,327	\$2,622,768
<b>% Lost Revenue</b>	4.6%	8.7%	14.0%	34.1%
<b>Potential Job Loss</b>	2.8	5.3	8.5	20.6

	<b>Large Retail Stores</b>			
	Recommended Option	Option A	Option B	Contingency Option
<b>Total Revenue</b>	\$112,145,169,000	\$112,145,169,000	\$112,145,169,000	\$112,145,169,000
<b>Lost Revenue</b>	\$577,781	\$1,137,064	\$1,620,987	\$4,211,867
<b>% Lost Revenue</b>	0.01%	0.03%	0.04%	0.10%
<b>Potential Job Loss</b>	0	0	0	0

Four companies were identified as producers of manufactured logs that are sold in Sacramento County. One of these companies, Duraflame, is located in nearby Stockton. Staff was unable to determine the market share for Duraflame logs in the county. If Duraflame represented 100% of the market share (worst case), the potential impact of lost sales to company revenues and associated employment would be:

- 0.5% of revenue and 1.2 jobs for the Recommended Option
- 0.8% of revenue and 2.1 jobs for Option A
- 1.8% of revenue and 4.4 jobs for Option B
- 3.8% of revenue and 9.4 jobs for the Contingency Option

Residents and businesses that burn wood for ambience would experience a cost saving by not burning on the additional No Burn days. For residents who burn wood for heat, there could be a decrease or an increase in cost depending on the particular circumstances. For residents who purchase their wood, there would be a decrease in cost get by switching to an alternative heat source on No Burn days. The average cost to heat a home using wood is higher than either electricity or natural gas, as discussed in the Cost Impact section of this staff report. Residents who get their wood for free would experience a cost increase; however, the maximum impact is less than 0.25% of the median household income for Sacramento County.

Under the second scenario, fuel suppliers would raise prices to compensate for the loss in sales volume. In this case, those who get their wood for free would experience the same cost impacts as in the first scenario, but no additional cost impacts. Those who pay for their wood would pay higher prices for the days they are allowed to burn, which would offset the savings they would experience from using alternative fuels on No Burn Days.

A more detailed economic analysis is included in Appendix G.

Range of probable costs, including costs to industry or business, including small business of the proposed rule: As noted in the Cost Impact section of this staff report, the total cost, in terms of the value of wood not purchased, is \$577,781 per year for the Recommended Option and \$1,137,064 - \$4,211,867 per year for the other options. If wood sellers cannot compensate for the loss in revenue by raising prices, these lost revenues would be spread over a variety of wood sellers, including large retail stores, small businesses that sell wood as a primary or secondary income, and manufacturers of manufactured logs. A more detailed analysis of the probable costs is included in Appendix G.

Availability and cost effectiveness of alternatives to the proposed rule: Alternatives to the proposed amendments include: not amending the rule; adopting different thresholds for Rule 421 for the Recommend Option, such as Options A, B, or the Contingency Option; and adopting other measures to reduce emissions from wood burning devices, such as requiring replacement of noncertified devices upon sale of property and/or limiting the number of devices allowed per acre. Not amending the rule would not increase costs to impacted businesses but would not increase the effectiveness of the rule in reducing the number of days that exceed the PM2.5 health standard. This could require the adoption of more costly measures in the future, most of which have much lower potential for reducing emissions from wood burning, and therefore lower effectiveness in reducing the number of days that exceed the PM2.5 health standard.

Alternatives to the Recommended Option for reducing the thresholds were analyzed as Options A, B, and the Contingency Options. These options have the same cost effectiveness to the proposed option, in the range of \$\$3.14-\$5.32 per pound of PM2.5. Each option reduces the number of days exceeding the PM2.5 health standard compared to the Recommended Option but also increases the number of No Burn days, and therefore the total cost, of the rule.

Additional wood burning control measures were analyzed as further study measures as part of the District's response to SB 656. The cost effectiveness in 2005 for requiring replacement of non-certified units upon sale of property was estimated to be \$2.62 - \$6.03/lb, however, the emission reductions are much less than those achievable through mandatory No Burn days. San Joaquin Valley APCD estimated a reduction of 2% for replacement of non-certified units upon sale of property. Staff estimates a reduction of 3.1% for replacement of non-certified units upon sale of property using the same assumptions from 2005 but using updated emission

inventory numbers. The cost effectiveness for replacement is estimated to be \$7.48. Using this assumption, the reduction for Sacramento County would be 0.36 tons per day.

Other measures that are available to reduce PM2.5 emissions that were identified during the SB656 process include measures to reduce fugitive dust from agricultural tilling; chipping and grinding activities; composting; paved and unpaved roads; street sweepers; and construction, grading, and demolition; as well as add-on controls for charbroilers. None of these measures approaches the potential of No Burn days in reducing PM2.5 emissions. Strengthening Rule 421 now may avoid the need to adopt some of these measures in the future.

Emission reduction potential of the proposed amendments: The proposed rule is estimated to achieve reductions of 4.97 tons of PM2.5 per Stage 1 day and 8.03 tons of PM2.5 per Stage 2 day. Each option has the same emission reduction per No Burn day; however, the options differ in the additional number of No Burn days that would occur. (See discussion under Emission Reductions section of this staff report.)

Necessity of adopting the amendments: A more effective Rule 421 is necessary to reduce the number of unhealthy air quality days that violate the federal 24-hour PM2.5 health standard and to provide further emission reductions that will contribute to attainment of the state and federal PM2.5 standards and state PM10 standards.

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## PUBLIC COMMENTS

Staff conducted five public workshops throughout Sacramento County between July 13<sup>th</sup> and July 22<sup>nd</sup>. Each workshop started with a structured presentation of the four options with time available for questions and comments. The workshops were held in downtown Sacramento, Carmichael, Folsom, Galt and at the District office.

Noticing for these public meetings included:

- Letters to all elected officials in Sacramento County
- Ad in the Our Region section of the Sacramento Bee
- Notices to newspapers across Sacramento County
- Notices to radio stations across the region
- Letters to homeowner associations
- Notice on the District's Web site
- Notices by mail to the District's list of parties interested in rule development.

Workshop Location	Date	Time
La Sierra Community Center Room 800 5325 Engle Rd., Carmichael	July 14	6:00 p.m.
Tsakopoulos Library Galleria 828 I Street, East Meeting Room, Sacramento	July 15	5:30 p.m.
SMAQMD District Office 777 12 <sup>th</sup> Street, 3 <sup>rd</sup> Floor, Sacramento	July 16	1:30 p.m.
Chabolla Center 610 Chabolla Avenue, Galt	July 20	6:00 p.m.
Folsom Community Center, Ballroom 52 Natoma Street, Folsom	July 22	6:30 p.m.



In addition, Staff conducted stakeholder industry meetings on July 9<sup>th</sup> and August 17<sup>th</sup>. The stakeholder meetings were attended by HBPA and various retailers. Attendees, comments and responses are listed in Appendix F.

Staff received comments and questions at the workshops, through the mail, e-mail and at stakeholder meetings. Comments and responses are listed in Appendix F.

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## ENVIRONMENTAL REVIEW AND COMPLIANCE

Rule 421 was created as part of the response to the requirements of Senate Bill 656 that the District implement cost-effective control measures for particulate matter emissions. Staff finds that the proposed rule is exempt from the California Environmental Quality Act as an action by a regulatory agency for protection of the environment (Class 8 Categorical Exemption, Section 15308 State CEQA Guidelines) and because it can be seen with certainty that there is no possibility that the activity in question may have a significant adverse effect on the environment (Section 15061(b)(3), State CEQA Guidelines).

California Public Resources Code (Section 21159) requires an environmental analysis of the reasonably foreseeable methods of compliance. Staff anticipates that users of solid fuel burning devices will comply with No Burn day restrictions by not burning for ambience and, where wood burning provides supplemental heat, by using alternative sources such as natural gas or electricity. The use of these alternative fuels will result in a decrease in the emissions of particulate matter and other air pollutants, including greenhouse gasses, with a corresponding improvement in air quality and public health.

There has been some debate as to whether the burning of wood should be considered “carbon neutral,” because even though carbon dioxide is released from the burning of wood, carbon dioxide was absorbed by the living trees. Burning simply returns that carbon dioxide to the atmosphere, thus the term “neutral.” However, the term “carbon neutral” is something of a misnomer, because other greenhouse gasses, including methane and nitrous oxide (much more potent greenhouse gasses than carbon dioxide) and black carbon particles (another global warming pollutant), are released when wood is burned, while only the carbon dioxide is absorbed by living trees. Carbon neutrality, at least with respect to carbon dioxide emissions, depends on a number of factors, including whether the wood has been harvested from a sustainable resource. Both BAAQMD<sup>23</sup> and SJVAPCD<sup>24</sup> have found that a large percentage of the firewood being burned comes from nonsustainable activities. In particular, there has been a loss in the acreage of oak woodlands in Northern California, including the foothills on the eastern side of the Central Valley, attributable to urban growth, firewood harvesting, and land clearing for vineyards and developments. Similar activities have been conducted in Sacramento County and the surrounding areas. It may take as long as 200 years for young trees to approach the carbon storage capacity of old growth forests.

Nevertheless, Staff has examined the net effect on greenhouse gas emissions under two bounding scenarios: 1) the burning of wood is not carbon neutral, and 2) the burning of wood is

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<sup>23</sup> BAAQMD, *Draft Environmental Impact Report for the Bay Area Air Quality Management District's Proposed Regulation 6, Rule 3 Wood-Burning Devices*, May 2008

<sup>24</sup> SJVAPCD, *Final Staff Report Proposed Amendments to Rule 4901*, October 2008

carbon neutral with respect to carbon dioxide. It should be noted that there are greenhouse gas emissions associated with electricity due to fuel burned at electrical power plants. The following table shows the results of this analysis, based on equal heat outputs using natural gas or electricity rather than wood combustion on No Burn days.

Heat Source	GHG Emissions (metric tons/yr CO <sub>2</sub> Equiv.)			
	Recommended Change	Option A	Option B	Contingency Option
Wood	6,249	11,891	19,070	46,557
Wood – Carbon (CO <sub>2</sub> ) neutral	552	1,051	1,686	4,116
Natural Gas	1,270	2,418	3,877	9,466
Electricity – Only CO <sub>2</sub>	1,418	2,698	4,326	10,561

As shown in the table, if wood burning is not carbon neutral, there is a net decrease in greenhouse gas emissions from using natural gas or electricity instead of wood on No Burn days. If wood burning is carbon (CO<sub>2</sub>) neutral, there is a net increase in greenhouse gas emissions from using the replacement fuels on No Burn days. Under the Recommended Option, assuming that wood burning is carbon (CO<sub>2</sub>) neutral, and wood is replaced by electricity on No Burn days, there is a net increase in greenhouse gas emissions of 866 metric tons per year of CO<sub>2</sub> equivalents, which represents only 0.005% of the greenhouse gas emission inventory for Sacramento County and 0.0002% of the California inventory.

Even in the worst case (Contingency Option, using electricity instead of wood), the increase in greenhouse gas emissions represents only 0.04% of the greenhouse gas emission inventory for Sacramento County and 0.001% of the California inventory.

Staff has concluded that no significant environmental impacts will be caused by compliance with the proposed rule.

## FINDINGS

The California Health and Safety Code (HSC), Division 26, Air Resources, requires local districts to comply with a rule adoption protocol as set forth in Section 40727 of the Code. This section has been revised through legislative mandate to contain six findings that the District must make when developing, amending, or repealing a rule. These findings, effective January 1, 1992, and their definitions are listed in the table below.

### Rule 421 – Required Findings

Finding	Finding Determination
<b>Authority:</b> The District must find that a provision of law or of a state or federal regulation permits or requires the District to adopt, amend, or repeal the rule.	The District is authorized to amend Rule 421 by California Health and Safety Code (HSC) Sections 40001, 40702, 40716, 41013 and 42402.5. [HSC Section 40727(b)(2)].
<b>Necessity:</b> The District must find that the rulemaking demonstrates a need exists for the rule, or for its amendment or repeal.	It is necessary to adopt the proposed amendments to Rule 421 to reduce the number of unhealthy air quality days that violate the federal 24-hour PM <sub>2.5</sub> health standard. [HSC Section 40727(b)(1)].
<b>Clarity:</b> The District must find that the rule is written	The District has reviewed the proposed rule and

Finding	Finding Determination
or displayed so that its meaning can be easily understood by the persons directly affected by it.	determined that it can be understood by the affected parties. In addition, the record contains no evidence that people directly affected by the rule cannot understand the rule. [HSC Section 40727(b)(3)].
<b>Consistency:</b> The rule is in harmony with, and not in conflict with or contradictory to, existing statutes, court decisions, or state or federal regulations.	The District has found the proposed rule does not conflict with, and is not contradictory to, existing statutes, court decisions, or state or federal regulations. [HSC Section 40727(b)(4)].
<b>Non-Duplication:</b> The District must find that either: 1) The rule does not impose the same requirements as an existing state or federal regulation; or (2) that the duplicative requirements are necessary or proper to execute the powers and duties granted to, and imposed upon the District.	The proposed rule does not duplicate any existing state or federal regulations. Rule 421 does not duplicate the federal requirements because it requires curtailment of use of any fires or solid fuel burning device on certain days. [HSC Section 40727(b)(5)].
<b>Reference:</b> The District must refer to any statute, court decision, or other provision of law that the District implements, interprets, or makes specific by adopting, amending or repealing the rule.	In adopting the proposed rule, the District is implementing the requirements of HSC Section 39614 (SB 656). [HSC Section 40727(b)(6)].
<b>Additional Informational Requirements:</b> In complying with HSC Section 40727.2, the District must identify all federal requirements and District rules that apply to the same equipment or source type as the proposed rule or amendments.	Appendix A includes a comparison with federal requirements. [HSC Section 40727.2].

## REFERENCES

1. Morley Chavero, Dawn, and Holobow, Naomi, "2009 Wood Burn Awareness Survey," May 2009
2. MacDonald, Clinton P., Craig, Kenneth J., DeWinter, Jennifer L., Pasch, Adam N., Brown, Steve G., and Wheeler, Neil J. M., "Evaluation of Sacramento Metropolitan Air Quality Management District's Check Before You Burn Program," May 2009
3. Fields, Paula, Kaplan, Maureen, and Lamb-Janney, Lilli., "Socioeconomic Impact Analysis for SMAQMD Rule 421 Amendments," August 2009.
4. STAPPA-ALAPCO, EPA, Emissions Inventory Improvement Program. (EIIP) 2001. "Residential Wood Combustion", Volume III, Chapter 2
5. Broderick, David R., and Houck, James E. 2003, Emissions Inventory Improvement Program (EIIP) Residential Wood Combustion Coordination Project"
6. Houck, James. 2003 "Results of Wood Burning Survey – Sacramento, San Joaquin, and San Francisco Areas, University of California Berkeley/California Air Resources Board – GIS Study"
7. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources, AP-42, Section 1.4 – Natural Gas Combustion, 1998

8. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources, AP-42, Section 1.9 – Residential Fireplaces, 1996
9. U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources, AP-42, Section 1.10 – Residential Wood Stoves, 1996
10. 2006 Winter Emission Inventory for PM2.5, Sacramento County, 2007 CARB Almanac, 2006 Baseline, extracted 4/15/2009,  
<http://www.arb.ca.gov/app/emsinv/fcemssumcat2007.php>

## APPENDIX A

### 40727.2 Matrix

		Comparative Requirements		
Elements of Comparison	Specific Provisions	Proposed Rule 421	Rule 417	40CFR60 Subpart AAA
Exemptions		Cookstoves Sole source of heat Religious Activity Economic Hardship Gaseous fueled appliances	Cookstoves	Open masonry fireplaces constructed on site Boilers Furnaces Cookstoves Devices with air-to-fuel ratio > 35-to-1, minimum burn rate > 11 lb/hr, firebox > 20 cubic ft, or weight > 1,760 lb
Averaging Provisions		None	none	none
Units		none	g/hr	g/hr
Emissions Limits		none	Catalytic Units: 4.1 g/hr Non-Catalytic Units: 7.5 g/hr	Catalytic Units: 4.1 g/hr Non-Catalytic Units: 7.5 g/hr
	Compliance alternatives	none	Pellet stoves, masonry heaters	none
Operating Parameters		Prohibits operation on days with PM2.5 concentration projected above: Recommended Change - 31 µg/m <sup>3</sup> Option A (A.1 or A.2) - 30 µg/m <sup>3</sup> . Option B - 25 µg/m <sup>3</sup>	Prohibits burning trash and other specified fuels	none
Work Practice Requirements		None	Wood advertised by retailers as "seasoned" or "dry" must contain less than 20% moisture.	none
Monitoring/ Records	Recordkeeping	none	none	none
	Frequency	none	none	none
Monitoring/ Testing	Test Methods	none	Wood Moisture Content, ASTM D4442-92	Test methods: -PM: Method 28 -Emissions Concentration, if a dilution tunnel sampling location uses: Method 5G -Emissions Concentration, if a stack location is used: Method 5H

## APPENDIX B

### List of Changes to Rules Rule 421, Episodic Curtailment of Wood and Other Solid Fuel Burning

Proposed rule changes implementing administrative change

NEW SECTION NUMBER	EXISTING SECTION NUMBER	PROPOSED CHANGES
402.1	Same	Clarify the intent that first-time violators must complete and pass (i.e. a test or other method) the smoke awareness course.

Proposed rule changes implementing Recommended Change

NEW SECTION NUMBER	EXISTING SECTION NUMBER	PROPOSED CHANGES
301.2	Same	Adjust Stage 1 threshold to 31 $\mu\text{g}/\text{m}^3$ .
301.3	Same	Adjust Stage 2 threshold to 35 $\mu\text{g}/\text{m}^3$ .
302	Same	Change Voluntary Curtailment section numbering to be consistent with the Mandatory Curtailment section.
302.1	N/A	Adjust Voluntary Curtailment to 25 $\mu\text{g}/\text{m}^3$ to 31 $\mu\text{g}/\text{m}^3$ .

Proposed rule changes implementing Option A (A.1 or A.2)

NEW SECTION NUMBER	EXISTING SECTION NUMBER	PROPOSED CHANGES
N/A	115	Eliminate exemption.
N/A	116	Eliminate exemption.
N/A	208	Eliminate definition no longer used.
N/A	209	Eliminate definition no longer used.
208	210	Renumbered.
209	211	Renumbered.
N/A	301.2	Eliminate Stage 1 Mandatory Curtailment.
301.2	301.3	Change Stage 2 to a single stage Mandatory Curtailment and adjust threshold to 30 $\mu\text{g}/\text{m}^3$ .
302	Same	Change Voluntary Curtailment section numbering to be consistent with the Mandatory Curtailment section.
302.1	N/A	Set Voluntary Curtailment Range to 25 $\mu\text{g}/\text{m}^3$ to 30 $\mu\text{g}/\text{m}^3$ ( <b>A.1</b> ) or 20 $\mu\text{g}/\text{m}^3$ to 30 $\mu\text{g}/\text{m}^3$ ( <b>A.2</b> ).

Proposed rule changes implementing Option B

NEW SECTION NUMBER	EXISTING SECTION NUMBER	PROPOSED CHANGES
--------------------	-------------------------	------------------

301.2	Same	Adjust Stage 1 threshold to 25 $\mu\text{g}/\text{m}^3$ .
301.3	Same	Adjust Stage 2 threshold to 30 $\mu\text{g}/\text{m}^3$ .
302	Same	Change Voluntary Curtailment section numbering to be consistent with the Mandatory Curtailment section.
302.1	N/A	Adjust Voluntary Curtailment to 20 $\mu\text{g}/\text{m}^3$ to 25 $\mu\text{g}/\text{m}^3$ .

Additional proposed rule changes either Recommended Change or Option B with Contingency Option

<b>NEW SECTION NUMBER</b>	<b>EXISTING SECTION NUMBER</b>	<b>PROPOSED CHANGES</b>
301.4	N/A	Add a contingency mandatory curtailment. The contingency mandatory curtailment changes the rule to a single stage with a threshold of 20 $\mu\text{g}/\text{m}^3$ .
302.2	N/A	Add a contingency voluntary curtailment. The contingency voluntary curtailment has a reduced threshold of 15 $\mu\text{g}/\text{m}^3$ .

Additional proposed rule changes Option A (A.1 or A.2) with Contingency Option

<b>NEW SECTION NUMBER</b>	<b>EXISTING SECTION NUMBER</b>	<b>PROPOSED CHANGES</b>
208	Same	Maintain U.S. EPA definition.
209	210	Renumbered.
210	211	Renumbered.
301.3	N/A	Add a contingency mandatory curtailment. The contingency mandatory curtailment changes the rule to a single stage with a threshold of 20 $\mu\text{g}/\text{m}^3$ .
302.2	N/A	Add a contingency voluntary curtailment. The contingency voluntary curtailment has a reduced threshold of 15 $\mu\text{g}/\text{m}^3$ .

**APPENDIX C**

**Final Aurora Survey Report**



**APPENDIX D**

**STI Final Report  
Evaluation of SMAQMD's Check Before You Burn Program**

## APPENDIX E

### Emissions Calculations

The baseline emissions are based on historical usage patterns. Emissions are calculated as follows:

$$\text{Emissions} = (\text{Number of Homes}) \times (\text{fraction of homes w/ device}) \times (\text{fraction of homes w/ device that burn}) \times (\text{Average amount of wood burned per home}) \times (EF_{\text{burning}})$$

This calculation is repeated for each type of device, and the totals are summed. These emissions are assumed to all be emitted during the Check Before You Burn season, which includes 120 days. It is assumed that the percent of fuel burned in November through February is 69.1% of all wood burned.

The reduction from a day of mandatory curtailment is calculated by taking 1/120<sup>th</sup> of the total calculated emissions, and adjusting this amount by the emissions reduction rate determined from the 2009 Aurora survey. The total reduction for the season for each option is calculated as the daily reduction times the expected additional number of days of mandatory curtailment.

Stage 1 and Stage 2 No Burn days are differentiated by allowing all certified and pellet devices to burn on Stage 1 and using stage specific emissions reduction rates.

The variables used and the calculations are summarized in the following tables:

**Recommended Change - Stage 1**

Total Housing Units	502095	Stage 1 Compliance Rate			57%
Threshold	31	µg/m <sup>3</sup>	Stage 1 Days		5
Wood Burning Appliance Types	Fireplace	Stoves	Inserts	Pellet Stoves	<b>Total</b>
%	31%	5%	16%	3.0%	55%
# total	155649	25105	80335	15063	276152
# total that burn	98059	15816	50611	9490	173976
# Phase II certified out of total that burn		6801	22775		
# Catalytic out of the Phase II certified		1156	11388		
<b>Cords of fuel burned per winter day Nov-Feb</b>	<b>125</b>	<b>137</b>	<b>350</b>		
Tons of fuel burned Nov thru Feb (heat+asthetic)	23046	25246	64629		
Tons PM2.5 Emissions from cord wood Nov-Feb	271.9				
<b>Manufactured logs burned per winter day Nov-Feb</b>	<b>2146</b>				
Tons Manufactured logs burned Nov thru Feb	644				
Tons PM2.5 Emissions from logs Nov thru Feb	9.5				
Total Fireplace Emissions Nov thru Feb	281.4				
<b>Cords of fuel burned per winter day (Nov-Feb) noncertified</b>		<b>78</b>	<b>192</b>		
<b>Cords of fuel burned per winter day (Nov-Feb) certified</b>		<b>59</b>	<b>157</b>		
Tons of fuel burned Nov-Feb uncertified		14390	35546		
Tons of fuel burned Nov-Feb Phase II - non cat		9010	24139		
Tons of fuel burned Nov-Feb phase II - cat		1845	4944		
Tons PM2.5 Emissions Nov-Feb from uncertified		220.2	543.8		
Tons PM2.5 Emissions Nov-Feb from phase II		65.8	176.2		
Tons PM2.5 Emissions Nov-Feb from phase II - catalytic		18.8	50.4		
Total Stove Emissions Nov thru Feb		304.8	770.5		
<b>Tons fuel burned per winter pellet stove per day</b>				<b>109</b>	
Tons PM2.5 Emissions from Pellet Stove Nov thru Feb				20.1	
\$ amount of fuel used per winter day Nov thru Feb	\$ 33,635	\$ 36,748	\$ 94,075	\$ 37,597	\$ 202,055.77
\$ amount of reduced fuel used per No Burn day Nov-Feb	\$ 19,172	\$ 11,939	\$ 29,493	\$ -	\$ 60,604.08
PM2.5 Total Uncontrolled Emissions (lb/day) Nov-Feb	4,690	5,079	12,842	334	22,945
PM2.5 Total Reduction (lb/day) Nov-Feb	2,673	2,092	5,167	-	9,931
Percent Reduction per curtailment day	57.0%	41.2%	40.2%	0.0%	43.3%
Overall PM2.5 Cost Effectiveness (\$/ton)					\$ 6,273.10
Overall PM2.5 Cost Effectiveness (\$/lb)					\$ 3.14
NOx Uncontrolled (lb/day)	540	517	1,314	415	2,786
NOx Reduction (lb/day)	308	295	749	-	1,351
NOx from NG	10	45	110	-	165
Net NOx Reduction	298	250	639	-	1,186
CO Uncontrolled (lb/day)	25,253	36,229	93,852	1,738	157,071
CO Reduction (lb/day)	14,394	8,749	21,612	-	44,755
CO from NG	8	38	93	-	139
Net CO Reduction	14,386	8,712	21,519	-	44,616
VOC Uncontrolled (lb/day)	44,191	7,487	18,731	4.37	70,410
VOC Reduction (lb/day)	25,189	3,623	8,949	-	37,760
VOC from NG	1	2	6	-	9
Net VOC Reduction	25,189	3,620	8,943	-	37,751

**Recommended Change - Stage 2**

Total Housing Units	502095	Stage 2 Compliance Rate			70%
Threshold	35	µg/m <sup>3</sup>	Stage 2 Days		23
<b>Wood Burning Appliance Types</b>	<b>Fireplace</b>	<b>Stoves</b>	<b>Inserts</b>	<b>Pellet Stoves</b>	<b>Total</b>
%	31%	5%	16%	3.0%	55%
# total	155649	25105	80335	15063	276152
# total that burn	98059	15816	50611	9490	173976
# Phase II certified out of total that burn		6801	22775		
# Catalytic out of the Phase II certified		1156	11388		
<b>Cords of fuel burned per winter day Nov-Feb</b>	<b>125</b>	<b>137</b>	<b>350</b>		
Tons of fuel burned Nov thru Feb (heat+asthetic)	23046	25246	64629		
Tons PM2.5 Emissions from cord wood Nov-Feb	271.9				
<b>Manufactured logs burned per winter day Nov-Feb</b>	<b>2146</b>				
Tons Manufactured logs burned Nov thru Feb	644				
Tons PM2.5 Emissions from logs Nov thru Feb	9.5				
Total Fireplace Emissions Nov thru Feb	281.4				
<b>Cords of fuel burned per winter day (Nov-Feb) noncertified</b>		<b>78</b>	<b>192</b>		
<b>Cords of fuel burned per winter day (Nov-Feb) certified</b>		<b>59</b>	<b>157</b>		
Tons of fuel burned Nov-Feb uncertified		14390	35546		
Tons of fuel burned Nov-Feb Phase II - non cat		9010	24139		
Tons of fuel burned Nov-Feb phase II - cat		1845	4944		
Tons PM2.5 Emissions Nov-Feb from uncertified		220.2	543.8		
Tons PM2.5 Emissions Nov-Feb from phase II		65.8	176.2		
Tons PM2.5 Emissions Nov-Feb from phase II - catalytic		18.8	50.4		
Total Stove Emissions Nov thru Feb		304.8	770.5		
<b>Tons fuel burned per winter pellet stove per day</b>				<b>109</b>	
Tons PM2.5 Emissions from Pellet Stove Nov thru Feb				20.1	
\$ amount of fuel used per winter day Nov thru Feb	\$ 33,635	\$ 36,748	\$ 94,075	\$ 37,597	\$ 202,055.77
\$ amount of reduced fuel used per No Burn day Nov-Feb	\$ 23,545	\$ 25,724	\$ 65,853	\$ 26,318	\$ 141,439.04
PM2.5 Total Uncontrolled Emissions (lb/day) Nov-Feb	4,690	5,079	12,842	334	22,945
PM2.5 Total Reduction (lb/day) Nov-Feb	3,283	3,556	8,989	234	16,062
Percent Reduction per curtailment day	70.0%	70.0%	70.0%	70.0%	70.0%
Overall PM2.5 Cost Effectiveness (\$/ton)					\$ 10,645.16
Overall PM2.5 Cost Effectiveness (\$/lb)					\$ 5.32
NOx Uncontrolled (lb/day)	540	517	1,314	415	2,786
NOx Reduction (lb/day)	378	362	920	291	1,950
NOx from NG	12	103	265	58	438
Net NOx Reduction	366	259	655	232	1,512
CO Uncontrolled (lb/day)	25,253	36,229	93,852	1,738	157,071
CO Reduction (lb/day)	17,677	25,360	65,696	1,216	109,949
CO from NG	10	87	222	-	319
Net CO Reduction	17,667	25,273	65,474	1,216	109,630
VOC Uncontrolled (lb/day)	44,191	7,487	18,731	4.37	70,410
VOC Reduction (lb/day)	30,934	5,241	13,112	3	49,287
VOC from NG	1	6	15	3	21
Net VOC Reduction	30,933	5,235	13,097	(0)	49,266

**Option B - Stage 1**

Total Housing Units	502095	Stage 1 Compliance Rate			57%
Threshold	31	µg/m <sup>3</sup>	Stage 1 Days		5
Wood Burning Appliance Types	Fireplace	Stoves	Inserts	Pellet Stoves	<b>Total</b>
%	31%	5%	16%	3.0%	55%
# total	155649	25105	80335	15063	276152
# total that burn	98059	15816	50611	9490	173976
# Phase II certified out of total that burn		6801	22775		
# Catalytic out of the Phase II certified		1156	11388		
<b>Cords of fuel burned per winter day Nov-Feb</b>	<b>125</b>	<b>137</b>	<b>350</b>		
Tons of fuel burned Nov thru Feb (heat+asthetic)	23046	25246	64629		
Tons PM2.5 Emissions from cord wood Nov-Feb	271.9				
<b>Manufactured logs burned per winter day Nov-Feb</b>	<b>2146</b>				
Tons Manufactured logs burned Nov thru Feb	644				
Tons PM2.5 Emissions from logs Nov thru Feb	9.5				
Total Fireplace Emissions Nov thru Feb	281.4				
<b>Cords of fuel burned per winter day (Nov-Feb) noncertified</b>		<b>78</b>	<b>192</b>		
<b>Cords of fuel burned per winter day (Nov-Feb) certified</b>		<b>59</b>	<b>157</b>		
Tons of fuel burned Nov-Feb uncertified		14390	35546		
Tons of fuel burned Nov-Feb Phase II - non cat		9010	24139		
Tons of fuel burned Nov-Feb phase II - cat		1845	4944		
Tons PM2.5 Emissions Nov-Feb from uncertified		220.2	543.8		
Tons PM2.5 Emissions Nov-Feb from phase II		65.8	176.2		
Tons PM2.5 Emissions Nov-Feb from phase II - catalytic		18.8	50.4		
Total Stove Emissions Nov thru Feb		304.8	770.5		
<b>Tons fuel burned per winter pellet stove per day</b>				<b>109</b>	
Tons PM2.5 Emissions from Pellet Stove Nov thru Feb				20.1	
\$ amount of fuel used per winter day Nov thru Feb	\$ 33,635	\$ 36,748	\$ 94,075	\$ 37,597	\$ 202,055.77
\$ amount of reduced fuel used per No Burn day Nov-Feb	\$ 19,172	\$ 11,939	\$ 29,493	\$ -	\$ 60,604.08
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PM2.5 Total Reduction (lb/day) Nov-Feb	2,673	2,092	5,167	-	9,931
Percent Reduction per curtailment day	57.0%	41.2%	40.2%	0.0%	43.3%
Overall PM2.5 Cost Effectiveness (\$/ton)					\$ 6,273.10
Overall PM2.5 Cost Effectiveness (\$/lb)					\$ 3.14
NOx Uncontrolled (lb/day)	540	517	1,314	415	2,786
NOx Reduction (lb/day)	308	295	749	-	1,351
NOx from NG	10	45	110	-	165
Net NOx Reduction	298	250	639	-	1,186
CO Uncontrolled (lb/day)	25,253	36,229	93,852	1,738	157,071
CO Reduction (lb/day)	14,394	8,749	21,612	-	44,755
CO from NG	8	38	93	-	139
Net CO Reduction	14,386	8,712	21,519	-	44,616
VOC Uncontrolled (lb/day)	44,191	7,487	18,731	4.37	70,410
VOC Reduction (lb/day)	25,189	3,623	8,949	-	37,760
VOC from NG	1	2	6	-	9
Net VOC Reduction	25,189	3,620	8,943	-	37,751

**Option B - Stage 2**

Total Housing Units	502095	Stage 2 Compliance Rate			70%
Threshold	35	µg/m <sup>3</sup>	Stage 2 Days	23	
Wood Burning Appliance Types	Fireplace	Stoves	Inserts	Pellet Stoves	<b>Total</b>
%	31%	5%	16%	3.0%	55%
# total	155649	25105	80335	15063	276152
# total that burn	98059	15816	50611	9490	173976
# Phase II certified out of total that burn		6801	22775		
# Catalytic out of the Phase II certified		1156	11388		
<b>Cords of fuel burned per winter day Nov-Feb</b>	<b>125</b>	<b>137</b>	<b>350</b>		
Tons of fuel burned Nov thru Feb (heat+asthetic)	23046	25246	64629		
Tons PM2.5 Emissions from cord wood Nov-Feb	271.9				
<b>Manufactured logs burned per winter day Nov-Feb</b>	<b>2146</b>				
Tons Manufactured logs burned Nov thru Feb	644				
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Total Fireplace Emissions Nov thru Feb	281.4				
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Tons PM2.5 Emissions Nov-Feb from phase II - catalytic		18.8	50.4		
Total Stove Emissions Nov thru Feb		304.8	770.5		
<b>Tons fuel burned per winter pellet stove per day</b>				<b>109</b>	
Tons PM2.5 Emissions from Pellet Stove Nov thru Feb				20.1	
\$ amount of fuel used per winter day Nov thru Feb	\$ 33,635	\$ 36,748	\$ 94,075	\$ 37,597	\$ 202,055.77
\$ amount of reduced fuel used per No Burn day Nov-Feb	\$ 23,545	\$ 25,724	\$ 65,853	\$ 26,318	\$ 141,439.04
PM2.5 Total Uncontrolled Emissions (lb/day) Nov-Feb	4,690	5,079	12,842	334	22,945
PM2.5 Total Reduction (lb/day) Nov-Feb	3,283	3,556	8,989	234	16,062
Percent Reduction per curtailment day	70.0%	70.0%	70.0%	70.0%	70.0%
Overall PM2.5 Cost Effectiveness (\$/ton)					\$ 10,645.16
Overall PM2.5 Cost Effectiveness (\$/lb)					\$ 5.32
NOx Uncontrolled (lb/day)	540	517	1,314	415	2,786
NOx Reduction (lb/day)	378	362	920	291	1,950
NOx from NG	12	103	265	58	438
Net NOx Reduction	366	259	655	232	1,512
CO Uncontrolled (lb/day)	25,253	36,229	93,852	1,738	157,071
CO Reduction (lb/day)	17,677	25,360	65,696	1,216	109,949
CO from NG	10	87	222	-	319
Net CO Reduction	17,667	25,273	65,474	1,216	109,630
VOC Uncontrolled (lb/day)	44,191	7,487	18,731	4.37	70,410
VOC Reduction (lb/day)	30,934	5,241	13,112	3	49,287
VOC from NG	1	6	15	3	21
Net VOC Reduction	30,933	5,235	13,097	(0)	49,266

**Option A1 or A2 - Single Stage**

Total Housing Units	502095	Stage 2 Compliance Rate			70%
Threshold	35	µg/m <sup>3</sup>	Single Stage Days		31
Wood Burning Appliance Types	Fireplace	Stoves	Inserts	Pellet Stoves	<b>Total</b>
%	31%	5%	16%	3.0%	55%
# total	155649	25105	80335	15063	276152
# total that burn	98059	15816	50611	9490	173976
# Phase II certified out of total that burn		6801	22775		
# Catalytic out of the Phase II certified		1156	11388		
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Total Fireplace Emissions Nov thru Feb	281.4				
<b>Cords of fuel burned per winter day (Nov-Feb) noncertified</b>		<b>78</b>	<b>192</b>		
<b>Cords of fuel burned per winter day (Nov-Feb) certified</b>		<b>59</b>	<b>157</b>		
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Tons of fuel burned Nov-Feb Phase II - non cat		9010	24139		
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Tons PM2.5 Emissions Nov-Feb from uncertified		220.2	543.8		
Tons PM2.5 Emissions Nov-Feb from phase II		65.8	176.2		
Tons PM2.5 Emissions Nov-Feb from phase II - catalytic		18.8	50.4		
Total Stove Emissions Nov thru Feb		304.8	770.5		
<b>Tons fuel burned per winter pellet stove per day</b>				<b>109</b>	
Tons PM2.5 Emissions from Pellet Stove Nov thru Feb				20.1	
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CO Uncontrolled (lb/day)	25,253	36,229	93,852	1,738	157,071
CO Reduction (lb/day)	17,677	25,360	65,696	1,216	109,949
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VOC Reduction (lb/day)	30,934	5,241	13,112	3	49,287
VOC from NG	1	6	15	3	21
Net VOC Reduction	30,933	5,235	13,097	(0)	49,266

**APPENDIX F**  
**Comments and Responses**



**APPENDIX G**

**ERG Final Report  
Socioeconomic Evaluation**