



## Project Summary

# Literature Review and Survey of Emissions from Residential Wood Combustion and Their Impact

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This report resulted from a literature search of 53 reports covering woodstove design, operating conditions, emissions, testing methods, and ambient air impacts. The woodstoves studied varied in design from simple to complex and included controlled (catalytic) and uncontrolled woodstoves. The primary considerations in operating conditions were that the stoves studied burned primarily cord wood. The results of the tests were segregated according to the type of wood utilized, the percent moisture in the wood as tested, the burn rate of the wood, the stage of burning which was tested, and the length of the test. In addition to the operating conditions, the emissions were qualified by the test method which was performed, the firebox temperature, and the stack temperature. Emission parameters studied included particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), hydrocarbons (HC), and polycyclic organic material (POM), especially benzo-a-pyrene (BAP). This report includes ambient air impact surveys at various locations in the U.S. Most ambient studies were concerned with the PM and HC impacts, but a few looked at relating these impacts back to their sources.

*This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

### Introduction

Radian Corporation has concluded a literature search of available data on woodstove emissions. In the computer search of various libraries of information, 239 citations were identified through the use of a key word listing which was primarily for residential wood combustion (RWC) emissions and their impact. Approximately half of these were unique citations; of that number, 53 were chosen as applicable to this study. A computerized abstract of the 53 citations and a key word list are both included in the full report. The citations and literature studies came from all sectors of industry and government. To date, no one agency or association has coordinated all of the work which has preceded this study. The result was that the information was mostly piecemeal as to its content, purpose, and methods utilized.

The report: summarizes and gives conclusions of this literature review; summarizes the ranges of pollutants emitted from RWC; reviews some of the literature derived from ambient air studies; discusses the tracer compounds or methods utilized to link ambient pollutants to woodstove emissions; describes sampling and analytical methods used to test stoves; and discusses alternative design approaches to residential wood burning appliances.

### Background

The use of wood for residential heating, while aesthetically pleasing and economically attractive, may carry a potential for adverse health effects to large segments of the population. The impact of RWC on

ambient PM emissions is especially noticeable because the plume impacts the ground very near the source. In addition, the areas of highest RWC emission density often coincide with the areas of maximum population density, and most of the RWC particulate emissions are within the size range deposited within the lungs. RWC emissions are relatively rich in carcinogenic organics, toxic pollutants, and respiratory irritants. For all of these reasons, wood smoke is a problem that is of growing public concern.

The chemical products formed during wood combustion have recently been shown to contain 17 priority pollutants, 14 carcinogenic compounds, and 6 toxic or mucus coagulating agents which, when considered in addition to toxic gaseous emissions and respiratory irritants, collectively represent a potential health risk.

RWC emissions are becoming increasingly important as a major contributor to violations of current PM air quality standards and are implicated in issues related to visibility reduction, odors, and public health. New attention being focused on the adoption of an Inhalable Particulate (IP) National Ambient Air Quality Standard (NAAQS) has also caused concern about the RWC impact on 24-hour particulate standard attainment. The continuing economic pressures to expand the use of wood and coal for residential heating, and the limited regulatory pressures restricting the use of wood, may cause additional concern about the impact of RWC emissions on public health, aesthetics, and the future "livability" of many communities.

## Summary

A literature search was conducted of 53 reports covering woodstove design,

operating conditions, emissions, testing methods, and ambient air impacts. The woodstoves studied, both controlled (catalytic) and uncontrolled, varied in design from simple to complex. The stoves studied burned primarily cord wood. The results of the tests were segregated according to the type of wood utilized, the percent moisture in the wood as tested, the burn rate of the wood, the stage of burning which was tested, and the length of the test. In addition to the operating conditions, the emissions were qualified by the test method which was performed, the firebox temperature, and the stack temperature. Emission parameters studied included PM, CO, NO<sub>x</sub>, HC, and POM, especially BaP. This report includes ambient air impact surveys at various locations in the U.S. Most ambient studies were concerned with the PM and HC impacts, but a few looked at relating these impacts back to their sources.

The test methodologies used for both the source testing of woodstoves and for the ambient impact varied from study to study. As a result, few conclusions or

trends could be drawn from the combined studies. Conclusions and trends are seen within each study, although the reader must exercise caution as to the test method and the test conditions utilized to achieve these conclusions. An overview of the testing methods and analytical techniques is presented, with no conclusions or recommendations. Each study selected a test method which best suited its needs for the data. There is no standard method of sampling and analysis for woodstove emissions. ASTM is working on such a standard. Also, there is no standard set of conditions for the operation of the woodstoves, although guidelines are available.

Since the widespread use of woodstoves is a recent recurrence, the use of controls on them is still somewhat rare. The studies that evaluated control devices (i.e., catalytic, secondary combustion, and modified combustion) all reported variable decreases in emissions relative to standard stoves. No control devices appeared to dramatically reduce emissions under all conditions.

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*The complete report, entitled "Literature Review and Survey of Emissions from Residential Wood Combustion and Their Impact," (Order No. PB 85-197 820/AS; Cost: \$13.00, subject to change) will be available only from:*

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