



March 20, 2007

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**Re: Comment on the Brown *et al.* Article "An Assessment of Risk from Particulate Released from Outdoor Wood Boilers"**

Dear Phil:

Peter Valberg and I recently submitted a Letter to the Editor of *Human and Ecological Risk Assessment (HERA)* regarding the publication of the Brown *et al.* article "An Assessment of Risk from Particulate Released from Outdoor Wood Boilers."<sup>1</sup> As detailed in our Letter, which is scheduled for publication in the June issue of *HERA*, the Brown *et al.* article has a number of major errors and methodological flaws that undermine the validity of both its risk assessment findings as well as the conclusions that the authors draw from their analysis.<sup>2</sup> We identified errors and methodological flaws along each step of the risk assessment process, most of which contributed to an overestimation of health risks associated with outdoor wood boiler (OWB) emissions. Due to the serious nature of these mistakes, we expressed strong reservations regarding any reliance on the Brown *et al.* analysis in the regulatory decision-making process.

In our Letter, we described serious methodological flaws and errors in the Brown *et al.* analysis, with perhaps the most egregious of these flaws being the reliance on a total of only 4.3 hours of ambient air measurement data as an estimate of chronic lifetime (*e.g.*, 30-year) exposure in the cancer risk assessment. As stated on page 193 of the article, "The release by OWB of PM<sub>2.5</sub> as measured by Johnson (2006) will be the basis for this risk assessment." More specifically, Brown *et al.* extract two numbers, *i.e.*, the mean PM<sub>2.5</sub> measurement of 186 µg/m<sup>3</sup> and the 95% percentile of 665 µg/m<sup>3</sup>, from DataRAM measurement data in Johnson (2006) to serve as exposure point concentrations (EPCs) in their cancer risk calculations. Only in a footnote (footnote #3 on page 195) is it acknowledged that the entire Johnson (2006) measurement dataset comprised a total of 4.3 hours, and nowhere do the authors clearly acknowledge the extremely limited nature of the dataset collected in the Johnson (2006) pilot study- *i.e.*, measurements made over two days at one residential property for one wood boiler with a nine-foot stack, at a range of distances from 50 to 150 feet from the stack. Johnson himself refers in a number of places to his measurements as a "pilot study," an "exploratory study," and a "screening level evaluation," stating on page 1166 of his paper that "this pilot study was not intended to quantify 24-h or longer-term average exposures (*e.g.*, a complete heating season)." In fact, Johnson concludes with the following statement: "This screening level monitoring study recommends future research that would collect monitoring and exposure data of sufficient quality to support the evaluation of potential risks."

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<sup>1</sup> Brown, DR; Callahan, BG; Boissevain, AL. 2007. "An assessment of risk from particulate released from outdoor wood boilers." *Human Ecol Risk Assess* 13:191-208.

<sup>2</sup> Prior to its publication, following our review of a pre-publication copy of the manuscript, we expressed our strong reservations regarding this article and enumerated its major errors and methodological flaws to both the journal editors as well as the authors. Unfortunately, with the exception of a typographical error in the Conclusions Section where cancer risks were misstated by a factor of 100, it appears that none of the other mistakes were addressed, prompting our Letter to the Editor.

Brown *et al.* also seem unaware of methodological issues raised by Johnson, and many others in prior publications (*e.g.*, Trent, 2006; Trent, 2003; Fischer and Koshland, 2006), regarding the well-known tendency of light-scattering monitors such as the DataRAM to overestimate ambient PM<sub>2.5</sub> concentrations, in particular for smoke aerosols. The DataRAM is a light-scattering monitor, and because light-scattering is affected by the composition and size of particles, it provides only an approximate estimate of PM<sub>2.5</sub> mass concentrations. As acknowledged by Johnson (2006), but not in the Brown *et al.* article, the U.S. Forest Service uses the DataRAM 4 (*i.e.*, the same model used by Johnson (2006)) to provide general trends of ambient wildfire smoke PM<sub>2.5</sub> concentrations and recommends using a correction factor of 0.37 to 0.48 based on numerous tests showing that it reports high overestimations of PM<sub>2.5</sub> when sampling biomass combustion aerosol compared to gravimetric sampling. In other words, the U.S. Forest Service reduces DataRAM data by a factor of 2.1 to 2.7 to provide more accurate measures of ambient wildfire smoke PM<sub>2.5</sub> concentrations. Johnson (2006) chose not to correct his OWB field measurement data since the application of any correction factor would not have changed the approximate and qualitative nature of his study results, but he makes the observation "Nonetheless, a more conservative assessment of these data could interpret the PM<sub>2.5</sub> concentrations as indicators of general trends relating to monitoring distance from the OWB, boiler operating modes, and time after fuel loading." Based on the well-recognized high bias of the DataRAM, it is clear that data correction is a necessary step prior to any quantitative use of DataRAM data, such as in a risk assessment.

As emphasized in our Letter, one of the more serious errors in the article involves the derivation of the "conversion factor" of 6.9 that Brown *et al.* use to adjust for what they describe on page 195 as "scaling differences in burn box capacity (*i.e.*, wood stove *vs.* OWB)." As described on page 194 of the paper, Brown *et al.* multiplied the PAH data they extracted from an indoor wood stove study by 6.9, claiming that "OWBs emit 6.9 times the amount of PAHs than an USEPA-Certified non-catalytic wood stove, as estimated in NYS EPB (2005)." In reality, NYS EPB (2005) made no such estimate, but they do provide a table (Table 2 on page 8 of their report) with PM and PAH emissions data in grams per hour for both OWBs and wood stoves. From this table, it is clear that Brown *et al.* obtained their conversion factor of 6.9 by simply dividing the PAH emission rate given for OWBs (0.96 grams/hour) by the PAH emission rate given for USEPA-Certified non-catalytic wood stoves (0.14 grams/hour). However, this calculation is simply wrong since Brown *et al.* are doing their risk calculations on a per unit particulate matter basis, and the NYS EPB (2005) Table 2 data actually reflect PAH emission rates of 0.0134 g PAH/g PM for OWBs *versus* 0.023 g PAH/g PM for USEPA-Certified non-catalytic wood stoves. In other words, NYS EPB (2005) provides data that show a higher PAH emission rate, on a per unit particulate matter basis, for woodstoves than for OWBs. In fact, the emissions data provided in NYS EPB (2005) indicate that OWB's have 0.58 the amount of PAHs per unit particulate matter compared to non-catalytic wood stoves, meaning that the Brown *et al.* calculation error has inflated their risk assessment findings by a factor of 12.

Furthermore, despite taking the bold step of proposing their own metric for quantifying acute health risks of PM (the "Unhealthy Air Day Concept")<sup>3</sup>, Brown *et al.* demonstrate a limited understanding of the state of the science regarding PM health effects, and on numerous occasions they misrepresent findings from the PM health effects literature. For example, on page 193, Brown *et al.* incorrectly refer to the fact that US EPA's Air Quality Index (AQI) "does not consider specific cardiopulmonary risks." This is simply incorrect, as the AQI for PM<sub>2.5</sub> is based on the PM<sub>2.5</sub> NAAQS which were

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<sup>3</sup> Although Brown *et al.* cite two previous publications authored by Dr. Brown as supporting materials for the Unhealthy Air Day Concept, both publications are white papers rather than peer-reviewed journal articles. Furthermore, neither publication provides any discussion of the scientific basis for the "At Risk" (90 µg), "Moderate Risk" (120 µg), and "High Risk" (250 µg) dose levels that underlie their Unhealthy Air Day Concept; such a discussion is also glaringly absent from the Brown *et al.* article.

developed to be protective of adverse health effects, including cardiopulmonary risks specifically. Furthermore, health effect statements provided with AQI values specifically refer to possible aggravation of heart or lung disease in people with cardiopulmonary disease and older adults.

Brown *et al.* misrepresent the Dockery *et al.* (1993) study of the Harvard Six Cities long-term prospective cohort, erroneously citing it on page 193 of their article as providing support for the induction of cardiopulmonary health effects following exposures of a few hours (note that the reference on page 193 to Zanobetti *et al.* (2000) is also incorrect since this study relied upon daily PM data in its analyses) and as showing 2-hour and 24-hour lags between PM increases and health outcomes on page 199. The Dockery *et al.* study was a long-term study that examined the association between mean pollution levels averaged over a number of years and mortality, with no references to hourly or even daily-averaged data. On page 205, Brown *et al.* refer to the association observed in the Dockery *et al.* study between PM<sub>2.5</sub> and lung cancer as providing support for their findings, without mention of the fact that this association was not statistically significant.

The article's citation errors also extend to literature offered in support of the health impacts of woodsmoke PM. In particular, Brown *et al.* cite epidemiological studies of ambient, all-source PM as providing evidence for the health effects of woodsmoke PM without once acknowledging that ambient PM typically consists of a complex mixture of chemical constituents from a variety of different sources (*e.g.*, automobiles, power plants, industries, windblown dust, bioaerosols, *etc.*) and of varying properties. This is important because it is now widely recognized that not all PM constituents are likely of equal toxicity, with large uncertainties remaining regarding the identity of the more toxic PM constituents. In addition, in a number of places (*e.g.*, page 198), Brown *et al.* refer to a Koenig *et al.* (1993) study<sup>4</sup> as providing evidence for the health effects of woodsmoke PM after exposures of 2 to 4 hours or less in duration to concentrations in the range of 12 to 29 µg/m<sup>3</sup>. However, examination of the Koenig *et al.* paper does not support such a statement. Although Koenig *et al.* observed that residential wood burning was likely a major source of particulate matter measured in their study, the ambient PM measurements were not specific to woodsmoke and included contributions from other sources, *e.g.*, vehicles and industrial emissions. In addition, the Koenig *et al.* paper used a light-scattering instrument and provided data in light-scattering units (*e.g.*, light-scattering coefficients) rather than µg/m<sup>3</sup>. Furthermore, light-scattering coefficients reported in the paper are for 12-hour and weekly-averaged data rather than the 2 to 4 hour periods asserted by Brown *et al.*

We concluded in our Letter that it is our opinion, based on the serious mis-steps in the Brown *et al.* analysis, that the Brown *et al.* risk assessment is too flawed to provide credible conclusions regarding the long-term health impacts of woodsmoke from outdoor wood-fired boilers. Even aside from the errors in analysis, reliance on such a limited dataset to characterize lifetime exposures raises such large uncertainties that undermine the entire cancer risk assessment and any conclusions that can be drawn from it. As state and local governments consider regulations for outdoor wood-fired boilers, there is a need for the best available scientific information on potential public health risks associated with OWB emissions. The Brown *et al.* analysis clearly does not meet this need.

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<sup>4</sup> Brown *et al.* incorrectly give the title of the Koenig *et al.* (1993) paper as "Pulmonary function changes in children associated with particulate matter air pollution in a wood burning community" when in fact, the actual title is "Pulmonary function changes in children associated with fine particulate matter."

Please do not hesitate to contact me if you have any questions or need additional information.

Sincerely,

GRADIENT CORPORATION



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