

CalEPA. Most notable differences between derivations for sample chemicals involved data available and methods used at the time of the assessment, as well as differences in scientific judgment including application of uncertainty factors, identification of key studies, and selection of critical toxicity endpoints.

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### UNHEALTHY FINE PARTICULATE EXPOSURES ASSOCIATED WITH INAPPROPRIATE OUTDOOR WOOD BOILER LOCATION

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The Wisconsin Division of Public Health (WI DPH) has received numerous complaints of excessive smoke exposure from neighbors of people operating outdoor wood boilers (OWBs) for residential heating. WI DPH has investigated whether such exposure is a public health concern. A review of literature, including that supporting the USEPA National Ambient Air Quality Standard (NAAQS) for fine particulate, suggests fine particulate exposure contributes to mucous membrane irritation, cardiopulmonary effects, and premature death. OWB manufacturers suggest setback distances  $\geq 100$  feet from neighbors and chimney heights  $\geq 2$  feet above neighboring rooflines. Where these guidelines have not been met, WI DPH found exposure to fine particulate  $< 2.5 \mu\text{m}$  in diameter (PM<sub>2.5</sub>) well above the USEPA NAAQS of  $35 \mu\text{g}/\text{m}^3$  for 24-hour exposures. In two cases where OWBs were located  $< 100$  feet from homes, 24 hour PM<sub>2.5</sub> averages were  $83 \mu\text{g}/\text{m}^3$  and  $198 \mu\text{g}/\text{m}^3$ . Over the entire seven day monitoring period, averages of  $56 \mu\text{g}/\text{m}^3$  and  $80 \mu\text{g}/\text{m}^3$  were recorded. Monitoring results indicate that fine particulate exposure associated with inappropriately located OWBs represent a public health concern and support the need to respect setback and chimney height guidelines. WI DPH encourages consideration of extending setback distance recommendations and adoption of ordinances that would prevent inappropriate locating of OWBs.

### Podium Session 103: Biological Monitoring

#### Papers 13-18

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### AN UNEXPECTED EXPOSURE TO TXIB FROM BUCCAL SWAB DNA COLLECTORS

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As part of a statewide effort to collect DNA samples from all incarcerated felons, the California Department of Justice began receiving buccal swab collectors from detention facilities at the end of 2004. Over 500 swabs were received and processed per shift, eventually totaling more than 100,000 samples collected. While processing the swabs, employees complained of headache, dizziness, nausea, and asthma. Using

classic industrial hygiene investigation techniques, the suspect compound was identified as 2,2,4-trimethyl-1,3-pentanediol diisobutyrate (TXIB) found in the soft plastic cover of the collector. TXIB is plasticizer, which is also an additive in water-based paints, and has been detected in newly painted homes where asthma symptoms have developed. However, exposure concentrations were found to be well below known symptomatic levels. Employees were offered charcoal facemasks until a ventilation system was installed. When the new ventilation system reduced the exposure concentration below odor detection level, the symptoms stopped. Discussions with the sample collector manufacturer produced an interim and final design solution to remove the TXIB source. When completely implemented final levels were reduced below odor detection level but some background levels remained. No further complaints have been received since the ventilation system has been shut off.

Subsequent investigation has revealed that the TXIB odor affects a part of the brain, which triggers physiological responses in some personnel, explaining why the low concentrations caused an effect in certain employees.

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### COMPARING EQUAL DELIVERED DOSES OF AIRBORNE BENZENE FOR 8 HR/DAY STEADY EXPOSURE VS. PEAK EXPOSURE REGIMENS USING A PB-PK MODEL

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A physiologically based pharmacokinetic (PBPK) model was used to characterize the difference in delivered dose of benzene and its metabolites as a function of exposure rate for inhaled benzene. The PBPK model of Cole, Tran, and Schlosser (2001) was modified and used to predict whether substantial differences in tissue concentrations of benzene and its metabolites occur when the same dose of benzene results either from steady exposure over an eight-hour workday or from numerous short-term exposures. Specifically, a scenario involving steady exposure to 1 ppm benzene over eight hours was compared to several peak exposure scenarios, all yielding 8 ppm-hours of exposure. Parameter values were obtained from *in vitro* and *in vivo* experimental data on benzene toxicokinetics and metabolism. The model predicted that peak exposures do not appreciably increase the molar quantity of benzene metabolized within 10 hours after the onset of exposure. The resulting molar quantities of oxidized metabolites such as phenol, hydroquinone, catechol, and trihydroxybenzene were predicted to be elevated by 1-5% across the peak exposure profiles studied, a biologically insignificant difference. The effects of peak exposures on the quantity of benzene and its metabolites delivered to the bone marrow were negligible. These findings indicate that the current occupational exposure limits, which allow for four 15-minute "peak" exposures dur-

ing a day, do not pose an increased health risk to workers versus having the same dose delivered steadily over an eight-hour day.

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### BIOLOGICAL MONITORING FOR DIOXINS IN RUSSIAN FIREFIGHTERS

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Firefighters risk exposure to complex and unpredictable mixtures of combustion products. We investigated dioxin exposure among 165 firefighters, of whom 118 were involved in a 1992 industrial fire in Shelekhov, Russia. More than 1,000 tons of polyvinyl chloride, polyethylene, and other plastics burned during the three-day fire. Subsequent environmental sampling and experimental burns indicated the formation of dioxins. The long half life of dioxin congeners ( $> 10$  years) makes it possible to measure exposure at this late date. Average serum dioxin levels in 20 randomly selected firefighters were  $153 \text{ pg/g}$  lipid total toxic equivalents (TTEQ). The firefighters directly involved in the 1992 fire had serum concentrations of  $169 \text{ pg/g}$  lipid compared to  $105 \text{ pg/g}$  lipid among firefighters who did not participate. These levels exceed the U.S. Centers for Disease Control and Prevention reference values of  $32.5 \text{ pg/g}$  lipid for comparably aged males. In an effort to understand the consequences of this exposure, we investigated the effect of dioxins upon the gene expression. Expression of AHR, CYP1A1, and CYP1B genes were measured by real-time RTPCR, while expression of CYP1A2 was measured with the metabolic probe antipyrine. Firefighters in the highest TTEQ tercile tended to have lower AHR expression ( $p = .056$ ), while those in the highest tercile of the biologically stable congener, 1,2,3,7,8-pentachlorodibenzodioxin, had significantly lower levels of CYP1B1 expression ( $p = 0.016$ ). Multivariate analysis controlling for the effects of smoking, age, BMI, and group provided evidence of a modest but significant relationship between TTEQ and 3-hydroxymethylantipyrine (3HMAP), the metabolite with the greatest dependence on CYP1A2 activity. We conclude that the Shelekhov firefighters have substantial exposure to dioxins and this exposure may be altering the regulation of the dioxin gene expression pathway. This project was supported by the U.S. Civilian Research & Development Foundation and PSC CUNY 35.

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### QUANTIFYING THE RELATIVE IMPORTANCE OF PREDICTORS IN MULTIPLE LINEAR REGRESSION ANALYSES IN EXPOSURE ASSESSMENT

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