

## 10821-VOCs IN NEW RELOCATABLE CLASSROOMS: ASSESSMENT OF SCHOOL-DAY EXPOSURES COMPARING INTERIOR FINISH MATERIALS AND HVAC SYSTEMS

Derek G. Shendell<sup>1,2</sup>, Alfred T. Hodgson<sup>1</sup>, Seung-Min Lee<sup>1</sup>, Michael G. Apte<sup>1</sup>, Douglas P. Sullivan<sup>1</sup>, Toshifumi Hotchi<sup>1</sup>, William J. Fisk<sup>1</sup>

<sup>1</sup> Lawrence Berkeley National Laboratory, Indoor Environment Department (EETD), Berkeley, CA, U.S.A.

<sup>2</sup> UCLA School of Public Health, Environmental Sciences and Engineering Program, Los Angeles, CA, U.S.A.

The prevalence of relocatable classrooms (RCs) at schools is rising due to initiatives to reduce K-3 class size, and limited capital resources. Concerns regarding inadequate ventilation and indoor air quality in RCs have been raised. Since students and teachers spend the majority of a 7-8 hour school day inside classrooms, indoor contaminant concentrations can be assumed to drive personal school-day exposures. We conducted a demonstration project in new relocatable classrooms (RCs) during the 2001-02 school year to address these issues. The benefits of upgrades including an energy efficient heating, ventilation, and air conditioning (HVAC) system and alternate interior finish materials were investigated. One specific goal was to demonstrate that improved ventilation coupled with source reduction could lower indoor concentrations of toxic and odorous volatile organic compounds (VOC), including formaldehyde and acetaldehyde. Four new 24' x 40' (960 ft<sup>2</sup>) RCs were constructed and sited in pairs at an elementary school campus in each of two participant school districts (SD) in Northern California. Each RC was equipped with a standard HVAC system with intermittent 25-50% outdoor air ventilation and an energy-efficient advanced system providing continuous 100% ventilation (15 cfm/occupant). Alternate carpets, wall panels, and ceiling panels were installed in two classrooms—one in each pair—based on the results of a laboratory study of VOC emissions from standard and alternate materials. The two HVAC systems were operated on alternate weeks. School day-integrated air samples were collected indoors and outdoors mid-week during eight and nine weeks in the cooling (fall) and heating (winter) seasons, respectively. VOCs were collected on sorbent media and analyzed by thermal desorption GC/MS. Aldehydes were collected on DNPH treated silica gel cartridges and analyzed by HPLC. At this writing, heating season data collection was ongoing. The effects of material selection on VOC concentrations were evaluated by emissions studies conducted prior to and after the first eight weeks of occupancy and by a comparison of occupied-hour classroom concentrations with the advanced

HVAC operational. Slightly lower phenol and 1-methyl-2-pyrrolidinone concentrations in source-modified RCs were attributed to the alternate wall panel. Slightly lower formaldehyde concentrations in these RCs were attributed to the lower-emitting ceiling panels. At one school, teaching materials brought in after the school year began were discovered to be formaldehyde sources. Concentrations of formaldehyde, acetaldehyde, toluene and/or phenol were lower in two or three RCs during weeks when the advanced HVAC was used. These results suggest improved continuous ventilation provided by the advanced HVAC outweighed source reduction as a VOC control measure in these new RCs.

10850-Personal Exposures to VOCs in a Population of Inner-City Teenagers in New York City :  
A Preliminary Cancer Health Risk Assessment

S Ramstrom<sup>1</sup>, S. Chillrud<sup>3</sup>, P. Kinney<sup>2</sup>, J Spengler<sup>1</sup>

1. Harvard School of Public Health, Boston, MA 2. Columbia School of Public Health, New York, NY. 3. Lamont Doherty Earth Observatory, New York, NY.

**INTRODUCTION:** Little is known about the adverse health impacts of urban air pollutants, in particular the mix of over 100 hazardous air pollutants, as defined by the USA EPA in the 1990 Clean Air Act Amendments. One of the potential health impacts associated with exposures to HAPs is cancer. With the goal of examining potential health risks associated with personal exposures to VOCs, the TEACH project (**T**oxics **E**xposure **A**ssessment- **A** Columbia and **H**arvard Project) recruited high-school students to participate in this study. This analysis presents a preliminary assessment of the cancer health risks associated with exposures VOCs, based on personal air concentrations.

**METHODS:** Approximately 30 high-school students were recruited from a single school in East Harlem in New York City. Most of the students participated in the winter and summer of 1999. The personal sampling of VOCs was done using a modified backpack that contained the sampling pump and battery. Each teenager was sampled for one 48-hour period in each season. Typically 3-5 teenagers were sampled each week for 8 weeks in each season. Dual-sorbent thermal desorption tubes were used for the collection VOCs and C<sub>18</sub> DNPH-coated cartridges were used for the collection of aldehydes. **ANALYSIS:** Personal concentrations were used to assess the individual cancer risks for a total of 13 VOCs using published cancer potencies associated with each VOC. These cancer risks were summed to provide an estimate of overall cancer risk for each subject from exposures to these VOCs. **RESULTS:** The sum of cancer health risks for all 13 VOCs yielded a median cancer risk of  $6 \times 10^{-4}$  (range=  $3 \times 10^{-3}$  -  $4 \times 10^{-5}$ ) in the winter and  $8 \times 10^{-4}$  (range  $4 \times 10^{-3}$  -  $2 \times 10^{-4}$ ) in the summer across all of the study participants. The largest contributions to cancer health risk were found for formaldehyde, 1,4-dichlorobenzene, and chloroform. Summer cancer risks were essentially the same for all compounds except for formaldehyde and ethyl benzene, for which increases were observed in the summer. These risks are within the order of magnitude range of risks found in the literature for urban areas. However, most studies have included polycyclic organic matter and chromium in their estimates, which have both been shown to contribute greatly to the over all cancer risk. **CONCLUSIONS:** The cancer health risks were found to be substantial even without the contribution of other known urban carcinogens. This preliminary assessment of cancer risks associated with VOCs can be used to help prioritize the efforts to reduce exposures of hazardous HAPs and helps to identify individuals who may be at increased risk.

**11014-Factors Associated with Personal Exposure to Aldehydes and Other Pollutants in Sacramento and Milwaukee.** J. H. Raymer<sup>a</sup>, G. Akland<sup>a</sup>, T. R. Johnson<sup>b</sup>, T. Long<sup>b</sup>, L. Michael<sup>a</sup>, L. Cauble<sup>a</sup>, M. Spruill<sup>a</sup>, B. Childs<sup>a</sup>,  
<sup>a</sup>Analytical and Chemical Sciences, RTI International, Research Triangle Park, NC; <sup>b</sup> TRJ Environmental Inc., Chapel Hill, NC.

The Clean Air Act Amendments of 1990 included a section devoted to the reduction of mobile source emissions through fuel reformulation in which the oxygen content of fuel is increased by adding compounds containing oxygen, termed oxygenates. Such compounds include ethers such as methyl tert-butyl ether (MTBE) and alcohols, such as ethanol. The resulting fuel should decrease the ozone forming hydrocarbons and total air toxics but can increase the emissions of aldehydes and thus increase human exposure to these toxic compounds. RTI has been conducting a study to improve the characterization of human exposure to selected aldehydes by means of microenvironmental and personal exposure monitoring in two areas chosen to represent different mobile source emission patterns, one from the use of MTBE (Sacramento, CA) and one from the use of ethanol (Milwaukee, WI).

The study consisted of two types of monitoring efforts in each area: (1) a scripted activity monitoring in which 1-hour and 8-hour personal exposures to 15 aldehydes and VOCs were measured by technicians according to scripts that specified a microenvironmental location and activity for each time period and (2) a personal monitoring effort in which 24-hour personal exposures to eight aldehydes were measured by volunteers as they engaged in typical daily activities. Supplemental data were obtained from indoor and outdoor pollutant monitors at the residences of the volunteers, from ambient pollutant and meteorological monitors at fixed-site locations in each city, from real-time diaries completed by the technicians and volunteers, and from questionnaires completed by the volunteers. A series of stepwise linear regression (SLR) analyses were performed on these data to identify the factors that best predicted exposure to each pollutant. Results for formaldehyde and acetaldehyde are summarized here. Formaldehyde exposures in the scripted studies tended to increase under the following conditions: low visibility; low wind speed or wind from specific directions; visits to residences, autoparts stores, restaurants, fabric stores, nail salons, churches, lumber stores, paint stores, and service stations; driving a car; air conditioning; open windows; solvent use; and forest fires. Acetaldehyde exposures in the scripted studies tended to increase with low visibility; low barometric pressure; low dew point temperature; visits to residences, restaurants, grocery stores, and pubs; driving a car; air conditioning; drinking alcoholic beverages; and proximity to smokers. Formaldehyde exposures in the personal monitoring studies tended to increase with grass/wood fire burning; visits to dry cleaners, churches, and beauty salons; closed windows; air conditioning; working in a pharmacy; use of wood products; and time spent in specific geographic areas. Acetaldehyde exposure in the personal monitoring studies tended to increase with low barometric pressure, time spent in residence, closed windows, smoking, camping, eating, and time spent in specific geographic areas.

*This work was supported by STAR grant number R 826787-01-0 from the United States Environmental Protection Agency.*