

Multi-Day Measurement of Airborne Particle Concentrations in a High-Rise Luxury Condominium Building in Downtown San Jose, California

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Prepared by

**Neil E. Klepeis, Ph.D.
Consulting Assistant Professor
Dept. of Civil and Environmental Engineering
Stanford University, Stanford, CA 94305
and
Director and Founder of ExposureScience.Org**

Preface

This report contains the results of more than 1 week of real-time monitoring of airborne particulate matter concentrations in multiple condominium units of the Axis Building, located at *38 N. Almaden Blvd.*, San Jose, CA 95110 (KT Properties, *developer*; Webcor Builders). Dr. Klepeis was contacted by one of the residents, Yllka Masada, who has previously complained to the building seller (Jeanne Anderson, VP of KT Properties) of health symptoms resulting from the intrusion of secondhand smoke (SHS) into her unit (#520) starting on her move-in date of June 14, 2010. At the time of the measurements, the resident had been given a temporary unit to inhabit (#706) as a result of her complaint. This unit (#706) did not appear to have any secondhand smoke intrusion (i.e., no odor). As a result of Ms. Masada's complaint, Dr. Klepeis was invited by Ms. Masada to set up two sets of monitors in each of her units (#520 and #706), measuring airborne particulate matter every minute and observing the rise and fall of levels over time. Airborne particles are an established indicator pollutant for the presence of secondhand smoke. Monitoring began on November 30, 2010, and is ongoing as of the latest revision of this report.

About Dr. Neil Klepeis

Dr. Klepeis has a Ph.D. in Environmental Health Sciences from the University of California at Berkeley. His past research at Berkeley and Stanford University has been focused on the measurement and modeling of indoor and outdoor air pollution and human exposure – especially secondhand smoke. He is an expert in the area of real-time monitoring of airborne particulate matter and other pollutants with over 17 years of experience. He has authored or co-authored published articles on secondhand smoke exposures occurring in homes, bars, restaurants, the outdoors, and in automobiles. He has recently become involved in research and community outreach regarding exposure to secondhand smoke occurring in multi-unit residential buildings. Dr. Klepeis' research seeks to synthesize elements of the environmental engineering and behavioral health fields -- finding effective ways to educate lay persons, health providers, educators, and policy makers on approaches to reducing or eliminating exposures and health risks.

Health Effects of Secondhand Tobacco Smoke

The health effects due to secondhand smoke (SHS) exposures are well known. These include long-term impacts such as cardiovascular diseases, pulmonary malfunction, lung cancer, and mortality (California EPA 2006; Surgeon General 2006) and serious short-term impacts on sensory, respiratory, and cardiovascular systems (Barnoya and Glantz 2005; Flouris et al. 2010). Junker et al. (2001) have reported odor thresholds for human detection of SHS at mass concentration equivalents of 0.6 to 1.4 $\mu\text{g}/\text{m}^3$ and thresholds for eye, nasal, and throat irritation at an SHS mass equivalent of 4 $\mu\text{g}/\text{m}^3$. Levels of SHS in this range or higher can present at least a clear nuisance to exposed persons and a potential health hazard, especially for susceptible individuals.

Disclaimer

The findings in this report are those of Dr. Neil Klepeis. This report is not a product of Stanford University but is an independent piece of work prepared at the author's sole expense. This report is meant for general informational use and is believed to contain correct and accurate data. However, future revisions and corrections may be made. In addition, Dr. Klepeis does not take responsibility for actions or additional claims of others made as a result of the information and findings presented.

Monitoring Protocol

We followed a simple case-control design -- placing the same types of monitors in the unit (case) where secondhand tobacco smoke (SHS) intrusion was apparently occurring (#520) and in another unit (control) where no intrusion was apparently occurring. If the case unit has significantly higher particle concentrations than the control, this provides evidence that SHS intrusion is occurring. The evidence is strengthened by first-hand accounts of smoke odor and presence of the smoker during or before times of elevated particle levels.

Monitor Types

We used two types of commercially-available airborne particle monitoring instruments to measure minute-by-minute particle levels in the condominium units. The first instrument is the Dylos DC1700 (\$425 per unit) particle counter, which is the top-of-the-line model manufactured by Dylos Products, Inc. in Riverside, CA. The Dylos DC1700 automatically records time-stamped reading of airborne particle counts in the 0.5+ micron size range and in the 2.5+ micron size range. Readings recorded every minute were downloaded from the instrument using the standard Hyperterminal™ software. The second instrument is the TSI AM510 Sidepak™ aerosol photometer (\$3600 per unit). The Sidepak has been previously calibrated by Jiang et al. (2010) to give reading of particle mass concentration for tobacco smoke (custom calibration factor = 0.29). We fit the Sidepak with a 2.5 micron size-selective impactor so that the instrument measured PM_{2.5} concentrations (fine particles under 2.5 microns in diameter). The Sidepak was set to record mass concentration every minute in its internal data logger.

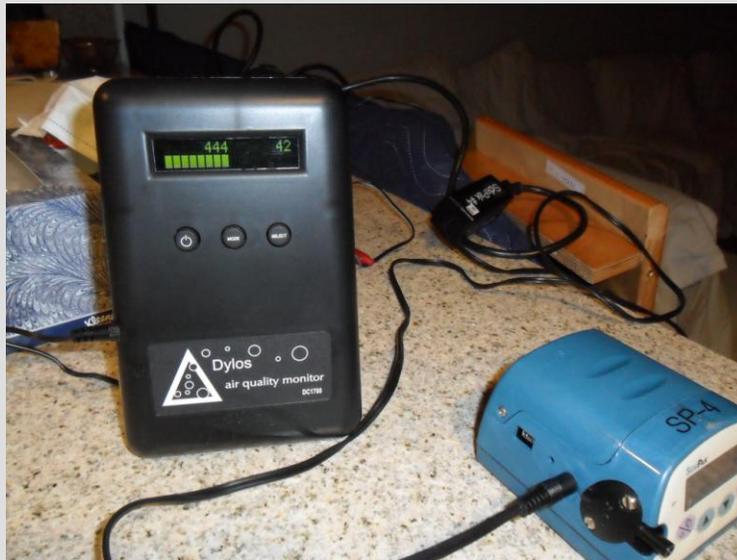


Figure 1. Dylos particle counter shown on the left (with display giving 0.5+ micron and 2.5+ micron counts) and Sidepak laser photometer shown on the right – located in unit #706.

Placement of Monitors

We placed a Dylos monitor in both the resident's unit (#520) and the temporary unit (#706) starting November 30, 2010. The temporary unit (#706) served as the control unit with no reported odor of secondhand smoke. In unit #520, secondhand smoke odors were apparent, especially in the bedroom sharing a wall with a neighbor. Starting December 7, 2010, we placed a Sidepak monitor in each unit alongside each of the Dylos.

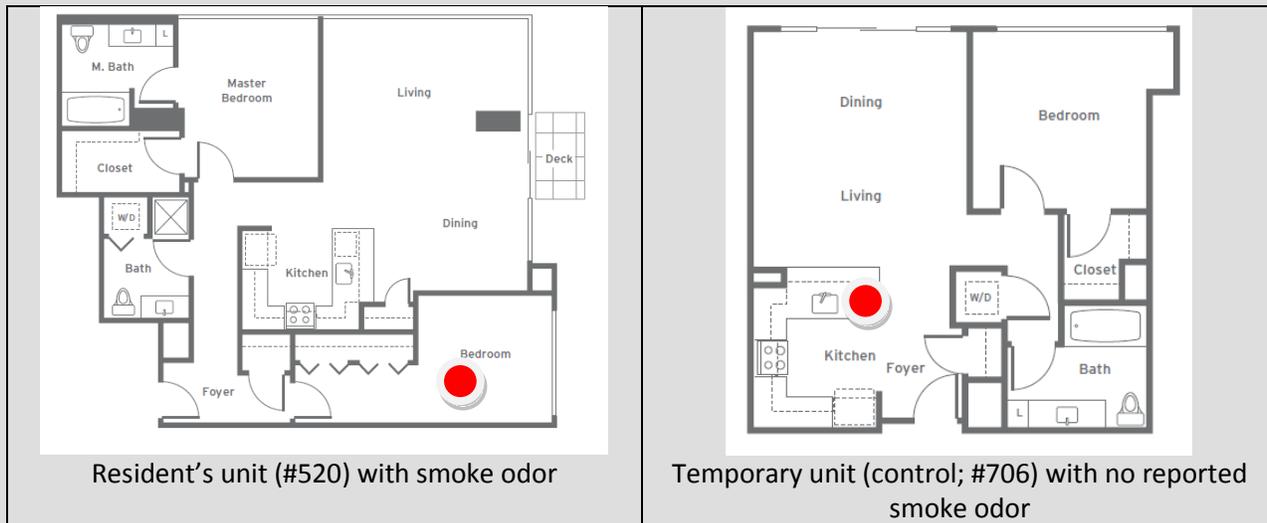


Figure 2. Layout of the two monitored units with a large red circle showing the position of the monitoring instruments (Dylos and Sidepak).

Smoking Activity in Neighbor's Unit

The resident of unit #520 reported strong odors in that unit sometimes observing visible streams coming from ceiling light fixtures. The next-door neighbor would apparently come home and smoke from work at approximately 7pm, a time when the strongest secondhand smoke odors were reported by the resident of #520. The resident of #520 was able to observe roughly when her neighbor was home by observing whether or not her neighbor's parking space was occupied. The resident of #520 has also spoken with her neighbor, who has admitted to smoking in her unit. On weekdays, the neighbor would return around 6pm to 8pm and on weekends the neighbor would tend to be around during midday.

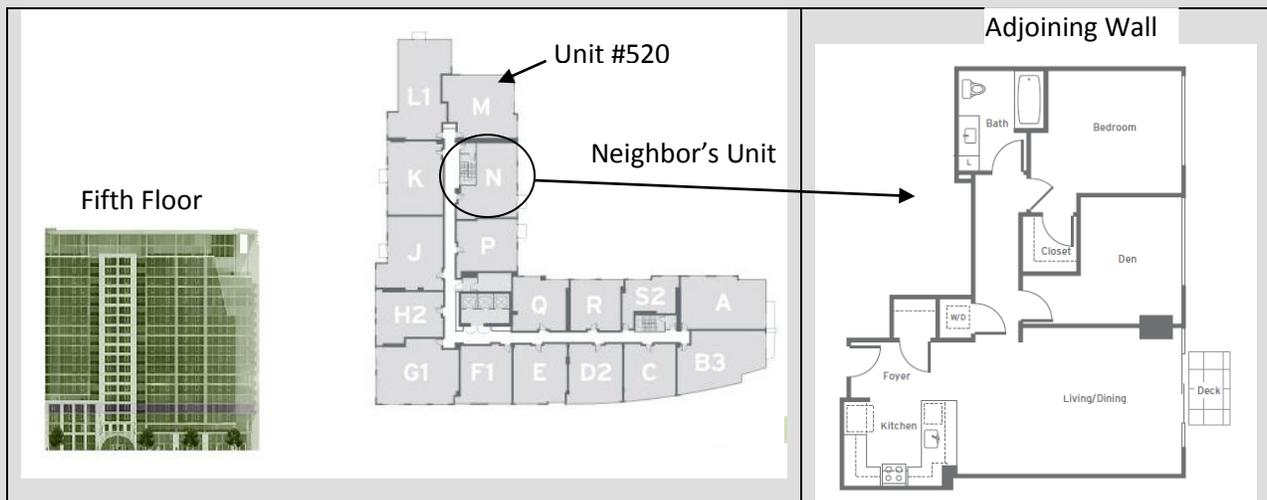


Figure 3. Floorplan (level 5) showing the resident's unit #520 where tobacco smoke odors were observed and the adjoining neighbor's unit (smoker). The two units share a wall between the bedroom in unit #520 and the bedroom in the adjoining neighbor's unit.

Results of Monitoring

The results of monitoring show clear evidence of elevated particle levels in the resident's unit (#520) in the evenings during weekdays (6- 8 pm), and during midday on weekends. The peak levels in #520 were up to 5 times or more higher than levels in the control unit (#706). On every day of monitoring, the adjoining neighbor (smoker) was observed to be home starting at roughly 6pm to 8pm on weekdays and during the day on weekends. These times correspond closely with the observed elevations in particle levels on each day of monitoring. Dr. Klepeis personally observed strong odors of secondhand smoke in unit #520 during one episode during monitoring when the neighbor was at home and presumably actively smoking a cigarette. The episodes of elevated concentrations could last 12 hours or more.

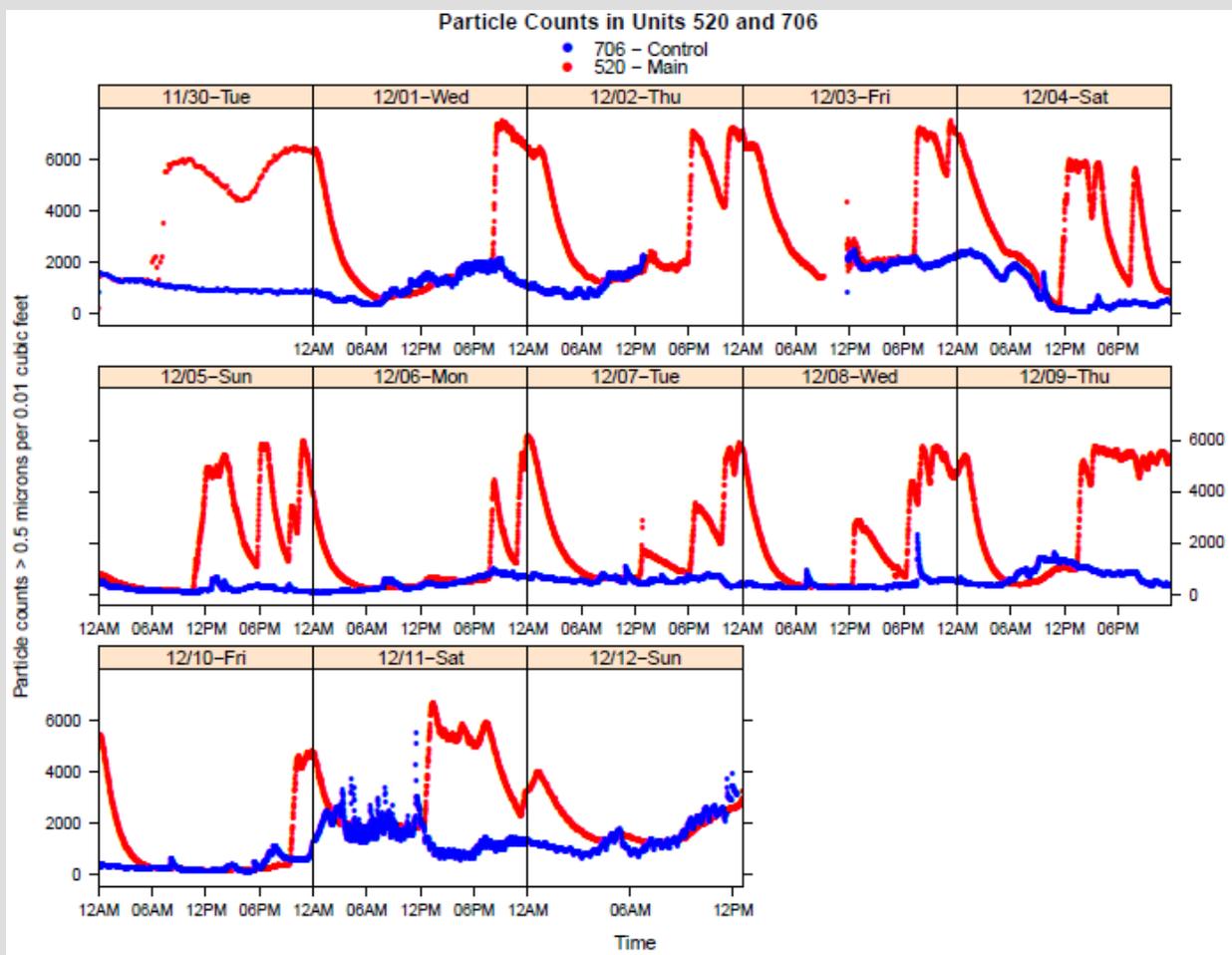


Figure 4. Particle levels from the Dylos (counts 0.5+ microns) measured over 13 days in unit #520, where smoke odors were reported by the tenant and also observed by Dr. Klepeis, and the control unit #720 where no smoke odors were reported or observed by Dr. Klepeis. Every day of monitoring shows significantly elevated particle levels in #520 relative to the control at times when the adjoining neighbor was home based on the presence of an automobile in that unit's parking space. Peak concentrations could be 5 or more times higher than in the control and elevated levels could last for 12 or more hours at a time.

The peak levels measured by the Sidepak monitor reached mass concentrations as high as 40 to 50 micrograms per meter cubed ($\mu\text{g}/\text{m}^3$). These levels are comparable to those observed in a smoky casino by Dr. Klepeis and his colleagues (see Jiang et al. 2010). These levels are 30+ times higher than Junker et al.'s SHS odor threshold and 10+ times higher than Junker et al.'s SHS irritation thresholds.

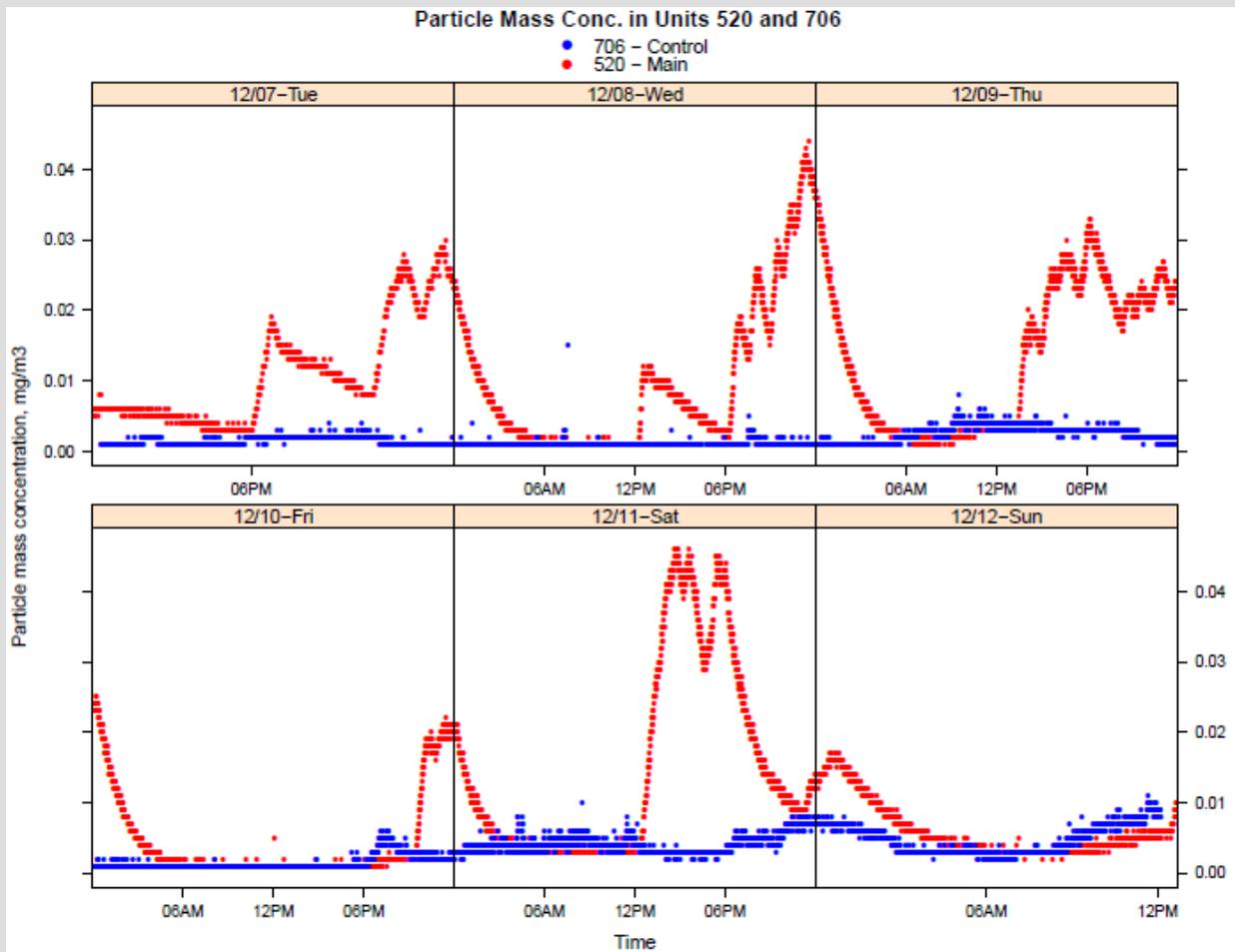


Figure 5. Particle mass concentrations measured by the Sidepak over 6 days in unit #520 and the control unit #720. Peak concentrations could be as high as 40 to 50 micrograms per meter cubed ($\mu\text{g}/\text{m}^3$).

Summary and Conclusions

1. The monitoring results show clear contamination of unit #520 with fine particle pollution relative to the control unit #706.
2. Two types of monitoring instruments were used, giving nearly identical results.
3. The particles levels in unit #520 were up to 5 times or more higher than levels in a control unit #706.
4. There is strong evidence showing that the elevated particle levels in unit #520 are due to smoking activity in the adjoining unit:
 - There are first-hand accounts of a strong tobacco smoke odor in unit #520 by the resident, Dr. Klepeis and others.
 - The adjoining neighbor is an admitted smoker.
 - The car parking space for the adjoining neighbor's unit (parking garage) was occupied during times of observed elevation in particle levels.

5. The mass concentration levels could be as high as 40 to 50 micrograms per meter cubed, comparable to levels in a smoky casino.
6. The observed particle mass concentrations in unit #520, attributed to secondhand smoke, are many times higher than reported SHS odor and irritation thresholds (Junker et al.).
7. Persons inhabiting unit #520 could receive significantly elevated exposures to fine particulate matter over many hours.
8. The particle levels observed in unit #520 present a clear nuisance for anyone inhabiting that unit and also present a likely health hazard due to the peak levels reached and the prolonged time period over which levels remain elevated.

References

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