APPENDIX I

HEALTH AND SAFETY CODE § 39930

The legislative mandate for the report to the legislature on Indoor Air Quality is contained in the Health & Safety Code amendment contained in Section 2 of Assembly Bill 1173 (Keeley, 2002):

39930. (a) The State board shall, not later than January 1, 2004, in consultation with the State Department of health Services, the Office of Environmental Health Hazard Assessment, the State Energy Resources Conservation and Development Commission, any other state agency the state board determines is appropriate, affected indoor emissions sources, and interested members of the public, provide a report to the Legislature summarizing all of the following:

(1) The best scientific information available including, but not limited to, the most recent empirical data, on indoor air pollution including, but not limited to, air contaminants that have been identified as toxic air contaminants pursuant to Sections 39655, 39657, or 39660, or air contaminants for which the state board has adopted ambient air quality standards.

(2) The potential adverse effects of indoor air pollution exposure on public health in the state, including, but not limited to, vulnerable populations, including, but not limited to, elderly persons, infants, and children, based upon the information described in paragraph (1).

(3) Readily available information about the effects of existing regulations and current industry practices in mitigating those exposures.

(4) A listing that references work performed by other state or federal entities regarding biological and radiological substances, including a summary of activities conducted by the State Department of health Services pursuant to Chapter 18 (commencing with Section 26100) of Division 20.

(b) The report described in subdivision (a) shall include all of the following:

(1) A list of indoor air pollutants that are described in the summaries provided pursuant to paragraphs (1) and (4) of subdivision (a).

(2) A list of indoor air pollutants, as defined in Section 39013, ranked in groups designated as high, medium, and lower priorities, that the state board has determined, based upon empirical data or other scientific information, are likely to have the most significant adverse impacts on human health through exposures in schools, non-industrial workplaces, homes, and other indoor locations, and the probable source categories for these pollutants.

(3) An analysis of the indoor emissions, indoor exposures, and potential health effects from the indoor source categories described in paragraph (1), and options for mitigating those health effects in schools, non-industrial workplaces, homes, and other indoor locations, including, but not limited to, a discussion of the feasibility and public health effects of implementing each option.

(4) A description of options for schools and school districts to improve indoor air quality in public schools. The state board shall develop these options in consultation with representatives from school district facility departments, school district maintenance departments, and statewide educational organizations.

(c) (1) The state board shall enter into an agreement with the National Academy of Sciences, the University of California, the California State University, or a similar institution of higher learning that has scientific expertise, any combination of those entities, or with a scientist or group of scientists of comparable stature and qualifications that is recommended by the president of the University of California, to conduct an external scientific peer review of the scientific basis for the report described in subdivision (a).

(2) The state board may not submit the report to the Legislature until all of the following conditions are met:

(A) The draft report is submitted to the external scientific peer review entity described in paragraph (1) for evaluation.

(B) The external scientific peer review entity, within the timeframe agreed upon by the board and the external scientific peer review entity, prepares written comments that contain an evaluation of the scientific basis for the draft report. If the state board disagrees with any aspect of the findings of the external scientific peer review entity, the state board shall include as part of the final report, an explanation of its basis for arriving at the determination, including, but not limited to, the reasons that the state board determined that the report was based on sound scientific knowledge, methods, and practices.

(d) The state board shall present and review the content of the report described in subdivision (a) at a public meeting prior to providing the report to the Legislature.

APPENDIX II
Explanation Of Indoor Cancer Risk Estimates

February, 2005

Summary: The toxic air contaminant (TAC)-related cancer risk estimates presented in this report are based on results of the *California Comparative Risk Project (CCRP), Final Report*, May 1994, for indoor indicator pollutants–excluding radon, environmental tobacco smoke (ETS), and asbestos–with adjustments (downward) based on changes in current exposure levels of formaldehyde relative to those from studies used in the CCRP assessment. This information is the best information available for California, and the indoor air concentrations on which these estimates are based are supported by more recent studies from other states. Background information on the estimates developed in the CCRP is discussed below, followed by a detailed discussion of how the cancer risk estimates for this report (AB1173) were developed.

BACKGROUND: the California Comparative Risk Project (report available at http://www.oehha.ca.gov/multimedia/comprisk.html**.**

- **The CCRP estimated about 268 excess annual cancer cases from indoor residential and consumer product sources** for the 10 indicator chemicals included in the estimate. The majority of that risk was from formaldehyde and p-dichlorobenzene. The excess annual cancer cases were taken from the table "Residential and Consumer Product Sources: II. Human Health Risk Assessment Results for Indicator Chemicals" from the CCRP. The 10 chemicals are:

formaldehyde	*p*-dichlorobenzene
benzene	benzo(*a*)pyrene
1,3-butadiene	chloroform
di-2-ethylhexylphthalate (DEHP)	styrene
tetrachloroethylene (perchloroethylene)	trichloroethylene

- **The risk is that which was attributable only to the emissions from the indoor sources.** In the CCRP Project, the outdoor contribution to the indoor concentrations was subtracted from the indoor levels, with the remainder attributable to indoor sources.

- **The cancer risks estimated are ANNUAL excess cancer cases.** This is somewhat different from the expression we typically use for outdoor air, expressed as cancer risk from 70 years of exposure per million people exposed, but the two can be roughly converted for comparison (see below).

- **The risk from residential and consumer products was ranked in the High Risk category with a high level of confidence** based on the extensive contribution to both cancer and non-cancer risks, the widespread exposure throughout the population, and the consistency of monitoring results across many studies.

- Like other source and media categories in the CCRP, the estimates developed for the Indoor (residential and consumer product) category do not include risk posed by other known carcinogens that occur indoors from indoor sources. **Thus, the cancer risk**

estimated for the 10 indicator chemicals is likely to be an underestimate of the actual cancer risk from indoor sources other than ETS, radon, and asbestos.

- **Notes regarding the CCRP estimates:**

  1. They are based on exposure distributions developed from the best available studies at the time, with greater weight given to California studies. Generally, 3-4 California studies of large numbers of homes in both northern and southern California (totaling about 600-800 homes) were available; these covered a range of seasons, income levels, etc. and were randomly selected using census tract information. For some pollutants, measurements from public buildings, offices, etc. in other studies were also available.

  2. Indoor concentrations tend to be log-normally distributed, meaning a small but decreasing portion of the population experiences particularly high exposures well above the mean. In the CCRP, indoor concentration distributions for a few pollutants appeared to be potentially bi-modal (having a group in the population with especially high indoor concentrations because their house contains large sources of a given pollutant, such as mothballs/*p*-dichlorobenzene…e.g., either the household uses mothballs, or they do not, and if they do, their levels are quite high and that group in the population has distinctly greater indoor concentrations than others). Because of this, concentration distributions (rather than means) were used to develop exposure estimates to achieve more accurate risk estimates.

  3. Although distributions were used to estimate risk, the resulting average individual risk was used to estimate annual cancer cases, and thus these may be conservative estimates, since the average does not necessarily fully capture those at very high risk. Additionally, only the population with an exposure level above the one in ten thousand risk level was included in the risk estimation; thus, those with lower cancer risks were not counted, effectively reducing the total count relative to the population estimate that would be derived if those with lower cancer risks had also been included.

CURRENT ESTIMATE for AB 1173 report:

- We reviewed the estimates for the 10 chemicals and performed a quick literature search to identify more recent data that might indicate that an adjustment is needed to better reflect current indoor exposure levels.

- Formaldehyde is the only one of the 10 indicator chemicals for which there are sufficient new data to develop a more current exposure distribution. Recent emissions studies (e.g., Kelly *et al*., 1999; Hodgson *et al*., 2000; Hodgson *et al*., 2002; Hodgson, 1999) show that indoor formaldehyde emissions from many materials and products have decreased by an average of 49% since the earlier Pickrell emissions study (1983). These and other studies indicate that indoor exposure concentrations have decreased by about 50% since the early to mid-1980s, when the majority of the studies used in the CCRP project were conducted. This was not surprising, since several industry initiatives and some known product changes had occurred since the mid-80s. **Thus, for our new estimate, we assumed that the current formaldehyde risk would be about half of that estimated in the CCRP Project, or about 62 excess cancer cases per year.**

- Recent studies show that levels of some of the other indicator indoor pollutants attributable to indoor sources, such as chloroform and styrene, may have increased in recent years, but there are no new indoor California studies in the last decade that would document this, and information obtained regarding changes in the known sources is mixed. For others, such as benzene, there is reason to believe that indoor levels from indoor sources have decreased somewhat since the earlier studies, due to product composition changes and reduced indoor smoking, but there are no readily available data to support a revised calculation.

  In the CCRP, DEHP was included in the list of chemicals used to develop the cancer estimates. However, IARC recently concluded that DEHP is not a human carcinogen, and downgraded its classification to Group 3 (not classified as a human carcinogen, due to inadequate evidence for human carcinogenicity). In the CCRP, DEHP accounted for one cancer case, so the total cancers estimated from CCRP was decreased by one for the current estimate. Thus, the current total risk posed by the indicators other than formaldehyde and DEHP remains a reasonable estimate of cancer risk.

- **Our current estimate is thus calculated as follows:**
  268 minus 63 (1/2 the previous formaldehyde estimate, and minus one for DEHP) = 205 excess cancer cases per year, times 34/30 (or 1.13) to adjust the original CCRP estimates to the year 2000 California population of 34 million, for a total of 232 excess cancer cases per year due to emissions from indoor sources of the chemicals. This rounds to 230. However, 230 is likely an underestimate due to: a) the conservative nature of the original estimate; b) the fact that there are other indoor carcinogens that are known but not included in the estimate (see bullet below); and c) the uncertainty of the risk estimation process, which is best addressed by using a range where possible. **Thus, at least 230 excess cancers per year are estimated.**

- **There are a number of additional carcinogens known to be emitted from indoor sources that were not included in the indicator** chemicals list for the CCRP Project due to a lack of sufficient indoor data to estimate an exposure level. For example, other PAHs, acetaldehyde and other aldehydes, and asbestos are carcinogenic and have been measured indoors and as emissions from products. Persistent chemicals such as PCBs have been found in house dust, and various toxic metals have been measured at higher levels in both indoor air and house dust. However, the data are not sufficient to estimate population exposure. Others like acrolein are just beginning to be studied in the indoor air. **Thus, the adjusted estimate above is assuredly an underestimate of the actual cancer risk posed by toxic chemicals emitted or produced by indoor sources.**

Comparison to Outdoor Risk Levels (Fig. 2.1 in the report).

- Using the excess cancer cases per million per 70 years in Table 7 of ARB's October 2000 diesel risk reduction plan and the year 2000 California population of 34 million, **current estimated ANNUAL excess cancer cases from diesel exhaust particles total 262** (540/million X 34 / 70), or about 260 excess cancers per year. This figure does not account for recently implemented or planned regulations, but those changes would have little impact on the 70 year lifetime exposures of most adults in the population, and thus this estimate remains reasonable.

- Using the same table, **the non-diesel risk from other outdoor sources is calculated to total 106** excess cancers (218/million X 34 / 70= 106), or about 110 excess cancers per year.

- The total excess cancer cases per year from different sources of air pollutants are thus estimated to be:

Residential and Consumer Product Sources:	**230 /year**
Diesel exhaust PM10:	**260 /year**
Other outdoor sources:	**110 /year**

  Figure 2.1 in the AB 1173 report reflect these numbers.

  Note: OEHHA has indicated previously that conversion of the outdoor risk estimates to annual cancer cases to allow comparison of the CCRP indoor annual excess cancer estimates is acceptable for this type of general comparison.

RADON, ETS, AND ASBESTOS

Radon and ETS: the exposure and risk estimates have been updated and are included in the text.

Asbestos has not been widely measured in California indoor environments, and there are many measurement difficulties for this set of fibers. There are insufficient data on which to base an indoor asbestos risk estimate (from indoor sources) at this time, just as there was at the time of the CCRP project.

APPENDIX III
Background for Estimates on Indoor Formaldehyde Concentrations

February, 2005

Figure 2.4 is intended to give a general indication of current estimates of indoor formaldehyde levels in several California environments, and to illustrate relative levels among those environments. Data on formaldehyde levels in homes, schools, and offices were obtained from several information sources. A description of the sources used for each category follows. Please note that these estimates were derived only for the illustration provided in Figure 2.4: they were not used for the cancer risk estimates discussed in this report. As discussed in Appendix II, the cancer risk estimates for formaldehyde were based on the estimates from the 1994 California Comparative Risk Project and reduced based on a more recent emissions study.

Manufactured homes
Estimated Average: 37 ppb, Maximum: 227 ppb

Formaldehyde levels in manufactured homes are based on measurements made in California manufactured homes during the early 1980s, reduced by a factor representative of the reduction in formaldehyde emissions in new composite wood products since that time. The resultant value is consistent with recent limited measurements in manufactured homes.

The California Department of Health Services measured formaldehyde levels in approximately 600 mobile homes in 1984 and 1985. Investigators obtained integrated one-week measurements for approximately 600 mobile homes. The geometric mean formaldehyde concentration measured in the summer was 72 ppb (arithmetic mean 91 ppb), and 78 ppb (arithmetic mean 91 ppb) in the winter (Sexton *et al.*, 1985). The maximum value was 464 ppb measured in the summer.

Formaldehyde emissions from new composite wood products are lower today than they were in the early 1980's due to changes in manufacturing procedures. A comparison of emission rates from Pickrell (1983) and Kelly (1999) indicate formaldehyde emission rates from these products have decreased an average of about 49% over the last 20 years. Comparison of data from the two investigators indicate particleboard emissions are 92% of what they were in 1983, interior plywood emissions are 15% of 1983 values, and paneling emissions are 39% of 1983 emissions. An unweighted average of these reductions in emissions yields a gross average estimate that emissions today are 49% of what they were in 1983.

The estimate of an average formaldehyde concentration of 37 ppb in manufactured homes is based on the average of the winter and summer geometric means determined by Sexton, then reduced by 49% to reflect changes in manufacturing practices. The maximum value measured by Sexton (464 ppb) was also reduced by 49% to reflect manufacturing changes.

Hodgson *et al*. (2002) measured formaldehyde levels inside four new manufactured homes in humid climates of the southeastern U.S. The homes were furnished but not occupied (sales models) and had a geometric mean formaldehyde concentration of 34 ppb. Over extended time periods, this level would be reduced as the emissions from building materials decline. However, human activities tend to elevate formaldehyde concentrations due to use of combustion appliances and products that emit formaldehyde, which would offset the decline from building materials. Thus, the level measured by Hodgson is consistent with the concentration estimated above.

Sexton K, Liu K, and Petreas M. (1986), Formaldehyde Concentrations Inside Private Residences: A Mail-Out Approach to Indoor Air Monitoring, *JAPCA* **36**: 698-704.

Pickrell J, Mokler B, Griffis L, Hobbs C, and Bathija A. (1983), Formaldehyde Release Rate Coefficients from Selected Consumer Products, *Environmental Science and Technology* **17(12)**: 753-757.

Kelly T, Smith DL, and Satola J. (1999). Emission Rates of Formaldehyde from Materials and Consumer Products Found in California Homes, *Environmental Science and Technology* **33(1):** 81-88.

Hodgson AT, Rudd AF, Beal D, and Chandra S. (2000) Volatile organic compound concentrations and emission rates in new manufactured and site-built houses, *Indoor Air* **10:** 178-192.

Classrooms (Inside)
Estimated Average: 18 ppb, Maximum: 110 ppb

The California Portable Classrooms Study (PCS) data from 2001 and 2002 were used to estimate school-year average and maximum concentrations of formaldehyde in California's K-12 classrooms. This is a large, representative statewide data set of formaldehyde measurements obtained across four seasons using both active and passive sampling methods.

School-Year Average Concentration

Because indoor formaldehyde levels increase with increased temperature and humidity, we combined PCS formaldehyde data from Phase I (warmer seasons) and Phase II (cooler seasons) to estimate school-year average concentrations. We excluded most of July and all of August in estimating the school-year average, although 22 % of California's K-12 students attend year-round schools or summer school (CDE, 2002). Therefore, our estimate of school-year average concentration for formaldehyde is likely a conservative estimate for the state.

We used field study data from the PCS Phase II to estimate classroom formaldehyde levels in the 6 months of cooler weather, October – March. In Phase II, formaldehyde was measured using the DNPH method with active sampling over 6-8 classroom hours from October 2001 to early March 2002. The mean concentration for this period was 13 ppb, and the geometric mean was 12 ppb. Monthly breakdowns of Phase II formaldehyde concentrations were not readily available, but they would be limited to only two time periods because of the limited sample size (201 classrooms) in Phase II. Phase II data provide reasonably accurate estimates of classroom concentrations of formaldehyde for the fall and winter seasons when monitoring occurred.

Mail survey data from the PCS Phase I were used to estimate classroom formaldehyde levels in the 6 months of warmer weather (April through September). In Phase I, formaldehyde was measured using a passive monitor deployed for 7-10 days, including nights and weekends, in April to early July 2001. The mean concentration for this period was 27 ppb (geometric mean of 22 ppb).

As expected, both the means and 95th percentile concentrations were notably higher in Phase I compared to Phase II (ARB-DHS, 2003). The higher indoor levels in Phase I were expected because the Phase I sampling was conducted during warmer weather when indoor formaldehyde levels are usually higher, and because the sample size was substantially larger, increasing the probability of including classrooms with more extreme levels in the sample. Phase I also included nights and one or two weekends in the sampling period, during which the classrooms were probably not ventilated, which could result in higher formaldehyde levels. Also, in Phase II sampling, technicians operated the ventilation system to make flow measurements, which might have reduced formaldehyde levels relative to what they might have been under normal operation conditions.

Phase I measurements confirm that there was a positive bias associated with the weekend sampling included in the 7 to 10 day measurement. The weekend bias was determined by comparing data from classrooms with >25% of the sample days on weekends (2 weekends) vs. those with < 25% weekend days (1 weekend). The first group had mean formaldehyde levels of 30 ppb vs. 25 ppb in the second group, or a difference of 5 ppb due to an additional weekend of sampling in these seasons. These results are from analyses using weighted data.

To estimate the overall effect of the weekend bias on the Phase I mean, we calculated a weighted average of the weekend bias. About half of the sample (52%) included one weekend, and about half of the sample (48%) included two weekends. The weighted average was calculated as follows:

(0.52 of sample x 1 x weekend bias) + (0.48 of sample x 2 x weekend bias)
= 1.48 x weekend bias = 1.48 x 5 ppb = 7 ppb positive bias on Phase I mean

Therefore, the positive bias in the Phase I mean for estimating the mean schoolday (weekday) concentrations was estimated to be 7 ppb. Additional positive bias may have occurred due to sampling overnight, but data are not available to quantify the magnitude of this bias. However, the magnitude of the overnight bias is expected to be much less than that for the weekend bias because the nighttime period is usually much cooler, which would result in reduced formaldehyde concentrations relative to weekend concentrations.

The Phase I data were also adjusted for the lack of data for September. To estimate formaldehyde levels during the warmer season (April – September), the Phase I data were extrapolated to estimate what concentrations would likely be in September, and the 4 month average was then calculated. The monthly means for April, May, and June-early July were 18, 29, and 36 ppb, respectively. July and August were considered to be mostly a vacation period for schools. The monthly mean for September was assumed to be the same as that for June – early July. The average for April, May, June, and September was calculated, and the weekend bias then subtracted, as follows:

(18 ppb + 29 ppb + 36 ppb + 36 ppb) / 4 - (7 ppb for weekend bias in means)
= 30 ppb – 7 ppb weekend bias
= 23 ppb for warmer season, excluding summer vacation

To estimate the school-year average concentrations of classroom formaldehyde in California, we then averaged the estimated concentrations for the warmer seasons and the measured concentration for the cooler season:

(23 ppb in warmer season + 13 ppb in cooler season) / 2
= 18 ppb school-year average estimate

In conclusion, the school-year average concentration of formaldehyde in California K-12 classrooms was estimated to be 18 ppb, after adjustment for weekend bias and the lack of September data. This value is slightly lower than the unadjusted average of the Phase I and Phase II data (20 ppb).

School-Year Maximum Concentration

To estimate school-year maximum concentrations of formaldehyde in California's K-12 classrooms, data from PCS Phase I, PCS Phase II, and case studies in California were considered. The maximum formaldehyde level measured among 199 classrooms in PCS Phase II was 71 ppb (Whitmore, 2003). Because these measurements were made in the fall and winter, and because extreme values are not easily measured with such a small sample size, this value assuredly underestimates the maximum formaldehyde concentration.

In the Phase I mail survey during the spring and early summer, the maximum formaldehyde level measured among 911 classrooms was 138 ppb (Whitmore *et al*., 2003). However, this value overestimates the maximum because the passive sampler measurement for 7-10 days includes weekends and nights. The highest percentile values reported with statistical confidence were the 95th percentile values for portable classrooms, so these values were used to estimate the weekend bias. The portables subsample with 2 weekends had a 95th percentile of 78 ppb, vs. 62 ppb for the portables subsample with one weekend, a difference of 16 ppb. Using the same approach used above to adjust the average concentrations for weekend bias, a weighted average of 24 ppb is estimated for the weekend bias in the 95th percentile (1.48 x 16 ppb). Subtracting this bias from the maximum value of 138 ppb yields an estimated maximum of 114 ppb. This value may be an overestimate of the maximum concentration because the bias due to overnight sampling is not included. Rounding down, the statewide maximum is estimated to be about 110 ppb.

Although higher than the 71 ppb maximum obtained in the Phase II field study, this value is supported by data from case studies of California schools, which include a maximum of 98 ppb for 6-8 hours. These studies employed active sampling using the DNPH method measurements in 90 classrooms in August, September, or October of 1999 and 2000. Selected classrooms in five school districts, including the Saugus and Beverly Hills districts, were examined.

Because each of these data sets represents a small sample size relative to the total population of classrooms in California, one would not expect the classrooms with the very highest formaldehyde levels to be included in the sample. Samples tend to reflect the mean but not the extreme values existent in the actual population being studied. Thus, the statewide maximum is estimated to be at least 110 ppb, and probably higher.

For more information on the Portable Classroom study, please see:
ARB and DHS, (November 2003) Environmental Health Conditions in California's Portable Classrooms, Report to the California Legislature.
http://www.arb.ca.gov/research/indoor/pcs/leg_rpt/pcs_r2l.pdf, p. 53 et seq.

California Department of Education (CDE). Year-Round Education, 2002-03 Statistics. Based on 2002 CBEDS. Sacramento, CA. http://www.cde.ca.gov/facilities/yearround/yrstat02.htm.

Whitmore R, Clayton A, Phillips M, and Akland G. (2003). California Portable Classrooms Study: Phase I-Mailed Survey and Phase II-Main Study, Final report to ARB for Contract no, 00-317.

Whitmore, R, 2003. Personal communication, February 24. Research Triangle Institute, Research Triangle Park, NC.

Conventional Homes

Estimated Average: 14 ppb**,** Maximum: 232 ppb.

Formaldehyde levels measured in the National Human Exposure Assessment Survey (NHEXAS) in Arizona and a southern California study were used to estimate current concentrations in Californian homes. The NHEXAS study was conducted from October 1993 through September 1998. Investigators used a probability-based sampling scheme to obtain results that are representative of the entire state of Arizona. Sampling was conducted over different seasons and included 189 homes. Passive sampling tubes with a sodium bisulfite-impregnated disk were used to collect formaldehyde for a 6 - 7 day period. Construction practices, climate, and ventilation practices are assumed to be reasonably similar in California and Arizona. Results from the NHEXAS study indicate the average formaldehyde level for all homes was 17 ppb. The maximum formaldehyde concentration was 331 ppb. Although unusually high, this value is considered a valid result by the authors. They report it is within a factor of 2 of maximum levels measured by other investigators.

Data are also available from a study sponsored by ARB, in which investigators measured formaldehyde levels in approximately 70 homes in limited areas of southern California (Avol et al, 1996). Investigators used the 2,4-dinitrophenylhydrazine method with active monitors. The results are lower than expected for a sample representative of the entire California population of homes for two reasons: sampling was conducted during the summer only with doors and windows open much of the time, and most of the homes were notably older homes, and not new homes. The mean concentration in this study was 9.1 ppb, and the maximum was 31.3 ppb.

Results from both of the above studies were used to estimate indoor concentrations in conventional California homes. The NHEXAS study has great credibility since it used a probability-based sampling scheme for a statewide study conducted in a neighboring state. The southern California study represents the portion of Californians who live in a mild southern California climate in homes that are not new, during under one set of conditions. Results from the two studies are weighted approximately by sample size of the two studies to obtain a current estimate for conventional California homes. The NHEXAS mean and maximum were weighted by a factor of .67, while the California data were weighted by a factor of .33.

Average: 0.67 (17) ppb + 0.33 (9) = 11 + 3 = 14 ppb.
Maximum: 0.67 (331) + 0.33 (31) = 222 + 10 = 232.

Avol, E. (1996), “Residential Microenvironmental and Personal Sampling Project for Exposure Classification", final report to ARB, Contract no. 92-317.

Gordon SM, Callahan PJ, Nishioka MG, Brinkman MC, O’Rourke MK, Lebowitz, MD, Moschandreas DJ. (1999). Residential environmental measurements in the National Human Exposure Assessment Survey (NHEXAS) pilot study in Arizona: preliminary results for pesticides and VOCs, *Journal of Exposure Analysis and Environmental Epidemiology* **9**, 456-470.

Office Buildings
Estimated Average: 13 ppb, Maximum: 26 ppb

The U.S. EPA Building Assessment Survey and Evaluation (BASE) Study examined pollutant levels inside 100 non-problematic office buildings in the U.S. Formaldehyde data from this study has not yet been fully analyzed or published. However, preliminary formaldehyde data were presented in an addendum to a U.S. EPA draft report; "Ranking Risks from Air Toxics Indoors" prepared for Pauline Johnston, U.S. EPA, Indoor Environments Division. Preliminary data available in the addendum were used to estimate formaldehyde levels in office buildings. When analyses of the BASE study data are completed, the final results will be used to represent California office buildings. The value of 26 ppb is likely lower than the maximum.

Source: U.S. EPA Building Assessment Survey and Evaluation (BASE) Study. More information on the U.S. EPA BASE Study can be found at http://www.epa.gov/iaq/largebldgs/index.html.

Outdoor levels
Estimated Average: 3 ppb, Maximum: 15 ppb

Outdoor formaldehyde concentrations are from the air toxics sampling network that was designed to produce a statewide annual average for individual toxic air contaminants. Data from the most recent five years (1998 - 2002) for which data are available were averaged to negate any effects due to global weather influences. Data from the Toxics Network is available at http://www.arb.ca.gov/aqd/toxics/statesubstance.html.