

# Formaldehyde Estimates from Laminate Flooring

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DRAFT WORK PRODUCT

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## Decay Model

Use the bi-exponential decay model fitted to Phase I and Phase II data presented in Sheehan et al. (2018) to estimate formaldehyde ERs and concentrations at the period of interest, i.e., at the time of removal or present time. The decay model has the form:

$$ER_T = ER_0 * [A \times \exp(-B \times t) + (1 - A) \times \exp(-C \times t)]$$

where A, B and C are fitted parameters.  $ER_0 = 61.3 \mu g/m^3$  is the mean of emission rates calculated from all new boards (Phase I) and  $t$  is the duration of installation in days.

## Residence-specific parameters

The following requisite parameters have been estimated for each Plaintiff

### Air-exchange rate (AER)

Provided by Ken Bogen from his analysis of Persily et al. contingent upon age of home, type of home and geographic region. AER for the newest Plaintiff, P1, has not been provided. *I have used 0.6/hour here.*

### Fraction of Flooring

Fraction of flooring ( $F_{floor}$ ) estimated from case documents, e.g., Plaintiff Fact Sheets, expert reports, depositions.  $F_{floor}$  for the newest Plaintiff (P1) estimated to be 0.5.

### Duration of installation

Laminate flooring may have been installed for any duration of time depending on the home. Duration of installation ( $T_{inst}$ ) for the Plaintiffs in this case have been estimated from case documents, e.g., Plaintiff Fact Sheets, expert reports, depositions.

For Plaintiff, P1, board has been installed since July 2011. At the time of this writing (June 23, 2020), it is approximately nine years. Therefore,  $T_{inst}$  estimated to be 9 years or 3,285 days.

### Height of ceiling

Height of ceiling is a constant estimated from average height of the ceiling in the U.S., i.e., 2.59 m

Plaintiff	AER	Ffloor	Tinst	H	ER0
Thomas	0.595	0.6400000	2557	2.59	61.3

Plaintiff	AER	Ffloor	Tinst	H	ER0
Choe	0.316	0.6300000	1278	2.59	61.3
Stein	0.287	0.7100000	3190	2.59	61.3
Jensen	0.287	0.5279489	1278	2.59	61.3
Craig	0.683	0.0842105	548	2.59	61.3
P1	0.600	0.5000000	3285	2.59	61.3

## Estimate ER at the time of removal or at present time

$ER_T$  can be directly estimated using the decay model.

Plaintiff	AER	Ffloor	Tinst	H	ER0	ERt
Thomas	0.595	0.6400000	2557	2.59	61.3	12.36400
Choe	0.316	0.6300000	1278	2.59	61.3	14.87912
Stein	0.287	0.7100000	3190	2.59	61.3	11.28129
Jensen	0.287	0.5279489	1278	2.59	61.3	14.87912
Craig	0.683	0.0842105	548	2.59	61.3	16.54324
P1	0.600	0.5000000	3285	2.59	61.3	11.12719

## Estimate concentrations

Formaldehyde concentrations inside the home at the time of installation, at the time of removal or present time and time-weighted average concentrations estimated here using the decay model.

### Decay Factor

Decay factor can be estimated using  $T_{inst}$  and the decay model provided in Sheehan et al. (2018). Decay factor is calculated by integrating the decay model for the duration of installation, i.e., from the time of installation to the time of removal, if removed, or to the present day divided by the total duration of installation.

This is a unitless measure that essentially the time-weighted average (TWA) decay. The longer the duration of installation, the lower the decay factor.  $decayFactor = 1$  means no decay. It can be multiplied by initial ER or initial concentration to estimate TWA concentrations.

Plaintiff	DecayFactor
Thomas	0.2610001
Choe	0.3004523
Stein	0.2474532
Jensen	0.3004523
Craig	0.3596356
P1	0.2455827

## Concentration at the time of installation, at the time of removal (or present day) and TWA concentrations

Concentration at any given time can be estimated using the following equation:

$$C = \frac{ER \times F_{floor}}{AER \times H}$$

where  $F_{floor}$ ,  $AER$  and  $H$  have been described above.  $ER$  at the time of interest can be estimated with the decay model.

TWA average concentrations can be estimated with the following modified equation:

$$C = decayFactor \times \frac{ER_0 \times F_{floor}}{AER \times H}$$

where  $ER_0$  is ER at the time of installation and  $decayFactor$  is estimated as described above.

Plaintiff	DecayFactor	C0	Ct	CTWA
Thomas	0.2610001	25.457967	5.1347855	6.644532
Choe	0.3004523	47.186110	11.4533090	14.177177
Stein	0.2474532	58.551384	10.7754481	14.488725
Jensen	0.3004523	43.538220	10.5678702	13.081160
Craig	0.3596356	2.918142	0.7875291	1.049468
P1	0.2455827	19.723295	3.5801765	4.843700

Using the parameters provided above, TWA formaldehyde concentration for Plaintiff P1 at the present time (June 2020) is anticipated to be  $4.84 \mu g/m^3$  or 0.0039 ppm. This is approximately 10-fold lower than the California Proposition (Prop) 65 NSRL of  $40 \mu g/m^3$ .

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