Performance of Electret Filters and Respirators Exposed to Paraffin Oil

J. S. Huberty, L.L. Janssen, J. O. Bidwell

3M Occupational Health and Environmental Safety Division

Background

- Laboratory studies in France have shown that intermittent loading of particulate filters with paraffin oil increases laboratory measured penetrations.
- Changes proposed to EN 143 include loading and storage prior to final penetration measurement.
- Relationship between the laboratory studies and actual workplaces is not known.

Goal

- Measure the overall mass based penetration of filters and respirators in a workplace containing paraffin oil aerosol over several days.
- Measure the laboratory penetrations each morning and at the end of the study.
- Compare the laboratory and workplace results.

Samples

- P1 Filter 5911
- P2 Filter 2125

- P1 Respirator 8710E
- P2 Respirator 8810

- These products did not contain oily-mist resistant filter media.


3M 2125
EN143 P2
CE 0086
3M 2128
EN143 P2
CE 0086
3M 2135
EN143 P3
CE 0086


3M

EN 143 Regulations

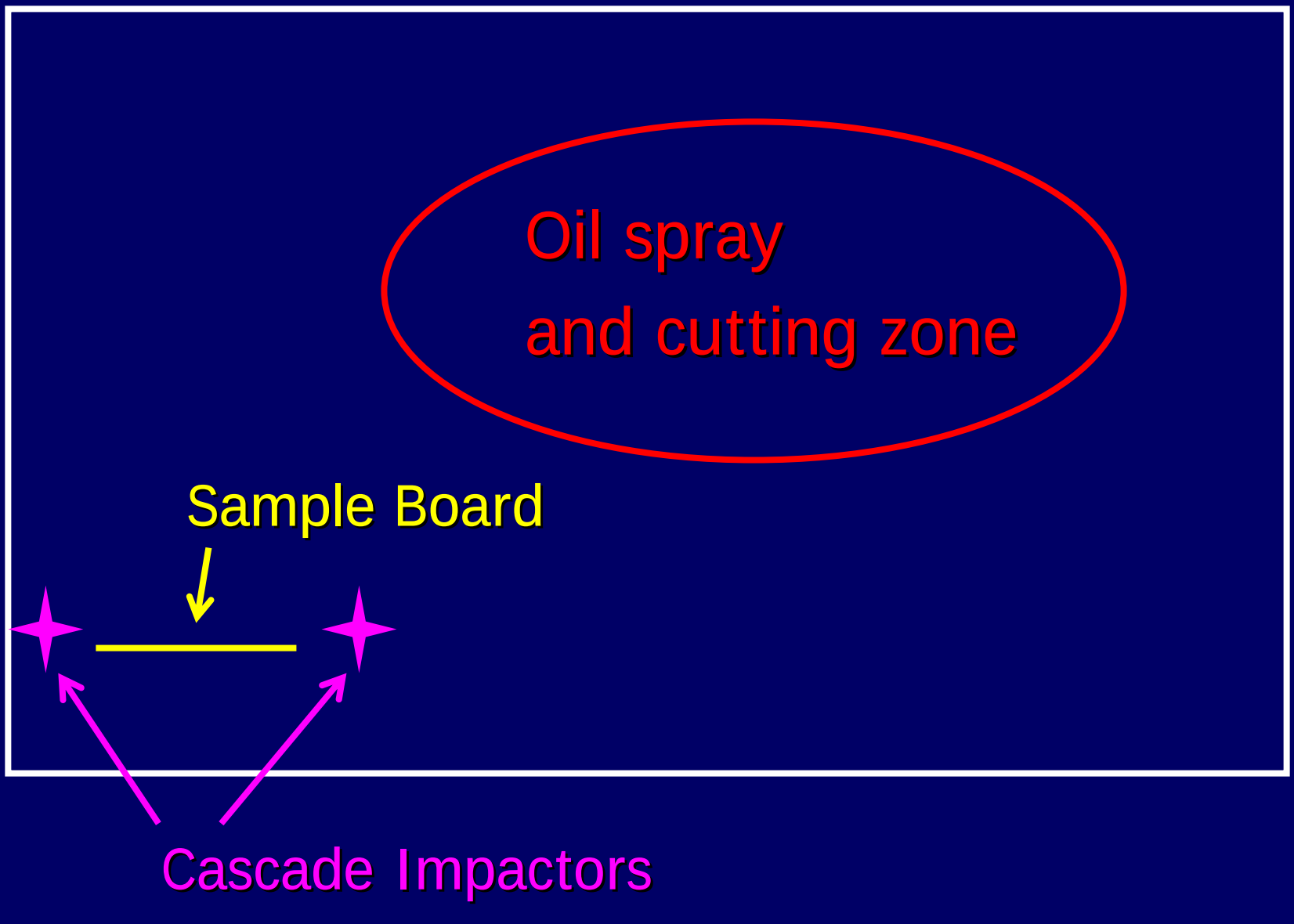
- Current P1 classification requires instantaneous paraffin oil penetration to be below 20%.
- Current P2 classification requires instantaneous paraffin oil penetration to be below 6% (filtration level similar to NIOSH N95 filtration level).

Workplace Description

- Proprietary tool cutting operation
  - Paraffin oil aerosol
  - Accessibility over several days
  - Room to accommodate study

Tooling Enclosure Schematic

view from above, 20 ft x 12 ft



Testing Schedule

- Lab penetrations measured at the start of each day.
- Workplace exposure of P1 respirators and P2 filters in the morning.
- Workplace exposure of P2 respirators and P1 filters in the afternoon.
- Repeat on days 2 and 3 with the same samples.
- Lab penetrations measured on day 4.

Lab measurement

- TSI 8130 Automated Filter Tester
- Paraffin oil
- Respirators
  - 95 lpm
- Filters (used in pairs)
  - 47.5 lpm

Workplace Measurements

- Particle size
  - Marple 298 Personal Cascade Impactors
- Concentration and mass penetration
  - Millipore 25 mm, MCE, 0.8 µm pore size
  - Analysis by modified NIOSH 5026; IR

Workplace Measurements

- 5 pumps Gast Model #323 and similar
  18.1-20.0 lpm
  19.1 lpm average

- 3 pumps Gast Model # 523
  23.4 – 25.8 lpm
  24.8 lpm average

- 8 MSA Escort Elf sampling pumps to measure concentration (2 lpm)


309


3M
8810
EN149:2001 FFP2
CE 0086
3M 2125
AS/NZS 1716 P2
US Pat. Re. 35,062
EN143:2000 P2
3M 2125
EN143:2000 P2
CE 0086
AS/NZS 1716 P2
US Pat. Re. 35,062
3M 2125

Workplace Exposure

$E = F * T * C$

- E = Exposure
- F = Flow Rate
- T = Time
- C = Concentration

Total Exposure = $E_{Day\ 1} + E_{Day\ 2} + E_{Day\ 3}$

Workplace Penetration

$\% P = M_d / E_t * 100$

$\% P$ = % Penetration

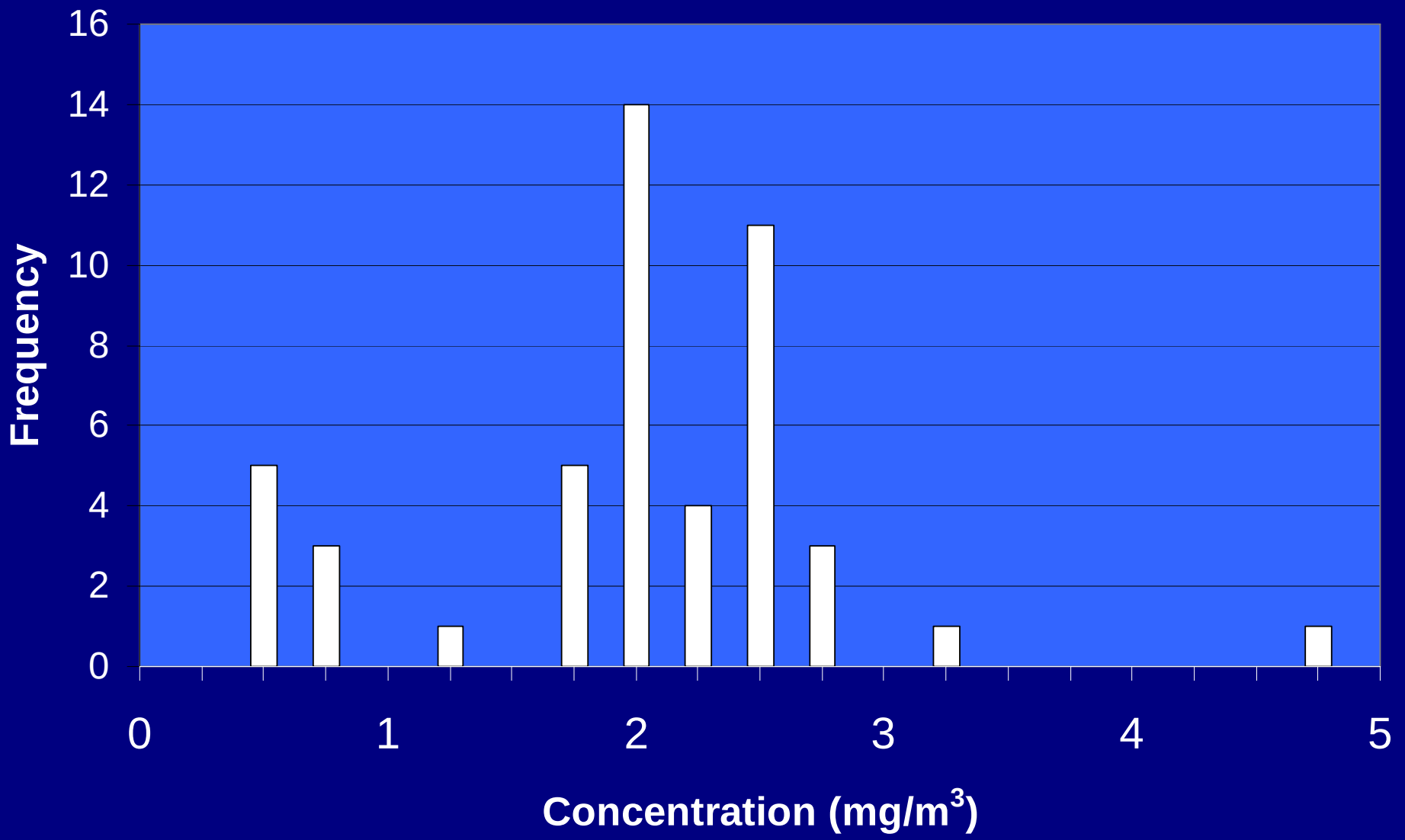
M_d = Mass on downstream filter

E_t = Total Exposure Mass

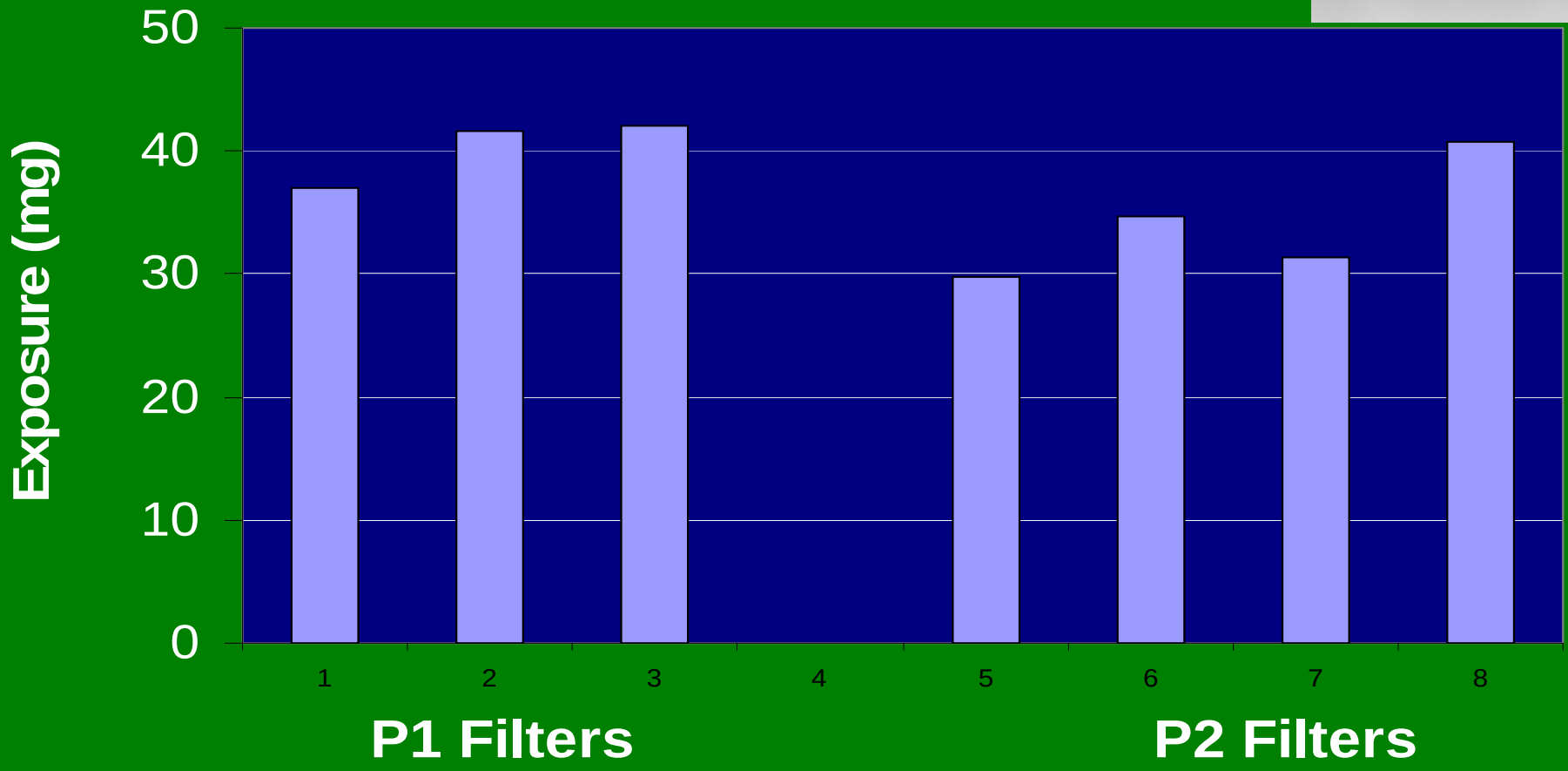
Results

- Particle Size in Enclosure
  - Towards center of room
    - mmad = 13 µm
    - gsd = 2.9
    - Mass below 2 µm = 9%
  - Towards wall
    - mmad = 6.8 µm
    - gsd = 3.1
    - Mass below 2 µm = 22%

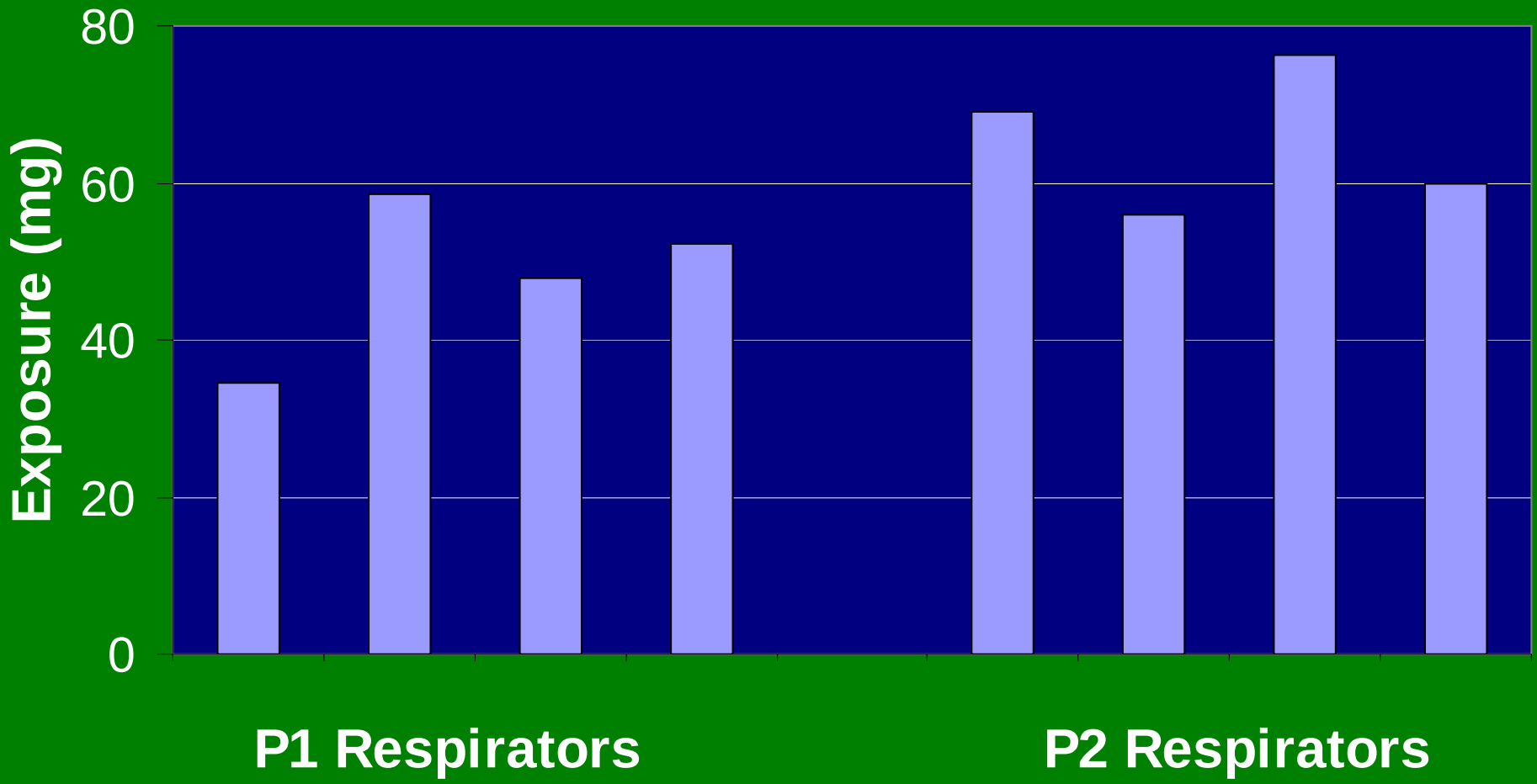
Concentrations during Study



Total Filter Exposures



Total Respirator Exposures



Lab Filter Measurements

Filter	Paraffin Oil % Penetrations at 47.5 LPM			
	Initial	Day 2	Day 3	Day 4
P1 Type 5911	3.61	5.97	8.87	11.1
	1.69	2.77	4.11	5.09
	2	3.03	4.64	5.66
P2 Type 2125	0.572	0.825	1.12	1.47
	0.43	0.661	0.745	0.973
	0.455	0.682	0.889	1.14
	0.344	0.529	0.732	0.904

Workplace Filter Results

Filter	Day 3 Lab Penetration	Downstream Filter Mass
	%	mg
P1 Type 5911	8.87	<0.045
	4.11	<0.045
	4.64	<0.045
P2 Type 2125	1.12	<0.045
	0.745	<0.045
	0.889	<0.045
	0.732	<0.045

Lab Respirator Measurements

Respirator	Paraffin Oil % Penetrations at 95 LPM			
	Initial	Day 2	Day 3	Day 4
P1 Type 8710E	15.1	19.8	24.4	28.4
	10.6	15.4	19.6	24.4
	11.6	16	20	24.3
	12.8	16.1	20.5	25.2
P2 Type 8810	1.96	2.68	3.54	4.29
	1.83	2.48	3.41	3.81
	1.59	2	2.64	3.18
	1.7	2.28	2.83	3.29

Workplace Respirator Results

Respirator	Day 3 Lab Penetration	Downstream Filter Mass
	%	mg
P1 Type 8710E	24.4	<0.045
	19.6	<0.045
	20	<0.045
	20.5	<0.045
P2 Type 8810	3.54	<0.045
	3.41	<0.045
	2.64	0.049
	2.83	<0.045

Workplace Summary

- The only downstream filter with a detectable mass came from 8810 P2 Respirator #3.
- The mass of 0.049 mg measured on the downstream filter calculates to a mass based penetration of 0.1%.
- All other samples were non-detects with less than 0.045 mg. (Less than 0.15% penetration for all samples.)

Conclusions

- Even with intermittent loading of a paraffin oil aerosol over several days, workplace filtration performance was excellent. All filter and respirator mass penetrations were below 0.15%.
- We were unable to correlate workplace measurements with the laboratory penetrations. This is consistent with previous results.