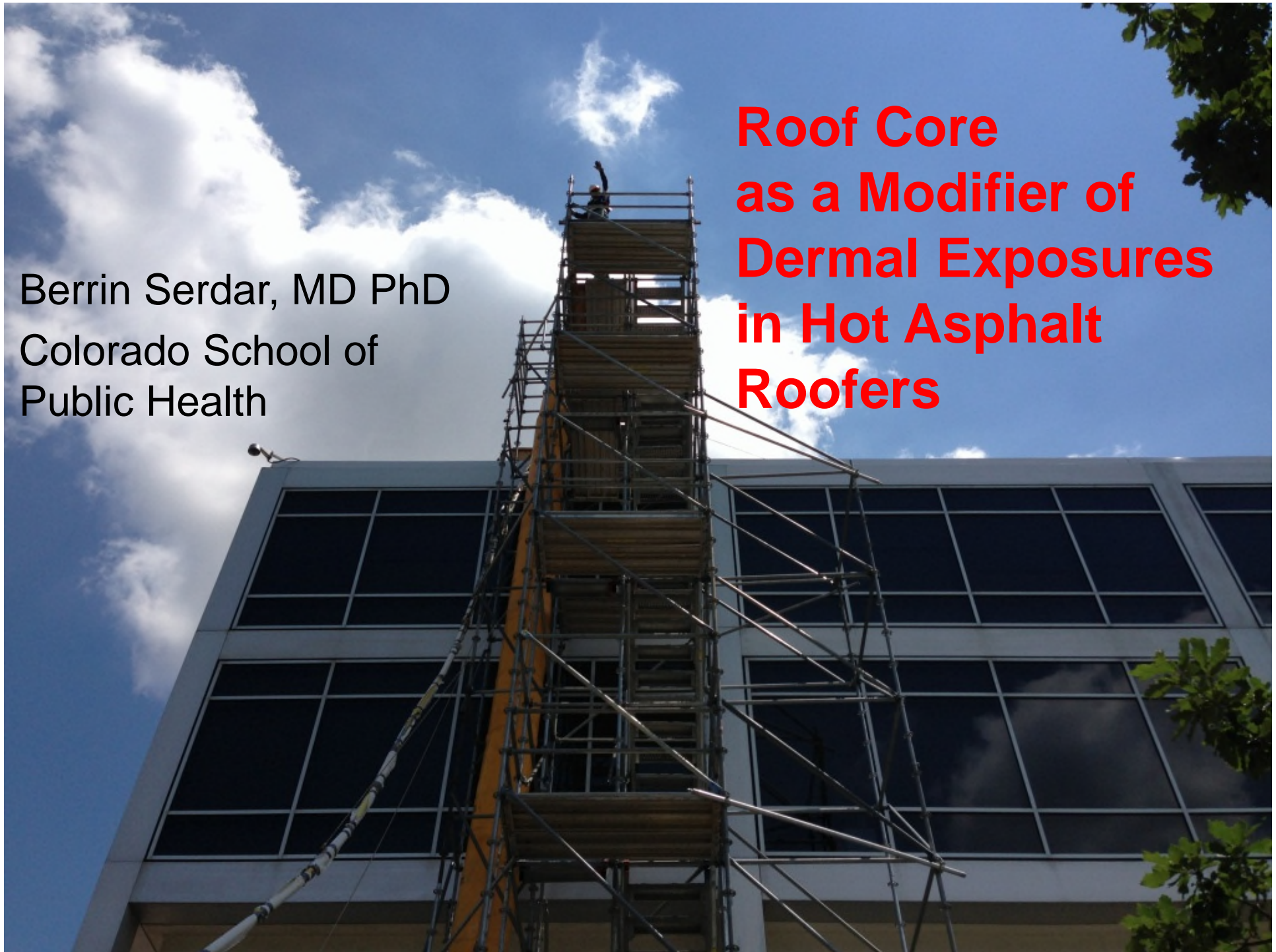


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Roof Core as a Modifier of Dermal Exposures in Hot Asphalt Roofers



Why study roofers?

Many occupational risks
(falls, accidents, back pain...)

Cancer in roofers?



Occupational exposures to polycyclic aromatic hydrocarbons, and respiratory and urinary tract cancers: a quantitative review to 2005

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Background: Exposure to polycyclic aromatic hydrocarbons (PAHs) has been reported in several industries, including those of the aluminum production, coal gasification, coke production, iron and steel foundries, coal tar and related products, carbon black and carbon electrodes production.

Patients and methods: This paper reviews the results from cohort studies conducted on workers exposed to PAHs in these industries, with a focus on cancers of the respiratory and urinary tract.

Results: An excess risk from lung/respiratory cancers was found in most industries, the pooled relative risk (RR) being 2.58 (95% CI 2.28–2.92) for coal gasification, 1.58 (95% CI 1.47–1.69) for coke production, 1.40 (95% CI 1.31–1.49) for iron and steel foundries, 1.51 (95% CI 1.28–1.78) for roofers and 1.30 (95% CI 1.06–1.59) for carbon black production. The evidence for cancers of the bladder and of the urinary system is less consistent, with a

Roofing asphalt a 'probable human carcinogen' (2A, IARC)

Cancer Mortality Among European Asphalt Workers: An International Epidemiological Study. I. Results of the Analysis Based on Job Titles

Paolo Boffetta,¹ Igor Burstyn,^{1,2} Timo Partanen,³ Hans Kromhout,² Ole Svane,⁴ Sverre Langård,⁵ Bengt Jönholm,⁶ Rainer Frentzel-Borome,⁷

Research

A Case-Control Study of Lung Cancer Nested in a Cohort of European Asphalt Workers

Ann Olsson,^{1,2} Hans Kromhout,³ Michela Agostini,³ Johnni Hansen,⁴ Christina Funch Lassen,⁴ Christoffer Johansen,^{4,5} Kristina Kjaerheim,⁶ Sverre Langård,⁷ Isabelle Stücker,⁸ Wolfgang Ahrens,⁹ Thomas Behrens,⁹ Marja-Liisa Lindbohm,¹⁰ Pirjo Heikkilä,¹⁰ Dick Heederik,³ Lützen Portengen,³ Judith Shaham,¹¹ Gilles Ferro,¹ Frank de Vocht,¹² Igor Burstyn,¹³ and Paolo Boffetta^{1,14,15}



Cancer of lung, bladder, skin, digestive tract???

Confounders? No exposure measurements?



Polycyclic aromatic hydrocarbons (PAHs): Asphalt, diesel exhaust, coal tar

Other sources?



...reported large differences in the smoking rates among over 200 occupational groups using nationally representative data from the National Health Interview Survey (NHIS).⁴ Pooled cigarette smoking rates in the period 1987 to 1994 varied from 4% in clergy and physicians to 58% in roofers, with consistently higher smoking rates among blue- versus white-collar workers. Furthermore, significant assoc

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Old roof? Hot asphalt? Or both?

- Dermal exposure higher if workers *tear old roof*
- If old roof contains *coal tar*, higher levels of carcinogenic PAHs (BaP) on skin
- Dermal exposure can be reduced by gloves (possibly more if roofers have *skin burn*)

But, why would roofers have skin burn?



But, why would roofers have skin burn?





Which one is more important:
Inhalation or dermal contact?



Personal breathing zone air



Particle-bound PAHs:
pumps (SKC XR-5000)
with $PM_{2.5}$ inlets & 37
mm Teflon filters.

Gas-phase PAHs:
adsorbent tubes (XAD-2,
75/150 mg), 2.7 L/min
flow rate.



Dermal wipes

Hand wash with sunflower oil. Dichloromethane
extracts.



Study design

Monday & Thursday

Morning:

- Questionnaire
- Hand wipe
- Blood/urine
- Refreshments
- Air monitors given
- Gift cards given

↓ **Work**

Afternoon:

- Return monitors
- Questionnaire
- Hand wipe
- Blood/urine
- Refreshments
- Gift cards given





Air PAHs

Gas phase PAHs:

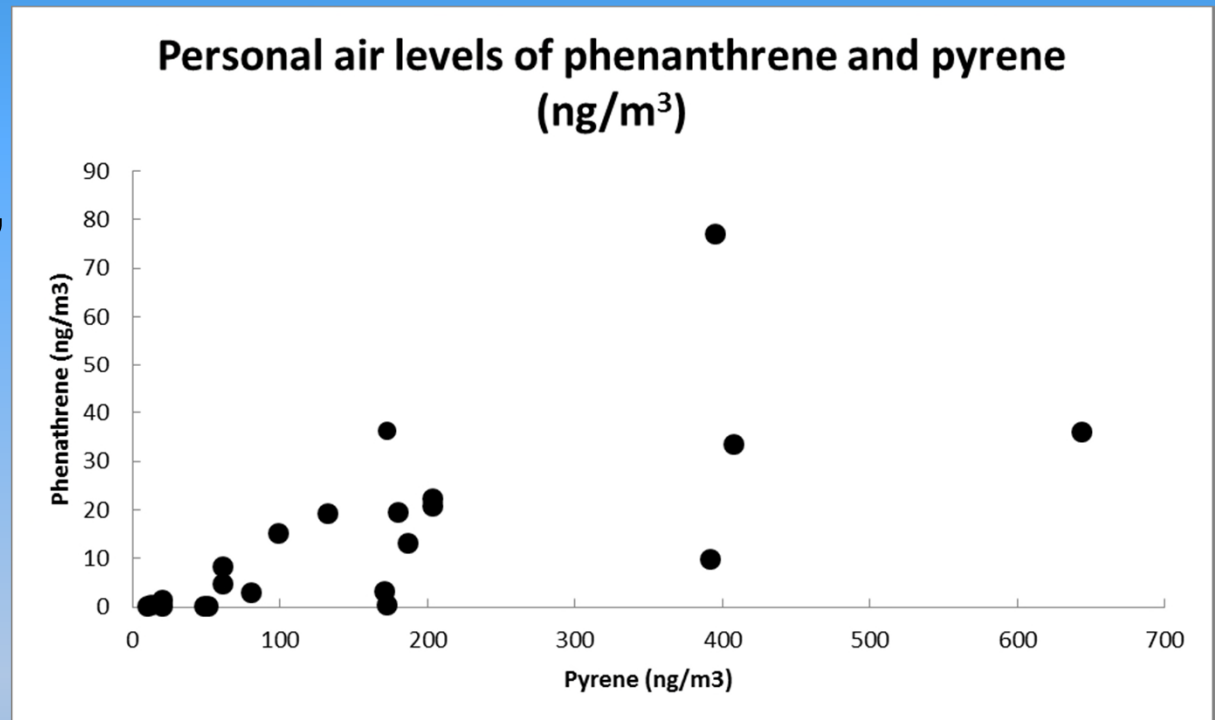
Naphthalene & Phenanthrene
most abundant

Particle bound PAHs:

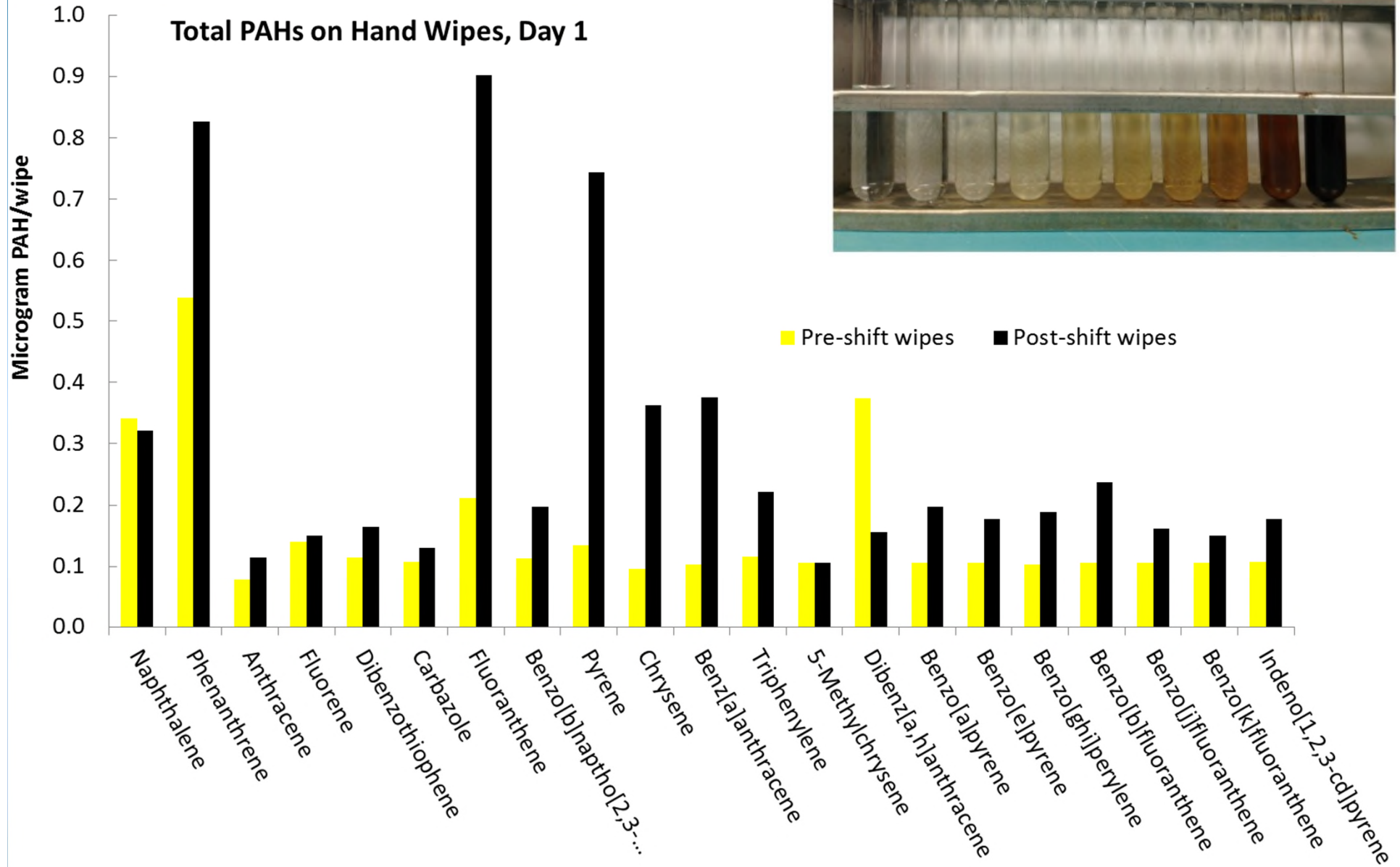
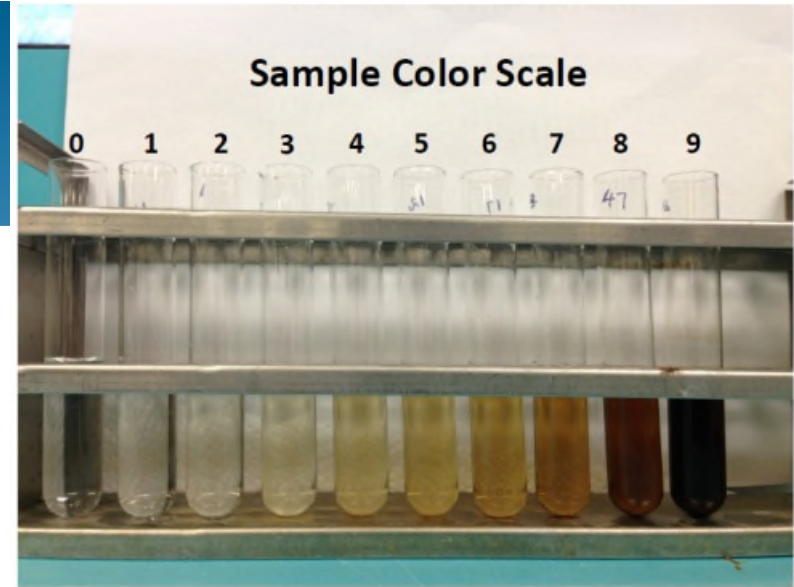
Naphthalene in most.

Also some:

Pyrene, Chrysene,
Benzo(a)anthracene,
Benzo(e)pyrene,
Benzo(a)pyrene



Dermal wipe extracts



PAHs in selected wipes					
No of Benzene Rings	Sample Concentration (µg per wipe)	186	166	186	166
		Pre-shift	Pre-shift	Post-shift	Post-shift
2	Naphthalene	0.16	0.20	0.18	0.18
2+	Carbazole				
2+	Dibenzothiophene		0.14	0.17	0.15
2+	Fluorene	0.04	0.04	0.04	0.02
3	Anthracene	0.09	0.09	0.10	0.10
3	Phenanthrene	0.24	0.23	0.33	0.34
3+	Benzo[b]naphtho[2,3-d]thiophene				
3+	Fluoranthene	0.24	0.22	0.50	0.55
4	Benz[a]anthracene			0.15	0.24
4	Chrysene	0.15	0.14	0.23	0.36
4	Pyrene	0.25	0.24	0.39	0.86
4	Triphenylene			0.32	0.39
4+	Benzo[b]fluoranthene			0.34	0.40
4+	Benzo[j]fluoranthene			0.19	0.19
4+	Benzo[k]fluoranthene			0.09	0.04
5	Benzo[a]pyrene			0.11	0.08
5	Benzo[e]pyrene			0.03	0.06
6	Benzo[ghi]perylene	0.18	0.17	0.20	0.20
5	Dibenz[a,h]anthracene				
5+	Indeno[1,2,3-cd]pyrene	0.22	0.21	0.22	0.22
4	5-Methylchrysene				0.14
	Σ 40 PACs (total µg)	1.57	1.67	3.59	4.51
	Σ 4-6 ring PACs (total µg)	0.81	0.76	2.27	3.17

Roof core samples

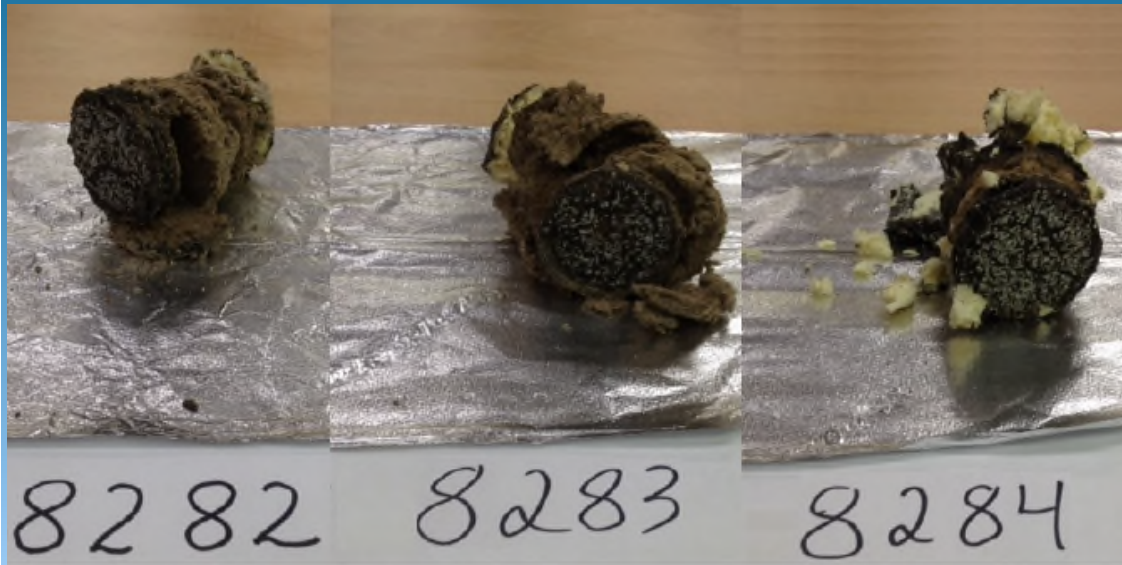


FIGURE 1. Roofing core samples from AFA – Falcon Club

- Extracts analyzed for **coal tar** via fluorescence scan



FIGURE 3. Roofing core sample #3 (HRG 8634) from AFA – Harmon Hall

No evidence of coal tar observed

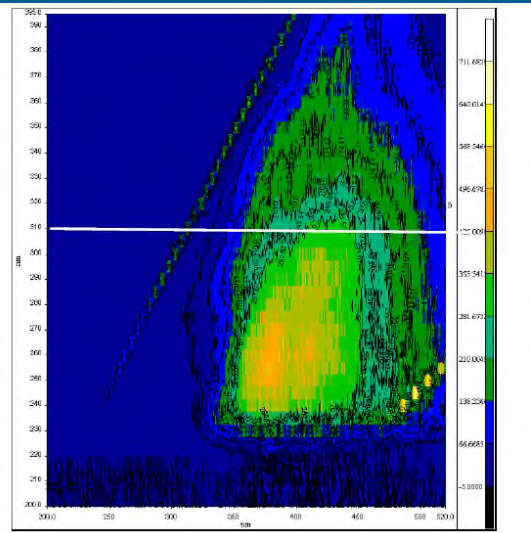


FIGURE 7. Full-scan 3-D map with contour plot of sample 8634 fluorescence fingerprint

Roof core sample

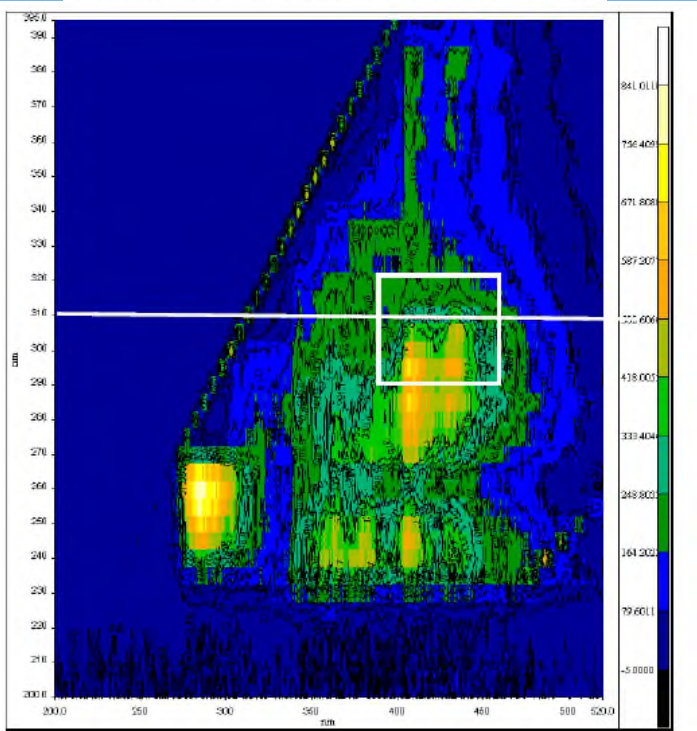


FIGURE 8. Full-scan 3-D map with contour plot of Coal Tar Standard fluorescence fingerprint.

Coal tar spiked control

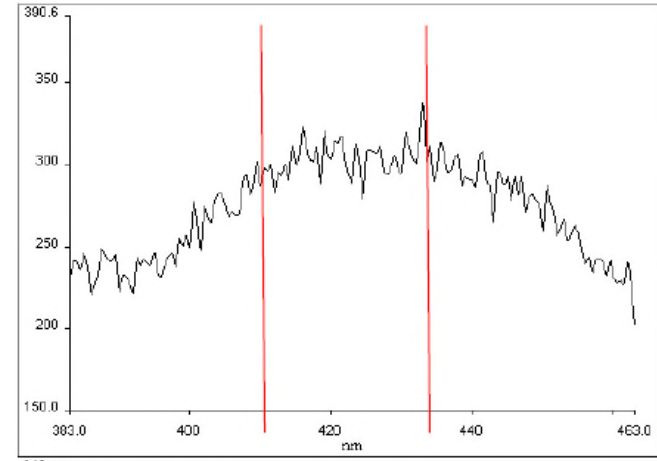


FIGURE 11. Overlay of horizontal cuts (383- 462 nm) at 310 nm excitation - 8634.

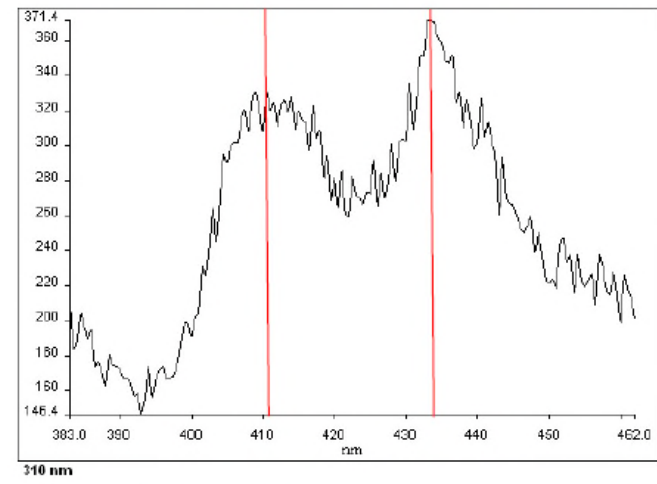


FIGURE 12. Overlay of horizontal cuts (383- 462 nm) at 310 nm excitation - Coal Tar Standard.

TABLE I. Polycyclic Aromatic Compounds in Asphalt Roof Samples from Harmon Hall

	Ring Size	CAS NO	PAC	8632	8633	8634
2	2	91-20-3	Naphthalene	0.27	0.15	3.38
3	2+	83-32-9	Acenaphthene	0.21	0.15	4.78
6	2+	225-51-4	Benz[c]acridine			6.06
7	2+	86-74-8	Carbazole			0.11
8	2+	132-65-0	Dibenzothiophene	1.73	2.03	9.90
9	2+	86-73-7	Fluorene	0.54	0.41	4.00
10	3	120-12-7	Anthracene	4.33	4.04	107.40
11	3	85-01-8	Phenanthrene	4.33	4.04	107.40
13	3+	206-44-0	Fluoranthene	2.20	2.39	151.53
14	3+	243-46-9	Benzo[b]naphtho[2,3-d]thiophene	11.59	11.92	33.96
15	4	56-55-3	Benz[a]anthracene	3.51	3.66	68.13
16	4	3697-24-3	5-Methylchrysene	4.95	5.14	6.36
17	4	218-01-9	Chrysene	6.40	6.21	51.89
18	4	129-00-0	Pyrene	5.58	5.44	118.93
19	4	57-97-6	7,12-Dimethylbenz[a]anthracene	13.04	13.58	15.14
20	4	217-59-4	Triphenylene	7.31	6.75	12.00
23	4+	205-99-2	Benzo[b]fluoranthene	5.46	5.48	33.16
24	4+	205-82-3	Benzo[j]fluoranthene	0.95	0.92	14.05
25	4+	207-08-9	Benzo[k]fluoranthene		0.13	15.92
28	5	50-32-8	Benzo[a]pyrene	4.32	4.38	32.23
29	5	192-97-2	Benzo[e]pyrene	26.40	18.79	34.34
30	5	53-70-3	Dibenz[a,h]anthracene	1.06	1.14	2.89
35	5+	193-39-5	Indeno[1,2,3-cd]pyrene	1.32	1.10	5.29
36	6	191-24-2	Benzo[ghi]perylene	6.83	6.03	8.26
38	6	189-55-9	Benzo[rst]pentaphene	2.90	2.37	2.23

Summary Data	Σ 40 PACs (mg/kg)	115.2	106.2	849.3
	Σ 4-6 ring PACs (mg/kg)	90.0	81.1	420.8
	% Σ 40 PACs	0.012	0.011	0.085
	% Σ 4-6 ring PACs	0.009	0.008	0.042

Results resemble those observed in skin wipes

Conclusions

- PAHs (esp. 4-6 ring) more abundant in wipes *after* the work
- No evidence of coal tar in roof core
 - But PAH levels higher than published asphalt samples
- Pattern of PAHs similar in roof core and dermal wipes after work

We thank all of the roofers who participated

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- Greg Dooley (CSU)
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