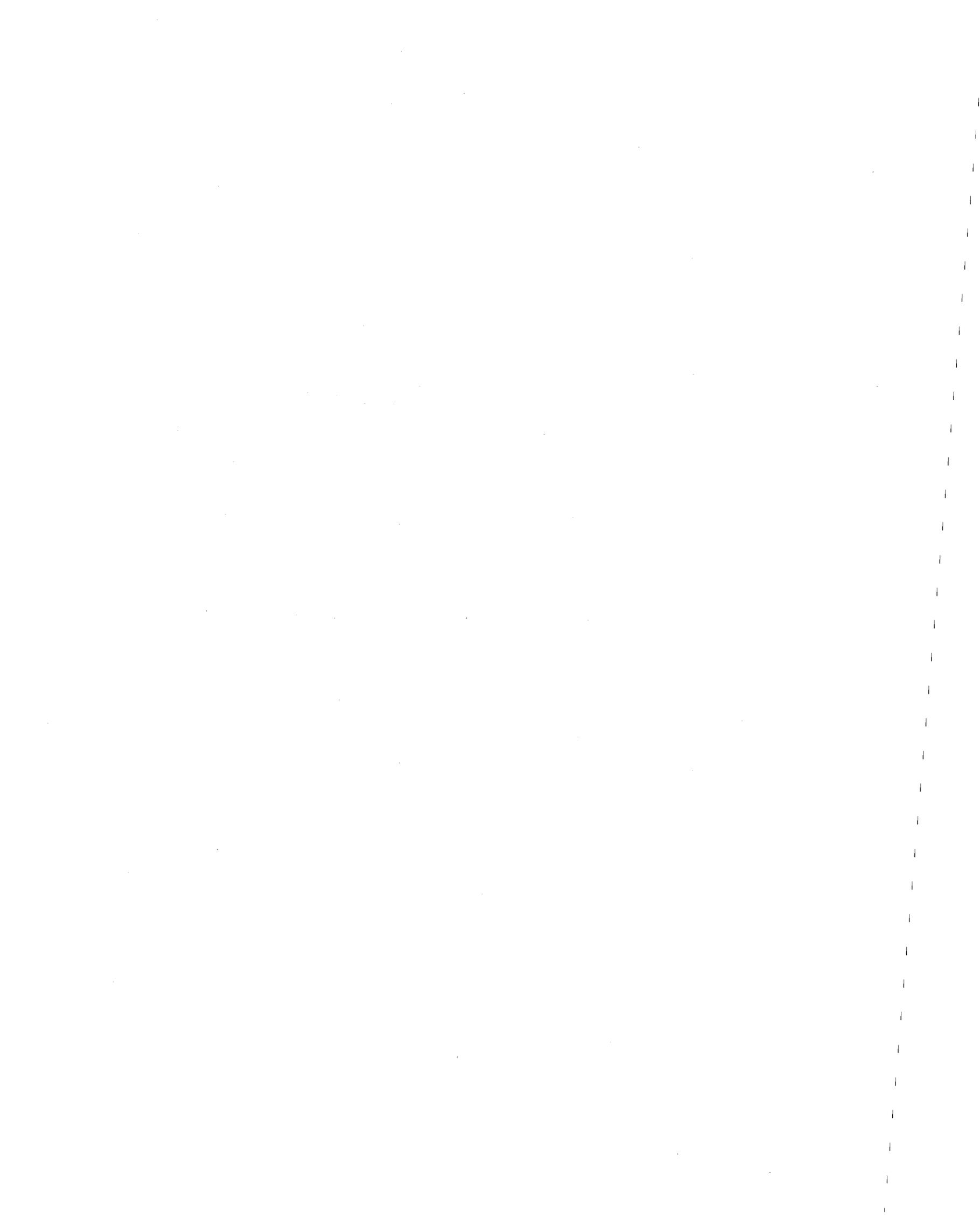


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16. Abstract (Limit: 200 words) Worker exposures to fluoranthene (206440) (Flu), pyrene (129000) (Pyr), benz(a)anthracene (56553) (BaA), chrysene (218019) (Chr), and benzo(a)pyrene (50328) (BaP) were surveyed at Zeric Roofing Corporation (SIC-2952) in Santee, California on November 8, 1977. A new asphalt roof was being applied by five workers. Bulk asphalt analysis indicated that concentrations of BaP, BaA, Flu, Pyr and Chr were 40, 90, 40, 220 and 130 micrograms per gram, respectively, by analysis using benzene, and 50, 100, 50, 230, and 150 micrograms per gram, respectively, by analysis using cyclohexane. Personal samples for coal tar pitch volatiles in asphalt indicated concentrations of BaP, BaA, Flu, Pyr and Chr ranging from 0.04 to 1.90, 0.10 to 1.90, 0.10 to 1.90, 0.23 to 1.10, and 0.29 to 1.10 micrograms per cubic meter, respectively, for different job operations. Area samples of coal tar pitch volatiles indicated concentrations of BaP, BaA, Flu, Pyr and Chr ranging from 10.10 to 4.20, 0.20 to 47.00, 0.74 to 10.00, 1.90 to 21.00 and 0.61 to 68.00 micrograms per cubic meter, respectively. The authors conclude that a potential health hazard exists from exposure to polynuclear aromatic hydrocarbons. They recommend engineering controls to reduce emissions, standard hygienic practices to reduce exposures and training programs for workers to avoid health hazards.			
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Industrial Hygiene Survey Report

CONTRACTOR: Zeric Roofing Corporation
8511 Ablett Road
Santee, California
(714) 449-0950

SITE:

DATE OF SURVEY: November 8, 1977

PERSONS CONDUCTING SURVEY: Jane Brown
John Fajen

UNION: United State, Tile & Composition Roofers,
Damp & Waterproof Workers Association
Local 45
San Diego, California

UNION REPRESENTATIVE: Mr. Milton L. Van Dyke
Business Agent

PURPOSE:

The roofing and sheet metal contract construction industry represents over 115,000 workers with potential for exposure to roofing hazards in the U.S. (Bureau of Labor Statistics Bulletin 1830, 1974). Both asphalt and coal tar pitch are in common use in roofing operations. Following the publication of a study by Selikoff and Hammond (Annals of the New York Academy of Sciences, Vol 271, 1976) indicating increased mortality rates among roofers using coal tar pitch and asphalt, there was increased concern over health hazards in the roofing industry. The purpose of this survey was to define occupational exposures incurred by roofers, particularly exposures to coal tar pitch volatiles in both asphalt and coal tar fumes.

DESCRIPTION OF OPERATION:

This job was a small warehouse (80' x 80') on which a new asphalt roof was being laid. The deck was plywood. Felt was applied directly to the plywood. One layer of felt and asphalt was used, covered with a layer of thicker coated material (CON-CAP). A felt laying machine was used to apply the felt and asphalt. Asphalt was mopped onto the periphery of the roof, and felt applied by hand. The crew consisted of about five men. The kettleman also helped in applying the roof. Asphalt was melted down in a kettle equipped

with hooding intended to reduce fume emissions. The kettle had exploded several times so that the hooding was no longer effective. The doors in the hooding, through which the asphalt was loaded were kept open throughout the day, so that the hooding proved only to be a nuisance, rather than accomplishing any semblance of fume reduction. A CAL-OSHA inspector who visited the site on the day of this survey indicated that the particular type of hooding on this kettle, although initially required by California environmental agencies, was being "red tagged" (operation shut down), as they were so unsafe. The hooding causes the kettles to explode on an average of once a week, resulting in severe burns in the kettlemen.

Weather conditions were sunny and warm (75°F), with little wind in the morning, and a slight breeze in the afternoon.

SAMPLING AND ANALYTICAL METHODS

The same sampling method was used for both coal tar pitch and asphalt roofs. Personal and area samples were taken using Model G MSA pumps at flow rates of between 1.5 and 2.0 liters per minute. The sampling apparatus consisted of a 37 mm diameter glass fiber filter followed by a 0.8 u pore size membrane filter and back-up pad. This filter cassette was followed by a solid sorbent (porous polymer) in an attempt to capture compounds lost by sublimation.

Sample analysis was performed by the Utah Biomedical Test Laboratory, Salt Lake City, Utah. Filters and tubes were analyzed separately. Both were analyzed utilizing ultrasonic extraction according to NIOSH method P&CAM Number 217. Particulate polycyclic organic matter levels were measured as total benzene solubles. The fraction of the sample remaining after the soluble analysis was analyzed by reversed phase liquid chromatography for five individual polynuclear aromatic hydrocarbons (PNA's). Those PNA's measured were benzo(a)pyrene (BaP), benz(a)anthracene (BaA), fluoranthene (Flu), pyrene (Pyr), and chrysene (Chr). The injection volume for the chromatography unit ranged from 1 to 50 microliters depending on the sample concentration. Sample chromatograms were compared with chromatograms from known standards for compound identification. Peak areas of several standard concentrations of each compound of interest were measured and standard curves were constructed. Quantitation data were obtained by comparison of the peak areas of the samples with the standard curves. The limits of detection for each PNA using a 1 ul injection are:

Fluoranthene	1 ug/sample
Pyrene	5 ug/sample
Benz(a)anthracene	2 ug/sample
Chrysene	3 ug/sample
Benzo(a)pyrene	1 ug/sample

The preceding detection limits apply to a 1 ul injection from a 1 ml sample. The detection limits listed in the table containing the field data are different from those listed above, because most samples were analyzed utilizing a larger injection volume to increase sensitivity. The reported limit of detection may vary between samples due to different injection volumes.

DISCUSSION AND PRESENTATION OF DATA

At present, occupational exposure to carcinogens within coal tar pitch and asphalt is regulated under the OSHA standard for coal tar pitch volatiles. While this standard was originally intended to protect individuals from exposure to coal tar products, the U.S. Department of Labor has ruled that employee exposure to polycyclic hydrocarbons volatilized from petroleum residues be controlled under the coal tar pitch volatile standard. The basis for this ruling was that many of the hazardous compounds found in coal tar pitch volatiles can be found in volatiles from petroleum residues. Thus, it is thought that petroleum volatiles can present a similar hazard to health.

The current occupational health standard promulgated by the U.S. Department of Labor limits allowable exposure to coal tar pitch volatiles to an 8-hour time-

weighted average of 0.2 milligrams of substance per cubic meter of air. Only the volatiles of particulates collected via total mass sampling which are soluble in benzene are reflected by this level. This standard is set at a level to protect workers from inhalation effects incurred from occupational exposure. The same limit is recommended as a Threshold Limit Value (TLV) for coal tar products by the ACGIH, while the TLV for asphalt fumes is 5 mg/m³.

NIOSH has recently completed criteria documents on coal tar products and asphalt fumes. The NIOSH recommended limit for exposure to coal tar products is 0.1 mg/m³ for up to a 10-hour workday, 40 hour week. The proposed limit for exposure to asphalt is 5 mg/m³ for any 15 minute period.

It should be noted that the legal (OSHA) standards for exposure to coal tar pitch volatiles relate to all benzene soluble materials in volatiles of coal tar products, petroleum residuals, and wood tars, and not merely the carcinogenic compounds in the volatiles. According to the ACGIH:

Since no "safe" limit of exposure can be established for carcinogens and because of instability in the composition of volatiles from coal tar pitch, a limit of 0.2 milligrams per cubic meter of air is recommended. A limit of 0.2 mg/m³ of total components present should minimize exposure to these carcinogens.

It is generally felt that the cancer causing agents within coal tar pitch volatiles include a group of compounds referred to as polynuclear aromatic hydrocarbons (PNA's). These are compounds consisting of fused carbon rings. Those PNA's in the five to six ring range are generally considered as most suspect of causing cancer in humans. Benzo(a)pyrene (BaP) in particular, is a potent cancer causing agent. In order to more fully characterize the constituents in the volatiles measured in the roofing industry, these samples were analyzed for total benzene solubles, and then fractionated the samples, to measure five individual PNA's, three of which are suspect carcinogens (BaP, benzanthracene, and chrysene).

Data obtained from bulk samples and air samples are presented in Tables I and II. Bulk sample analysis was done primarily to identify PNA constituents of the parent material. As can be seen in Table I, all five PNA's examined were reported as less than the detectable limit. As some PNA's were found in the air samples taken, and the temperature of the kettle was hardly high enough for PNA formation, problems with the bulk analysis were suspected. This was confirmed upon contact with the laboratory. The asphalt chromatogram yielded unidentifiable plateaus in the PNA region, rather than isolated distinct peaks. Attempts were made to clean up the analysis, but the bulk sample data remains suspect. The detectable limits reported for this analysis are high due in part to the problems mentioned here. This lessens the value of the data, as significant quantities of PNA's might be present, but not detected.

The data presented in Table II - Sampling Results reflects sample concentrations rather than 8-hour time weighted averages (TWA's). The variable nature of the work shift of roofers (often a twelve hour day, or more), as well as the variability of the work week (which is weather dependent) does not lend itself to extrapolation of the data to TWA's, as only one day's samples was taken. From

observations made at this and numerous other worksites, it was apparent that exposures to hot materials is fairly consistent throughout the work day, lasting from the beginning of the day, until the roof is finished. Most roofing jobs last only a short time, usually one day to perhaps a week or two.

Assuming an eight hour exposure at the levels measured for five hours or more in this survey, all personal samples taken were well above the standard for the benzene soluble fraction. No detectable PNA's were found on any of the filter sections of the personal samples, although BaP was found on one of the tube sections. It is important to note that the potential for exposure to PNA's is present, as all area samples measuring emissions from the kettles showed significant quantities of benzantracene and chrysene on the filters. BaP was found on one of the tubes in the areas samples, and pyrene was found on another. It also should be noted that both the highest and lowest benzene soluble fractions exposures were in men doing the same job, laying felt. Generally, work practices were very variable. This factor, in combination with the fact that exposures vary with wind speed and direction, means that little can be said to connect job with exposure. The roofers change jobs day to day, or even within one day, so that such generalizations would not be worthwhile in terms of attempting to estimate chronic exposures.

CONCLUSIONS AND RECOMMENDATIONS

The exposure levels measured here are sufficiently high to warrant concern over chronic exposures at such levels. Although PNA's were not consistently found on the personal samples, the potential for exposure was present, as evidenced by the area samples.

Little published work has been done to characterize the chemical constituents to asphalt fumes, particularly focusing on carcinogens. PNA's were measured in this survey as they are known to be carcinogenic in other industries. As animal experiments have been done showing some tumor response from exposure to asphalt via skin painting, and one published epidemiologic study has shown increased cancer mortality in roofers, it is felt that a potential hazard exists.

It is recommended that further work be done toward developing engineering controls for the various pieces of equipment to reduce emissions. Standard work practices should be developed, as exposures could be drastically reduced using hygienic practices. Some type of training or indoctrination program should be set up to inform the employees of the safety and health hazards that exist, and how to avoid them.

Table 1

BULK SAMPLE ANALYSIS

Company: Zeric Roofing Corporation
 Santee, California
 Date of Survey: November 8, 1977
 Roofing Material Used: Asphalt

Type of Bulk Sample	Total Benzene Solubles (mg/g)	Polynuclear Aromatic Hydrocarbons (µg/g)				
		BaP	BaA	Flu	Pyr	Chr
Hot asphalt - analyzed with benzene	789.5	< 40	< 90	< 40	< 220	< 130
Hot asphalt - analyzed with cyclo- hexane	688.1	< 50	< 100	< 50	< 230	< 150

SAMPLING RESULTS

Coal Tar Pitch Volatiles

Eric Roofing Corp.
San Diego, California
Date of Sample: 11-8-77
Roofing Material Used: Asphalt

Job Title	Sampling Medium ^k	Flow (l/min)	Time (min)	Volume (m3)	Total Benzene Solubles (mg/m3)	Polynuclear Aromatic Hydrocarbons (µg/m3)				
						BaP	BaA	Flu	Pyr	Chr
Felt layer, kettle-man	F T	1.7	298	0.51	0.75 <0.04	<0.10 <0.08	<0.20 <0.16	<0.10 <0.47	<0.49 **	<0.30 <0.47
Laying felt	F T	1.7	311	0.53	1.3 <0.04	<0.09 0.04	<1.9 <0.15	<0.09 <0.45	<0.47 **	<1.1 <0.45
Laying felt	F T	1.7	305	0.52	0.35 0.23	<1.9 <0.08	<0.10 <0.15	<1.9 <0.46	<0.23 **	<0.29 <0.46
Foreman, mopping asphalt	F T	1.6	303	0.48	0.49 0.12	<0.10	<0.21	<0.10	<0.52	<0.39
Tacking felt	F T	1.7	300	0.51	1.1 0.16	<0.20 <0.08	<0.39 <0.16	<0.20 <0.47	<0.98 <1.1	<0.58 <0.47
Area sample - on kettle hood	F T	1.6	74	0.12	420 <0.17	<4.2 <1.7	32. <3.4	<4.2 <10.	<21. <6.4	68 <10.
Area sample - duplicate to previous sample	F T	1.8	169	0.30	170 1.1	<1.6 0.66	43. <1.3	<1.6 <4.2	<8.2 <3.3	20. <3.9
Area sample - background	F T	1.7	291	0.50	Not analyzed <0.40	<0.10	<0.20	<0.61	**	<0.61
Area - top of kettle hood	F T	1.8	74	0.13	230 0.45	<1.5 <0.75	47. <1.5	<1.5 <4.5	<7.5 3.3	59. <9.0
Area - duplicate to previous sample	F T	1.6	169	0.27	220 0.15	<0.74 <0.37	40. <0.74	<0.74 <2.2	<3.7 <1.9	52 <2.2

** Interfering peaks render quantitation impossible

* F - silver membrane, glass fiber filter

T - solid sorbent tube