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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 72-77-109

ASHLAND OIL INCORPORATED
(ASPHALT DEPT., REFINERY NO. 1, CATLETTSBURG, KENTUCKY)
Ashland, Kentucky 41101

FEBRUARY, 1974

I. TOXICITY DETERMINATION

It has been determined that petroleum pitch produces seasonal phototoxic reactions (e.g. exaggerated sunburn-like effects) in employees at the concentrations normally used and found in the Asphalt Department of Refinery No. 1, Ashland Oil Inc., Catlettsburg, Kentucky. This determination is based on (a) analysis of the pitch product in use, (b) environmental air sampling, and (c) medical interviews/cutaneous examinations of exposed employees.

(a) Analysis of the petroleum pitch produced in the Asphalt Department showed it to contain phenanthrene, a known photosensitizer. Benzo(a)pyrene and other closely related compounds were also identified in the material.

(b) Environmental air sampling conducted in the Asphalt Department on August 15, 1973, when there was little or no wind, light truck traffic, and the truck roadway was wetted showed employee exposures and work area concentrations to be at or below 0.2 mg/M^3 (the occupational health standard applicable to petroleum pitch promulgated by the U.S. Department of Labor). These measurements are believed to reflect normal airborne petroleum pitch concentrations during damp or wet weather. Airborne pitch concentrations are undoubtedly higher during dry weather when settled pitch particulate is reintroduced into the atmosphere by wind, truck traffic, etc.

(c) Exposed employees reported recurrent episodes of skin discomfort, redness, and peeling resembling exaggerated sunburn responses during summer months. One employee was observed to have erythromelanosis colli, a peculiar discoloration of the neck, and common sequalae of phototoxicity. Employees also reported episodes of eye and throat irritation which they related to higher dust concentrations during dry weather. In addition, members of the NIOSH survey team experienced skin burning, smarting and stinging following one day's exposure to petroleum pitch in the work area.

To date, phototoxic injury to the skin appears to have been temporary and reversible. It must be emphasized, however, that repeated and prolonged phototoxic injury to the skin may increase the danger of developing more serious skin disease. Every effort should be made to control phototoxic reactions.

Exposure (via inhalation) to coke oven emissions containing benzo(a)pyrene and similar compounds has been correlated with an increased incidence of lung cancer among coke oven workers. However, exposures to these compounds at this facility have been determined to be much less than those historically associated with occupationally related lung cancer. No evidence of serious internal disease was found during this survey. This does not preclude the possible eventual development of such effects since the facility surveyed has been in operation only since 1968 and the latency period for most serious occupationally related health hazards is frequently several decades.

It should be emphasized that employees are only intermittently exposed (via inhalation) to the pitch. However, pitch particulate and condensed vapor which settles into skin creases, clothing, etc. remains in direct contact with the worker. In this case, where irritation and phototoxic reactions are caused by direct contact with petroleum pitch, the standard applicable to petroleum pitch appears not to be protective to employees. Minimization of contact with the pitch and protection against ultraviolet light (sunlight) coupled with better dust control would seem to be elements of a logical solution. Recommendations are included in the body of the report in the interest of reducing employee exposures and resulting toxic effects.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Ashland Oil Incorporated - Ashland, Kentucky
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region IV
d) NIOSH - Region IV

For the purposes of informing the approximately 20 "affected employees" the employer shall promptly "post" copies of the Determination Report in places near where affected employees work for a period of 30 calendar days.

III. INTRODUCTION

Section 20 (a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669 (a)(6), authorizes the Secretary of Health, Education,

and Welfare, following written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees working in the Asphalt Department of Refinery No. 1, Catlettsburg, Kentucky, regarding employee exposures to flaked and molten petroleum pitch. The request alleged that employees were experiencing skin and throat irritation and burning of the eyes.

IV. HEALTH HAZARD EVALUATION

A. Evaluation Progress

An initial visit to the Asphalt Department of Refinery No. 1, Catlettsburg, Kentucky was made on October 25, 1972, by Messrs. R. Vandervort and J. P. Flesch, and Dr. E. Shmunes. Bulk samples of the pitch were obtained, possible employee exposures were identified, and employees were privately interviewed and examined. It was determined that employee symptomatology had subsided with the end of hot summer weather and that evaluation of the problem at that time would have been incomplete.

It was decided that employee exposures to petroleum pitch could be best evaluated with the return of hot summer weather. During the months after the initial visit the scientific literature was searched for information regarding petroleum pitch; other manufacturers of petroleum pitch were contacted; and chemical analysis of the bulk samples of pitch collected during the initial visit was performed.

A follow-up visit was made to the Asphalt Department on August 15, 1973 by Messrs. R. Vandervort and R. Steinhorn, and Drs. J. Lucas and J. Cromer. Environmental measurements were made and employees were privately interviewed and examined.

B. Description of Process - Conditions of Use

In addition to producing standard forms of petroleum asphalt, the Asphalt Department of Refinery No. 1, Catlettsburg, Kentucky is engaged in the production of "Petroleum Pitch." Petroleum pitch, not to be confused with coal tar pitch, is "a highly aromatic and resinous material produced by the dealkylation and dehydration (with subsequent condensation and polymerization) of low boiling aromatics, such as bicyclics and tricyclics."[1]

Employees in the Asphalt Department are intermittently exposed to both the vapors from molten petroleum pitch and to finely divided particles of solidified or "flaked" petroleum pitch. Petroleum

pitch vapors are encountered during the loading of tanker trucks and railroad tank cars with molten pitch, and at the hot end of the flaker conveyor. Exposure to petroleum pitch particulate is associated with the loading of trucks and railroad cars with flaked pitch and in the maintenance and operation of flaked pitch conveyance equipment. Airborne pitch particulate is also generated by truck traffic and wind in the Asphalt Department which disturb settled pitch particulate accumulations from conveyor overflows or loading spills.

C. Background Technical Information - Petroleum Pitch

There is a pronounced lack of technical information regarding petroleum pitch in the scientific literature. During this evaluation, information was gathered from petroleum pitch manufacturers, from other government agencies, and through direct analysis of the petroleum pitch in use.

Much of what follows is taken from Hoertz and Ball:[1]

As previously stated, petroleum pitch is a product of the refining of crude petroleum. The fraction of crude petroleum boiling between 500°F and 1100°F is taken from the first crude oil distillation units and fed to the fluid catalytic cracking units. The residual from the catalytic cracking process known as clarified slurry oil is the source of bicyclic and tricyclic compounds used in the manufacture of petroleum pitch.

Using clarified slurry oil as feed stock, two basic refining processes have been responsible for most of the production of petroleum pitch in the last 15 to 20 years. The first process (essentially the process used by Ashland Oil Inc.) fractionates the clarified slurry oil to remove light ends; may extract the slurry oil with phenol or furfuryl alcohol to concentrate aromatics; heats the slurry oil to approximately 1000°F to crack non-aromatic compounds to lower boiling materials; fractionates the product to remove light ends; cracks the product at high temperature facilitating dealkylation, dehydrogenation, condensation and polymerization; flashes off light ends leaving the final petroleum pitch product. The second process extracts the slurry oil to minimize saturated hydrocarbon content; fractionates the slurry oil to raise its boiling point to approximately 750°F; oxidizes (polymerizes) the slurry oil with air at approximately 450°F to form a final petroleum pitch product that is somewhat less aromatic than that formed by the first process.

The final petroleum pitch products formed by the above processes contain compounds with molecular weights ranging from about 150 to 5000. Pitch products have been produced with softening points of 140°F, 170°F, 230-250°F, and 290°F. (Refer to Appendices A and B for chemical and physical properties.) Ashland Oil Inc. produces primarily 170°F and 240°F softening point pitches at its Catlettsburg refinery.

Petroleum pitches have been utilized as substitutes for coal tar pitch in the manufacture of fiber pipe, fiber board, clay pidgeons, refractory brick, electrodes for the aluminum industry, and in cores for the foundry industry.

Information regarding the toxicity of petroleum pitch products is limited. Several researchers have reported on the toxicity of petroleum asphalts and coal tar pitch products, however, to our knowledge there are no published studies of petroleum pitch toxicity.

A report supplied to NIOSH by the Standard Oil Company of Ohio regarding its 170°F softening point petroleum pitch product, Trolumen 170, provided the following toxicity information:

Oral LD_{50} in rats: 3890 mg/Kg

Minimal primary irritancy to the skin of humans in the absence of ultraviolet light was observed. Very minimal eye irritancy for the rabbit was also reported.

The relevance of this information with respect to the potential toxicity of the pitches produced by Ashland Oil Inc. is unknown.

With the assistance of the staff of the U.S. Bureau of Mines - Laramie Energy Research Center in Laramie, Wyoming, several analyses were performed on the bulk sample of 240°F softening point pitch obtained from Ashland Oil Inc. on October 25, 1972. The results of these analyses follow:

1. Slightly more than 13% of the pitch sample was found to be insoluble in warm benzene.
2. Using gas chromatographic simulated distillation, it was determined that only 38% of the sample boiled before 537°F.
3. Using ion exchange chromatography,[3] on that portion of the pitch which was soluble in methylene chloride (almost 100% of sample), the sample was split into three fractions. The first fraction retained by the anion resin amounted to 4.4% of the sample. Infrared analysis showed the presence of alkanes and amides in this fraction. The second fraction retained by the cation resin comprised 4.8% of the sample. Infrared analysis of this fraction was inconclusive. The third fraction which passed through the anion and cation resins was analyzed by nuclear magnetic resonance. This analysis revealed that most of the polyaromatic compounds were methyl substituted.
4. Using gel permeation chromatography[4,5] the pitch sample was split into approximately 30 fractions. Every fifth fraction collected in the high sample evolution segment was analyzed by thin layer chromatography and ultraviolet fluorescence spectrophotometry. The following compounds were identified from the selected fractions: (1) phenanthrene, (2) pyrene, (3) benzo(a)pyrene, (4) benzo(e)pyrene, (5) 1,12-benzoperylene, and (6) anthanthrene. Other ring systems were found but time constraints precluded their identification.

5. Qualitatively, the polycyclic fraction of the pitch was found to be primarily composed of tricyclic and tetracyclic ring structures. Bicyclic, pentacyclic, and hexacyclic ring structures were found to be present in relatively smaller quantities. The wide variety of methyl substitution significantly hindered individual compound identification.

D. Evaluation Methods

1. Petroleum Pitch Air Sampling

Employee exposures to petroleum pitch were measured via personal air sampling equipment. Both work area and breathing zone samples were obtained using both total and respirable particulate sampling procedures. Samples were analyzed for total particulate weight and for benzene soluble material according to the procedure of Richards et al.[6] Silver membrane filters were used exclusively.

2. Medical Survey Methods

Medical evaluations were conducted on both October 25, 1972 and on August 15, 1973 by different NIOSH physicians. Employees were interviewed and a brief cutaneous examination was performed by a dermatologist during each visit.

E. Evaluation Criteria

The U.S. Department of Labor has ruled that employee exposures to the "fused polycyclic hydrocarbons which volatilize from the distillation residues of petroleum" be controlled to the same extent as exposures to coal tar pitch volatiles (Federal Register, Vol. 37, No. 225, November 21, 1972, page 24749). The basis for this ruling was that volatiles from petroleum residues contain many of the same compounds found in coal tar pitch volatiles and should therefore present a similar hazard to health. The current occupational health standard promulgated by the U.S. Department of Labor (Federal Register, October 18, 1972, Title 29, Chapter XVII, Subpart G, Table G-1) applicable to exposures to petroleum pitch is as follows:

Substance	8-hour time-weighted-average exposure (mg/M^3)[a]
Coal Tar Pitch Volatiles	0.2[b]

[a] mg/M^3 - approximate milligrams of substance per cubic meter of air.

[b] 0.2 - only the volatiles or particulates collected via total mass sampling which are soluble in benzene are reflected by this number.

In general, occupational health standards for individual materials are established at levels designed to protect workers occupationally

exposed on an 8-hour per day, 40-hour per week basis over a working lifetime. In this case, the standard is based primarily on inhalation effects and may not be protective to employees with regard to potential skin irritation or phototoxic reactions.

F. Evaluation Results

1. Petroleum Pitch Air Sampling

A total of twelve samples for airborne petroleum pitch volatiles and particulate were collected in the Asphalt Department on August 15, 1973. Eleven of the samples were collected at various stations in the Asphalt Department as shown in Figure 1. The twelfth sample was collected in the breathing zone of the Flaker Operator. The results of this sampling are presented in Table I. As noted in the table, six of the eleven stationary samplers collected total or gross airborne particulate and the remaining five collected only respirable airborne particulate. The sampler worn by the Flaker Operator collected total or gross particulate. As reflected by the sample results, very little airborne contamination was present in the Asphalt Department on the day of evaluation. In fact, August 15, 1973 was a "good" operating day since there was little or no wind, light truck traffic, and a heavy rain the day before had completely wetted the truck roadway resulting in neglible reintroduction of settled pitch particulate into the air. It is suspected that these types of operating conditions are present during many days of fall, winter and spring months.

The sampling and analytical method used to determine airborne concentrations of coal tar pitch volatiles, and in this case petroleum pitch, is not reproducible at concentrations of benzene soluble material near or below 0.2 mg/M^3. This limitation is primarily due to the poor sensitivity of the procedure. The procedure, however is sufficiently sensitive to identify exposure levels above 0.2 mg/M^3. Thus, when samples are collected over several hours and no benzene soluble material is detected by this method, it is reasonably safe to conclude that concentrations are near or below 0.2 mg/M^3. With these considerations in mind, the results in Table I are judged to reflect concentrations of airborne benzene soluble material near or below 0.2 mg/M^3 on the day of evaluation.

It is important to note that Asphalt Department employees are <u>intermittently</u> exposed to petroleum pitch. In actuality only two employees each shift work in the immediate pitch process area. One individual is the Flaker Operator and the other is basically responsible for loading trucks and railroad cars with pitch product. Both spend much of their workday inside the Operator and Loader shacks shown in Figure 1. These shacks afford protection from extremes of temperature and exposure to pitch. Exposure to pitch occurs when routine process checks are made, and during cleanup and maintenance of conveyance equipment.

The remaining employees in the Asphalt Department are exposed to pitch as they pass by the pitch process or help in cleaning up pitch spills. When the yard area becomes covered with dry pitch dust, then truck traffic and wind disperse the dust resulting in relatively higher exposure of all personnel in the department.

2. Medical Findings

Eleven individuals, all men, were interviewed and given brief cutaneous examinations during the survey. Three men were interviewed during both visits. The age range was 25 to 60 years with an average age of 37.3 years. Average length of employment with Ashland was 12.6 years and all had worked in the asphalt Department for 3 to 4 years. Two individuals spent very little, if any, time in the actual area of exposure and both were essentially asymptomatic, although one had noted eye irritation in the past. Five men worked approximately half-time in the area.

Seven of the nine men with significant exposures to petroleum pitch reported past episodes consistent with phototoxicity. These episodes had been more frequent in past years, perhaps because of the unusally rainy and cloudy weather conditions which prevailed during the Spring and Summer of 1973 directly preceding our evaluation. Phototoxic symptoms included skin discomfort, redness, and peeling resembling exaggerated sunburn responses on exposed skin surfaces. In most instances these symptoms recurred at frequent intervals throughout the summer months. One worker exhibited typical findings of erythromelanosis colli, a peculiar discoloration of the neck, and common sequalae of phototoxicity. Only one individual was taking a medication known to occasionally cause phototoxic reactions, but this man was one of the asymptomatic workers.

Six of the men with significant past exposures also complained of eye and upper respiratory tract irritation (burning and stinging of the eyes and throat soreness) in relation to their work. Incidental findings included tinea (fungus) infection, actinic keratosis (related to sun exposure) and one individual with several hyperkeratotic lesions on the back of one hand (possibly pitch warts). Three men complained that, even though they carefully showered before leaving the plant, they continually discolored (yellow stains) clean shirts put on when they got home. They also noted the staining of bedding.

In addition to the above findings, four individuals comprising one NIOSH study team experienced skin discomfort (stinging, burning, smarting) following exposure at the work site. One investigator developed an erythematous area on the neck. These symptoms cleared within 24 hours.

3. Discussion and Recommendations

Phototoxic reactions due to various tars, asphalts, and pitches are among the most common of all photosensitivity reactions. As expected, these reactions principally affect outdoor workmen who handle these materials and receive intense exposures to sunlight (e.g. roofers, road workers, wood preservers, etc.). The increased pigmentation of the Negro and Indian has proven to be of definite protective value and such workers are essentially immune to this reaction. Photosensitivity is a seasonal disease, since only during the summer months is sufficient ultraviolet light available to trigger the reaction. Ultraviolet light of wavelengths 3500-4000°A is responsible. The elimination of either the light or contact with the phototoxic substance eliminates the reaction.

At least 300 distinct compounds have been isolated from coal tar, and of these, several (acridine, anthracene, phenanthrene, and pyridine) are known photosensitizers. Analysis of petroleum pitch from Ashland revealed phenanthrene and other closely related compounds.

Although complete recovery from episodes of phototoxic reactions was observed in employees of the Asphalt Department, it must be emphasized that repeated and prolonged phototoxic injury to the skin may increase the danger of developing more serious skin disease. Every effort should be made to minimize phototoxic reactions.

Prevention of phototoxic reaction is difficult since protection from ultraviolet light exposure is necessary at the time of contact with the pitch and for several days or weeks thereafter. Most sun screens have little activity in blocking longer ultraviolet light which is responsible for this reaction. Those that are effective are usually cosmetically or esthetically unsatisfactory. However, a new sunscreen (Duoshield, Rowell Laboratories, Inc., Baudette, Mn. 56623) seems very promising. Initial protection is developed for several days prior to exposure by three alternate applications of the two Duoshield components. In most persons, protection can be maintained by a single, daily application of both lotions. An invisible barrier to ultraviolet light is actually formed within the outer layers of the skin. It, thus, cannot be washed off by swimming, perspiration, or even soap bathing.

Recommendations:

1. When trucks or railcars are loaded with flaked pitch, the loading chute should be lowered or extended into the hauling vehicle to minimize generation of dust and subsequent accumulations of settled particulate.
2. The yard area of the Asphalt Dept. should be routinely wetted down to control reintroduction of settled particulate into the air by truck traffic, wind, etc.

3. Before large spills or accumulations of flaked pitch or pitch dust are cleaned up, the accumulation should be dampened to minimize dust generation.
4. Employees should wear fresh work clothing each day. Long sleeves and gloves are recommended. Cuffs and collars should be loose fitting to prevent entrapment of particulate matter. Hardhats should be fitted with capes (neck and shoulder protectors) to prevent pitch from falling onto and down the back of the neck. These capes would also offer some protection from sunlight.
5. Safety glasses with side shields or goggles should be worn to prevent pitch particulate and vapor from getting into the eyes.
6. The new sunscreen Duoshield should be tried.

V. REFERENCES

1. Hoetrz, C. D. and G. L. Ball of Ashland Chemical Company, Division of Ashland Oil and Refining Company, Ashland, Kentucky. "Properties and Possibilities of Petroleum Pitch" - A paper presented at MAP-PENNTAP'S Carbon Industry Seminar, October 6, 1969, in cooperation with Pennsylvania State University.

2. Personal communication with Ashland Oil Inc., Mobil Oil Corporation, and Standard Oil of Ohio.

3. Jewell, D.M. Ion Exchange Coordination and Absorption Chromatographic Separation of Heavy-End Petroleum Distillates. Analytical Chemistry, Vol. 44, No. 8, July, 1962.

4. Cogswell, T. E., et al. Gel Permeation Chromatographic Separation of Petroleum Acids. Analytical Chemistry, Volume 43, No. 6, May, 1971.

5. McKay, J. F., et al. The separation of Acidic Compound Types Isolated from High Boiling Petroleum Distillates Separation Science, Vol. 7, No. 4, 1972.

6. Richards, R. T., et al. A Preliminary Report on the Use of Silver Metal Membrane Filters in Sampling for Coal Tar Pitch Volatiles. American Industrial Hygiene Association Journal, Nov. - Dec., 1967.

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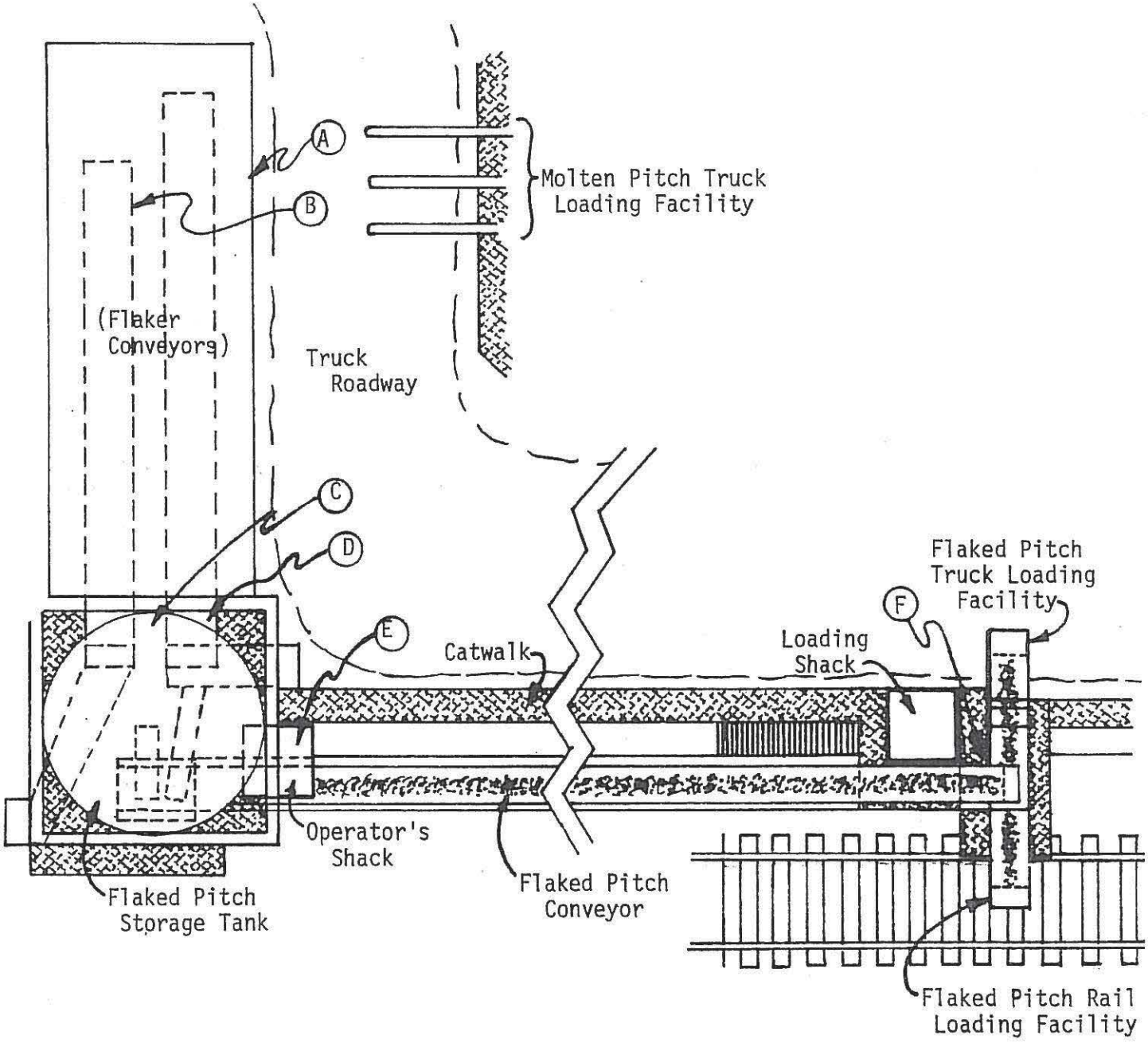
Table I - Air Sampling Data - Samples Collected 8/15/73

Sample Location	Type	Total Sample Volume (M^3)	Total Sample mg/Filter[e]	Benzene Solubles mg/Filter[e]	Particulate mg/M^3[g]	Benzene Solubles mg/M^3[g]
A[a]	T[b]	0.50	ND[f]	ND	ND	ND
A	R[c]	0.57	2.4	ND	4.2	ND
B	T	0.50	0.3	0.1	0.6	0.2
B	R	0.56	ND	0.1	ND	0.2
C	T	0.42	ND	ND	ND	ND
C	R	0.48	ND	ND	ND	ND
D	T	0.47	0.1	ND	0.2	ND
D	R	0.53	ND	ND	ND	ND
E	T	0.43	ND	ND	ND	ND
F	T	0.48	0.3	0.1	0.6	0.2
F	R	0.54	ND	ND	ND	ND
G	TBZ[d]	0.51	ND	ND	ND	ND

a - Refer to Figure 1 for sampling locations
b - Sampler collected total particulate (i.e. open-face filter)
c - Sampler collected respirable particulate via use of size selective presampler.
d - Sampler collected total particulate in worker's breathing zone.
e - Adjusted values, average blank value has been subtracted.
f - ND menas "none detected" (i.e. sample present in an amount below the lower detection limit of the analytical method)
g - Milligrams of substance per cubic meter of air.

Figure 1 - Location of Sampling Stations (8/15/73)



Designation	Description
A	On Railing Adjacent to Large Flaker Conveyor and to Molten Pitch Truck Loading Facility
B	Between Flaker Conveyors at Start of Small Flaker Conveyor
C	Between Flaker Conveyors at End of Conveyors
D	Adjacent to End of Large Flaker Conveyor
E	Inside Operator's Shack
F	Adjacent to Loading Shack - Below Conveyor Transfer
G	Breathing Zone of Flaked Pitch Operator

Appendix - A

Petroleum Versus Coal Tar Pitch
Comparison of Elemental Analyses [1]

	Petroleum Pitch		
	Thermally Cracked	Oxidized	Coal Tar Pitch
Low Softening Point Pitch			
Sofening Point (Rand B), °F	170	168	155
Carbon, Wt. %	93.22	90.6	90.46
Hydrogen, Wt. %	5.89	6.1	4.67
Sulfur, Wt. %	0.7	0.7	0.85
Ash, Wt. %	0.02	0.1	0.05
Oxygen, Wt. %	0	2	4
High Softening Point Pitch			
Softening Point (Rand B), °F	245	230	230
Carbon, Wt. %	91.75	89.6	94.10
Hydrogen, Wt. %	5.61	6.4	4.35
Sulfur, Wt. %	0.7	0.5	~0.8
Ash, Wt. %	0.02	0.1	0.3
Oxygen, Wt. %	0	1.7	4.4
Nitrogen, Wt. %	0.1	-	0.75
Iron, Wt. %	0.003	0.02	0.025

Appendix - B

Petroleum Versus Coal Tar Pitch
Comparison of Physical Properties [1]

	Petroleum Pitch		
	Thermally Cracked	Oxidized	Coal Tar Pitch
Low Softening Point Pitch			
Softening Point (Rand B), °F	170	168	155
Specific Gravity 77°F/77°F	1.1880	1.1620	1.2672
Flash Point, COC, °F	545	500	445
Penetration, 77°F/60 Sec/ 200g, 0.1 MM	0	7	0
Viscosity, CPS			
@ 300°F	125	300	135
@ 325°F	64	140	72
@ 850°F	35	75	44
Coking Value (ASTM D2416), Wt. %	39	36	45
Quinoline Insolubles, Wt. %	0	0	10
Benzene Insolubles, Wt. %	3	6	21
High Softening Point Pitch			
Softening Point (Rand B), °F	245	230	230
Specific Gravity 77°F/77°F	1.2251	1.1900	1.3270
Flash Point, COC, °F	555	530	500
Penetration, 77°F/60 sec/ 200g, 0.1MM	0	0	0

	Petroleum Pitch		
	Thermally Cracked	Oxidized	Coal Tar Pitch
High Softening Point - Cont.			
Viscosity, CPS			
@ 400°F	170	3300	230
@ 425°F	85	1350	135
@ 450°F	45	375	90
Coking Value (ASTM D2416), Wt. %	54	-	56
Quinoline Insolubles, Wt. %	0	0	17
Benzene Insolubles, Wt. %	8	12	30
Infrared Index	1.05	-	1.3
290°F Softening Point Pet. Pitch			
Specific Gravity, 77°F/77°F		1.2025	
Sofening Point (Rand B), °F		296	
Flash Point, COC, °F		600	
Viscosity, CPS			
@ 425°F		3000	
440°F		1500	
460°F		700	
480°F		500	
500°F		300	
Quinoline Insolubles, Wt. %		0	
Conradson Carbon Residue, Wt. %		45.17	
Ash, Wt. %		0.58	