Background Report Reference

AP-42 Section Number: 10.8

Background Report Section: 4

Reference Number: 5

Title: Non-criteria Pollutant Emissions Calculations for Koppers Industries

ETS, Inc

June 17, 1991

AP-42 Section 10.8
Reference
Report Sect. 4
Reference 5

93/2/18

LYCHBURG

582 5120

DON SHEPEARD
(703) 561 7000

BOB SAMUDERS

MARGARET KEES

UNLOADING (1 HR STD.)

SPLIT EMISSIONS
INTO 2-3 SUB GROUPS
BASED ON TOXICITY

AIR DISPERSION MODELING PROTOCOL

PREPARED FOR THE NON-CRITERIA POLLUTANT ANALYSIS

FOR KOPPERS INDUSTRIES IN SALEM, VIRGINIA

NOT A TEST OR MODELING ANALYSIS — ONLY PROTOCOL Proposed

JULY 17, 1991

ETS, INC.

A subsidiary of ETS International, Inc.

1401 MUNICIPAL ROAD, N.W.

ROANOKE, VA 24012

Pollution Control Consultants
Specializing In
Toxic Emission Measurement and Control

ETS CONTRACT NO: 91-468-R

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I. Modeling Protocol: Prepared for the Non-Criteria Pollutant Analysis of the Koppers Industries Salem Facility

The following is the proposed air dispersion modeling protocol for creosote emissions from the Koppers Industries wood treating operations located in Salem, Virginia. The plant is located in Roanoke County at UTM coordinates 4125130 North and 577190 East at an elevation of approximately 1070 feet above mean sea level. Attached are the Glenvar and Salem Quadrangle USGS topographic maps showing the site location and nearby terrain features.

Section I of this plan describes the pollution emission characteristics and locations. Section II provides an overview of the good engineering practice (GEP) stack height evaluation, the screening modeling planned, and the purpose of the modeling. Section III lists the modeling output products available for the Virginia Department of Air Pollution Control (DAPC) review. The modeling analysis will conform to DAPC's modeling guidelines.

If DAPC mandates changes to the modeling protocol, or if unexpected regulatory actions or project alterations warrant, this protocol will be revised and resubmitted for review and approval.

I.1. SOURCE LOCATION AND DESCRIPTION

Wood preservation is the impregnation of chemicals into wood to a depth that will provide effective long-term resistance to attack by fungi and insects. Three preservatives commonly used in the U.S. for wood preservation are pentachlorophenol, creosote and aqueous formulations of arsenic, copper, chromium and ammonia. The Koppers Industries Salem Plant applies creosote to railroad ties.

Coal tar creosote is a heavy oil made by distilling coal tar. The properties of creosote oil are shown in Table 1. It consists of many components, most of which belong to the family known as polyaromatic hydrocarbons (PAH). Only approximately 20 components are present in concentrations greater than 1 percent. Table 2 shows a representative list of major components in creosote. Either coal tar or petroleum oil can be mixed with coal tar creosote. Koppers uses a mixture consisting of 40% coal tar oil and 60% creosote. The material safety data sheet (MSDS) for this mixture is presented in Appendix C. This mixture is obtained premixed from an offsite supplier.

Koppers operates three steel treatment retorts on a staggered schedule. This serves to optimize the utilization of common process resources and minimize instantaneous emission rates. Figure 1 depicts a schematic of the plant operations. Figure 2 shows the process steps for a typical cycle. The creosote is applied to three different types of ties: cross-ties, switch-ties, and bridge-ties. Creosote is applied by filling a large (8 foot diameter, 140 foot long) retort with a "charge" consisting of approximately 500 to 1000 ties (depending on the type of tie being treated). The ties are stacked on rail trollies, each holding up to 70 typical ties. Small wooden spacers are used to gap the ties.

After the charge is loaded, the retort is closed and sealed. Approximately 20,000 gallons of creosote is introduced into the retort from a 50,000 gallon working tank. The ties first go through a Boultonizing process in which water moisture is removed from the wood. The retort contents are heated and maintained at a temperature of 190 to 200°F under a vacuum of approximately 24 inches of mercury for approximately 16 hours. This process removes water from the pores of the wood and replaces it with creosote oil. Water moisture and process vapors are removed to a condenser with the condensate going to a wastewater treatment plant. At the end of the Boultanizing cycle, creosote is pumped

out of the retort and back to the working tanks. Vacuum is maintained for an additional period until the optimum moisture content is attained. The retort is then refilled with creosote, under 160 to 170 psi pressure at 190 to 200°F. This cycle is called the Reuping Process and takes 2 to 4 hours. The Reuping Process forces creosote deep into the wood pores. The tank is then emptied and the pressure released. Displaced air is scrubbed to remove creosote emissions. The creosote is released from the inner pores leaving treated cell walls. A vacuum (20 to 30 inHg) is maintained for 2.5 to 3 hours prior to opening the retort and removing the charge. This step is performed to reduce the emissions of volatile components during the retort opening and from the treated ties as they cool. This measure also reduces the amount of drippage from the charge after it is removed from the retort. The treated ties are removed from the retort, rolled along approximately 400 feet of railroad track, and left for loading onto railroad cars (for removal from the plant), or longer-term storage on the plant grounds.

The facility consists of three retorts, each of which may operate simultaneously. A typical cycle time is approximately 24-hours and the retorts generally operate on a time staggered cycle.

I.2. POLLUTANT CHARACTERISTICS

Creosote is a complex mixture of chemicals resulting from selective distillation of coal tar oil. The typical boiling point ranges continuously from approximately 200 to 300°F. Due to the complexity of the mixture of compounds and due to the sparse toxicological data available for certain creosote constituents, modeling will be performed in such a manner that each constituent may be evaluated separately or the total, as creosote emissions, may be evaluated. The nature of the modeled impacts may warrant either a more detailed look at individual

constituents or possibly a situation whereby an engineering solution may cover all constituents at once. Creosote air emissions occur from two primary sources:

1) Creosote vapor emitted from the treated ties which are awaiting transport off-site.

2) Creosote vapor released to atmosphere when the treated ties are unloaded from the retort after boultanizing (treatment).

The basis for the emissions calculations is contained in Appendix A which contains a report entitled "Non-Criteria Pollutant Emissions Calculations for Koppers Industries, Salem, Virginia" dated June 17, 1991 and Appendix B which contains "AWPI GUIDANCE FOR EMISSIONS REPORTING UNDER TITLE III/SECTION 313 OF THE EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT". Table 1 lists the maximum 1-hr emission rates for the individual creosote components.

Emissions calculations in this document are made on a maximum one-hour basis for calculation of maximum 1-hr and maximum 24-hr ambient concentrations. Maximum annual ambient concentrations are based on total annual emission rates.

Conversion of pollutants to other species, depletion and deposition will not be considered in the dispersion modeling.

II. OVERVIEW OF THE MODELING PROTOCOL

To demonstrate compliance with Virginia non-criteria pollutant SAAC 1-hr, 24-hr and annual averages, the following modeling protocol is proposed. This consists of screening modeling using the EPA ISCST Model. The emissions from the Koppers plant are expected to produce their maximum impact in ambient air at the plant fenceline due to the fact that the

predominant emissions occur from groundlevel area and volume sources. The retort doors will be considered to be individual area sources. The fresh ties removed from the retort and still on their trollie cars are treated as volume sources. The highest 1-hr emission rates are used to generate short-term 1-hr and 24-hr averages. All modeling is performed using nominal 1 gram per second emission rates such that ambient impacts can be calculated either on an individual constituent basis or as total creosote. The emission rates to convert normalized (X/Q) impacts to actual impacts are contained in Appendix A.

II.1 Good Engineering Practice Stack Height (GEP) Analysis

GEP analysis will not be applicable to the initial modeling study since the retort doors and fresh ties will be treated as area and volume sources respectively. In the event that it becomes necessary to build a structure and vent emissions through a stack in order to resolve ambient impacts in excess of Virginia SAAC, a GEP analysis will be conducted as a part of the followup modeling. GEP is calculated using the following equation:

$$H_g = H_b + 1.5L$$

where H_g = calculated GEP stack height
H_b = height of the nearby building
L = lesser of height or projected width of the nearby building
"nearby" means any building within a distance of 5L of the stack

A GEP analysis will be conducted for all structures "nearby" the stack. Guideline for Determination of Good Engineering Practice Stack Height Regulation (Ref 1) will be followed for determining the GEP for each stack modeled. The building or structure resulting in the largest GEP for each stack will be

identified as the dominant building for that stack. The actual GEP calculations will be included with the final analysis.

II.2 Simple Terrain Analysis - ISCST Model

The ISCST Model will first be run in the screening mode. The model will be used with meteorological data corresponding to the SCREEN default meteorological data. The site will be modeled out 1.0 kilometer in each direction. The site will be divided into 100x100 meter grids. The highest terrain feature within each grid will be assigned to that grid. The model will calculate 1-hr, 3-hr and 24-hr averages. Annual averages will be calculated from 1-hr averages using the factor of 0.07.

Koppers proposes to construct a fence surrounding the property. Individual discrete receptors will be placed at 25 meter intervals along the fenceline. Additional square grid receptors (25x25 meter grid) will be placed out to 100 meters beyond the fenceline (4 deep) around the plant.

Koppers is located in the same valley as the Roanoke Airport NWS meteorological weather station. The valley runs approximately northeast/southwest and is oriented very similarly for both Koppers and the NWS. Koppers proposes to use 5 recent years of Roanoke NWS (1983-1987) met data, if additional refined modeling is required to resolve impacts.

II.3 Intermediate and Complex Terrain Modeling

Special treatment for elevated terrain will be performed if elevated stacked emission points are designed to remediate modeled problems. The EPA SCREEN Model will be used in the Valley mode. The minimum distance to each terrain contour will be input into the model without regard to direction. This represents a worst case treatment for intermediate and complex terrain.

II.4 Results

Maximum modeled concentrations for each averaging period will be compared to SAAC values for creosote and its individual constituent components. Modeled impacts in excess of acceptable levels will be scrutinized to determine whether additional refined modeling will provide acceptable results or if it is clear that additional controls will be necessary to accomplish acceptable levels. Additional modeling will be performed accordingly.

III. OUTPUT PRODUCTS AVAILABLE TO DAPC

In addition to the documentation of all aspects of the dispersion modeling, we will provide DAPC with copies of the computer model output to the extent desired. This would include the entire set of modeling inputs and outputs for the modeling. This information can be provided in hard-copy form, and on disk.

If the initial modeling fails, Koppers will review the modeling results in order to determine the options available to control emissions. Where possible, additional modeling will be performed to test the viability of these control strategies.

IV. REFERENCES

1. United States Environmental Protection Agency, 1981: Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for Good Engineering Stack Height Regulations). EPA-450/4-80-023 U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711

2. Guidelines for Air Pollution Maintenance Planning and Analysis Volume 10 (Second Edition) (Revised)(EPA-450/4-77-001)

V. MODELING CONTACT

Dr. Ted Handel - ETS, Inc. 1401 Municipal Rd NW, Roanoke, VA 24012 (703) 265-0004

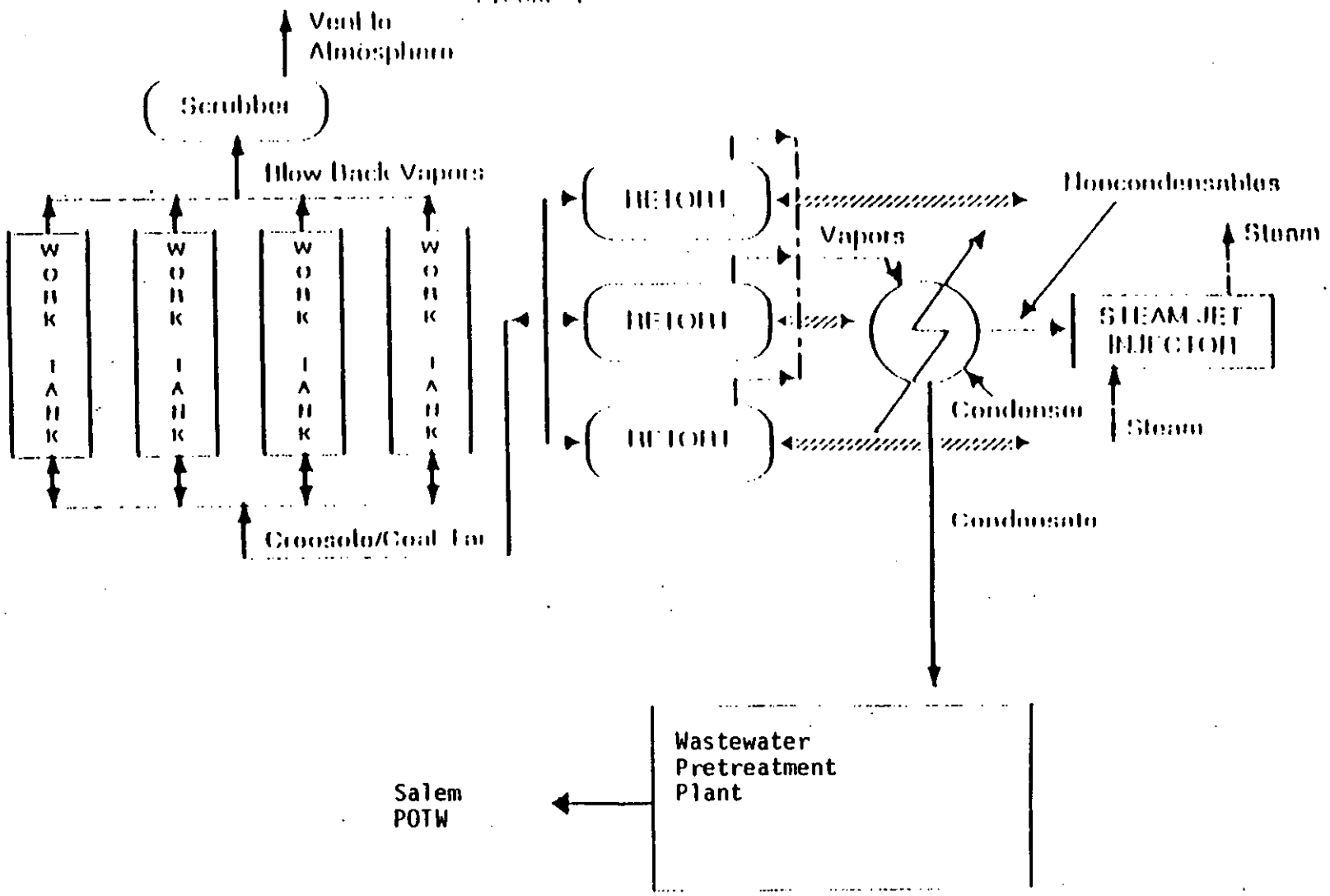

Figure 1. Process flow diagram of Koppers' Salem, Virginia wood treatment operation.

FIGURE 2

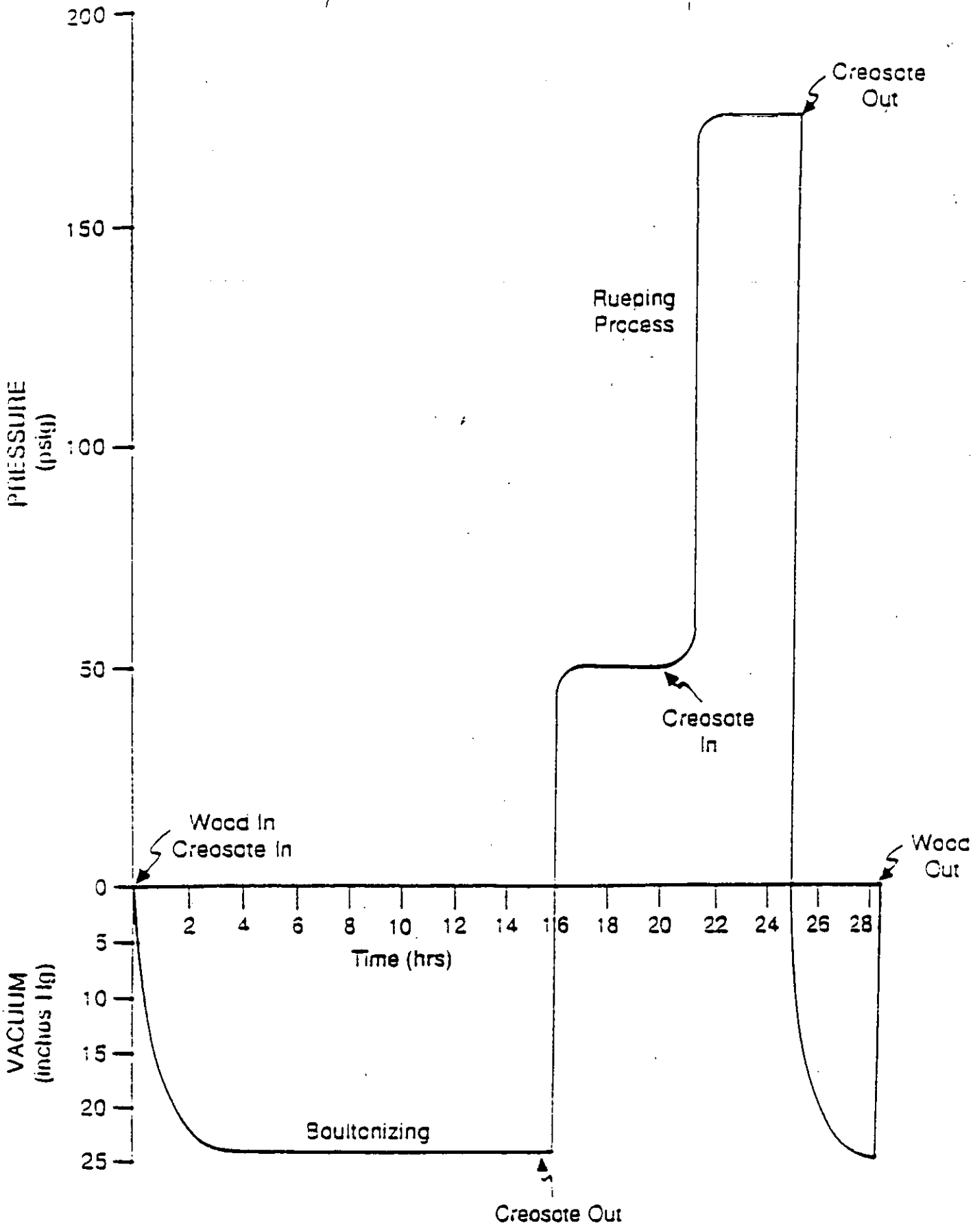

Figure 2. Pressure fluctuations in the retort during the treatment cycle at Koppers' Salem, Virginia wood treatment plant.

TABLE 1. PHYSICAL AND CHEMICAL PROPERTIES OF CREOSOTE[3]

Identification	
Common:	Creosote oil
Synonym:	Coal tar creosote
CAS Registry No.:	8001-58-9
Physical and chemical properties	
Physical state:	Liquid
Solubility:	Insoluble in water. Soluble in alcohol, benzene, and toluene
Specific gravity:	1.05-1.09 at 15°C (sinks in fresh and marine waters)
Vapor pressure:	Variable
Boiling point:	200° to 540°C
Odor:	Acrid, tarry aromatic
Vapor density:	Variable
Appearance:	Yellow to black oily liquid with sharp, smoky or tarry odor
Melting point:	Varies (-60° to -20°C)
Flash point:	>74°C-combustible liquid
Explosive limits:	Variable, 1 to 7 percent
Hazard data	
Fire	
Extinguishing data:	Use dry chemical, foam, or carbon dioxide. Use water to cool fire-exposed containers
Fire behavior:	Forms irritating heavy black smoke
Ignition temperature:	Variable, typically 400°C
Burning rate:	4 mm/min
Reactivity	
With water:	No reaction, insoluble
With common materials:	May react with oxidizing agents or strong acids
Stability:	Stable

Reference: EPA-450/3-89-028
Evaluation of Emission Sources from Creosote Wood Treatment Operations

TABLE 2. MAJOR COMPONENTS IN CREOSOTE[6]

Component	Whole creosote, percent[a]	Boiling point, °C.760[b]	Melting point, °C[b]	Molecular weight
Naphthalene	5.0	218	80.55	128.2
2-Methylnaphthalene	1.2	241.05	24.58	142.2
1-Methylnaphthalene	0.9	244.64	-22	142.2
Biphenyl	0.8	255.9	71	154.2
Dimethylnaphthalenes	2.0	268	-18-104	156.2
Acenaphthalene	9.0	279	96.2	156.2
Dibenzofuran	5.0	287	86-87	168.2
Fluorene	10.0	293-295	116-117	166.2
Methylfluorenes	3.0	318	46-47	180.2
Phenanthrene	21.0	340	101	178.2
Anthracene	2.0	340	216.2-0.4	178.2
Carbazole	2.0	355	247-248	167.2
Methylphenanthrenes	3.0	354-355	65-123	192.2
Methylanthracenes	4.0	360	81.5-209.5	192.2
Fluoranthene	10.0	382	111	202.3
Pyrene	8.5	393	156	202.3
Benzofluorenes	2.0	413	189-190	216.3
Chrysene	3.0	448	255-256	228.3
	90.4			

[a]Approximate pct. ±0.7 percent.
[b]Values from Handbook of Chemistry and Physics, 1971-72, 52nd ed., Chemical Rubber Publishing Company, Cleveland, Ohio.

Reference: EPA-450/3-89-028
Evaluation of Emission Sources from Creosote Wood Treatment Operations

APPENDIX A

NON-CRITERIA POLLUTANT EMISSIONS CALCULATIONS

Ref 5.

NON-CRITERIA POLLUTANT EMISSIONS CALCULATIONS

FOR

KOPPERS INDUSTRIES
SALEM, VIRGINIA

REPORT DATE: JUNE 17, 1991

ETS, INC.

A subsidiary of ETS International, Inc.

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ROANOKE, VA 24012

Pollution Control Consultants
Specializing In
Toxic Emission Measurement and Control

ETS CONTRACT NO. 91-468-R

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1.0 INTRODUCTION

The Koppers Industries Salem Plant applies creosote to railroad ties. The creosote is applied to three different types of ties: cross-ties, switch-ties, and bridge-ties. Creosote is applied by filling a large (8 foot diameter, 140 foot long) cylinder (retort) with a "charge" consisting of approximately 500 to 1000 ties (depending on the type of tie being treated), loaded on trollies. The ties go through a process (boultanizing) in which water is removed from the wood, and heated creosote is allowed to soak into the wood. The treated ties are then removed from the cylinder, rolled along approximately 400 feet of railroad track, and left for loading onto railroad cars (for removal from the plant), or longer-term storage on the plant grounds.

This document will calculate plant emissions related to the creosoting process. These emissions come from two sources:

1) Creosote vapor emitted from the treated ties which are awaiting transport off-site.

2) Creosote vapor released to atmosphere when the treated ties are unloaded from the retort after boultanizing.

Emissions calculations in this document are made on a maximum one-hour basis.

2.0 EMISSIONS FROM TIES AWAITING TRANSPORT

2.1 GENERAL APPROACH

The approach used in this analysis was as follows:

1) Conduct a review of Koppers research emissions testing data from Koppers' Feather River, California plant. This testing determined pollutant emission rates from creosote-treated wood. A copy of the summary of the test plan and test results is included in Appendix A.

The Feather River, California tests involved placing six creosoted poles underneath a small temporary "tunnel". Air was drawn through the "tunnel" by a fan, with a flowrate corresponding to a 2 mph wind.

The concentrations of 22 separate non-criteria pollutants were determined (by gas chromatotography), and the individual mass emission rates were then determined (emission rate = concentration x volumetric flowrate). Koppers California test emission rates were given in units of mg/hr (milligrams per hour).

2) The Koppers Salem Plant operational data was reviewed, and the results of this review were used to calculate Salem Plant emissions, based on the California emissions research test results.

2.2 REVIEW OF KOPPERS FEATHER RIVER, CALIFORNIA EMISSIONS RESEARCH TEST RESULTS

A comparison was made between the 22 separate compounds which were examined in the California test, and compounds identified by a chemical analysis of the coal tar creosote used at the Salem Plant. The pollutants which were measured in the California testing (Appendix A) closely correspond to a capillary gas chromatograph/mass spectrometer analysis of coal tar creosote, presented in Appendix B. Therefore, the California test results can be utilized to predict Salem plant emissions.

The California testing determined emission rates from the logs as a function of time. It was found that emissions decreased with time (as the poles cooled, creosote soaked farther into the poles, and volatile compounds were emitted into the air). Three tests were conducted within 24 hours of removal of the poles from the creosoting process (1 test at 0-3 hours, 1 test at 4-6 hours, and 1 test at 7-18 hours). These tests were labelled in the test report as "Fresh 1", "Fresh 2" and "Fresh 3". Three more tests were conducted after 24 hours had elapsed. These tests were reported as "1 day (1)", "1 day (2)", and "1 day (3)". Additional tests were conducted at 4 days, 7 days, 12 days, and 30 days after removal. Figure 1 presents of the California tests, with elapsed

time after removal from the cylinder on the X axis, and concentration as a function of the "Fresh 2" (5 hours after removal) concentration plotted on the Y axis. Figure 1 presents the data plotted out to 360 hours (12 days) after removal from the cylinder. Figures 2 and 3 present this same data, with time durations shortened to 160 hours and 50 hours after removal from the cylinder (respectively). If Figures 2 and 3 are examined, it can be seen that the measurements for "Fresh 1" (approximately 2 hours after removal) do not agree with the measurements for "Fresh 2" (5 hours after removal) or "Fresh 3" (12.5 hours after removal). These measurements do not agree, because measurements taken 2 hours after removal from the cylinder should be higher than measurements taken 5 or 12.5 hours after removal. (It should be noted that this either means that the "Fresh 1" data is too <u>low</u>, or the "Fresh 2" and "Fresh 3" data are too <u>high</u>.) In order to provide a conservative (equal to or higher than actual emissions) calculation of emmisions, a line was extended from the 12.5 hour (Fresh 3) and 5 hour (Fresh 2) data. This line predicts concentrations in the first hour to be, on average, 1.22 times the 5-hour concentrations (see Figure 4).

Table 1 shows calculated emission rates in the first hour, as well as reprinted (from Appendix A) California test emission rates for "Fresh 2" (hour #5), "1 Day (3)" (hour #30), and "Day 12" (hour #288).

The Koppers California tests were conducted utilizing six creosoted poles. The poles were approximately 45 feet long, with a total volume of 163.8 ft^3. In order to utilize these results to calculate emissions from the Salem Plant, it was necessary to determine the volume for a typical "charge" the Salem Plant. The volume for a charge was calculated to be 3532 ft^3. The ratio of the volume of wood in a charge at the Salem Plant to the volume of wood in the California tests was therefore 21.6 to 1.

2.3 CALCULATION OF SALEM PLANT EMISSIONS, BASED ON SALEM PLANT OPERATIONAL DATA

The volume of wood and approximate age of railroad ties at the Salem plant was estimated. Table 2 presents the results of the wood volume/age analysis for the Salem plant.

Emission rates for non-criteria pollutants at the Salem Plant were calculated, based on the converted California test data, and the Salem Plant wood volume/age analysis. Calculated total emission rates are presented in Table 3 in terms of milligrams/hour. Table 4 presents the results in the typical air pollution modelling terms of grams/second.

3.0 EMISSIONS FROM DISCHARGE OF CYLINDERS (RETORTS)

Emissions were calculated for vapor released when the treated ties are unloaded from the cylinder (retort) after boultanizing (treatment).

The emission calculation for cylinder unloading was based on "American Wood Preservers Institute Guidance for Emissions Reporting Under SARA Title III / Section 313 of the Emergency Planning and Community Right-to-Know Act".

The document describes a method to calculate emissions due to opening of the cylinder (retort) door, to remove a charge after treatment. The emissions calculations are based on (1) the total number of charges per year, (2) the average charge volume, (3) the total retort (cylinder) volume, and (4) the retort temperature when the door is opened. The concentration of the various components in the released volume is calculated, based on the temperature of the vapor which is released.

Calculated emissions for napthalene and anthracene are presented in Table 5. Table 5 presents the calculated emissions on a per-charge basis, and the average emission rate in grams per second over a one hour period, assuming that two charges have been unloaded during the hour.

4.0 RESULTS

Table 6 presents calculated conservative one-hour emissions from ties awaiting transport off-site and from cylinder discharge. The total of the two represents total plant emissions for a one-hour period.

TABLE 1

CALIFORNIA TEST RESULTS
EMISSION RATE (mg/hr)

SPECIES		HOUR #1		HOUR #5		HOUR #30		HOUR #
BENZENE		31.74		26.02		3.65		2.1
CRESOLS	<	364	<	298	<	330	<	242
PHENOL	<	364	<	298	<	330	<	242
TOLUENE		220		180		130		330
FORMALDEHYDE		694		569		1218		187
NAPHTHALENE		24366		19972		2803		1610.1
ACENAPHTALENE		392.1		321.4		62.1		29.5
ACENAPHTHENE		11485.8		9414.6		1601.9		670.9
FLUORENE		5431.2		4451.8		1086.5		363.9
PHENANTHRENE		5090.2		4172.3		1682		526
ANTHRACENE		109.6		89.8		144.2		14.8
FLUORANTHENE		263.0		215.6		114.14		30.86
PYRENE		48.71		39.93		30.51		2.15
BENZ[A]ANTHRACENE	<	2	<	2	<	2	<	1.38
CHRYSENE	<	2	<	2	<	2	<	1.38
BENZO[B]FLUORANTHENE	<	2	<	2	<	2	<	1.38
BENZO[K]FLUORANTHENE	<	2	<	2	<	2	<	1.38
BENZO[A]PYRENE	<	2	<	2	<	2	<	1.38
BENZO[GHI]PERYLENE	<	2	<	2	<	2	<	1.38
DIBENZ[AH]ANTHRACENE	<	2	<	2	<	2	<	1.38
INDENO[1,2,3,-CD]PYRENE	<	2	<	2	<	2	<	1.38
TOTAL PAHs (EXCL. METHYL	<	47205.98	<	38693.43	<	7540.35	<	3259.25
CREOSOTES	<	47205.98	<	38693.43	<	7540.35	<	3259.25
2-METHYLNAPTHALENE	<	24366	<	19972	<	3404	<	1342

NOTES:

1. "HOUR #1" = EXTRAPOLATED FROM CALIFORNIA TEST RESULTS

Table 2

VOLUME/AGE ANALYSIS
FOR TIES AWAITING TRANSPORT OFF-SITE

Condition	Number of Charges On Site
"Fresh" (hour #1)	2
"Fresh" (hour #5)	1
"1 Day" (hour #30)	1
"12 Day" (hour #288)	1

Note:

One "charge" equals the amount of wood put into one cylinder during the creosote soak process. Each charge represents 3532 cubic feet of wood.

Table 3

SALEM PLANT EMISSION RATE (mg/hr)

SPECIES		HOUR #1 CHARGE(S		HOUR #5 CHARGE(S		HOUR #30 CHARGE(S		HOUR #288 CHARGE(S)		TOTAL
BENZENE		1369		561		79		45		2009
CRESOLS	<	15679	<	6426	<	7116	<	5218	<	29220
PHENOL	<	15679	<	6426	<	7116	<	5218	<	29220
TOLUENE		9470		3881		2803		7116		16155
FORMALDEHYDE		29937		12269		26264		4032		68470
NAPHTHALENE		1050795		430654		60441		34718		1541890
ACENAPHTALENE		16910		6930		1339		636		25179
ACENAPHTHENE		495334		203006		34542		14467		732882
FLUORENE		234224		95994		23428		7847		353646
PHENANTHRENE		219519		89967		36269		11342		345755
ANTHRACENE		4725		1936		3109		319		9770
FLUORANTHENE		11343		4649		2461		665		18454
PYRENE		2101		861		658		46		3620
BENZ[A]ANTHRACENE	<	105	<	43	<	43	<	30	<	191
CHRYSENE	<	105	<	43	<	43	<	30	<	191
BENZO[B]FLUORANTHENE	<	105	<	43	<	43	<	30	<	191
BENZO[K]FLUORANTHENE	<	105	<	43	<	43	<	30	<	191
BENZO[A]PYRENE	<	105	<	43	<	43	<	30	<	191
BENZO[GHI]PERYLENE	<	105	<	43	<	43	<	30	<	191
DIBENZ[AH]ANTHRACENE	<	105	<	43	<	43	<	30	<	191
INDENO[1,2,3,-CD]PYRENE	<	105	<	43	<	43	<	30	<	191
TOTAL PAHs (EXCL. METHYL	<	2035794	<	834342	<	162592	<	70279	<	3032723
CREOSOTES	<	2035794	<	834342	<	162592	<	70279	<	3032723
2-METHYLNAPTHALENE	<	1050795	<	430654	<	73400	<	28937	<	1554849

Table 4

SALEM PLANT EMISSION RATE (g/s)

SPECIES	HOUR #1 CHARGE(S	HOUR #5 CHARGE(S	HOUR #30 CHARGE(S	HOUR #288 CHARGE(S)	TOTAL
BENZENE	3.80E-04	1.56E-04	2.19E-05	1.26E-05	5.58E-04
CRESOLS	< 4.36E-03	< 1.78E-03	< 1.98E-03	< 1.45E-03	< 8.12E-03
PHENOL	< 4.36E-03	< 1.78E-03	< 1.98E-03	< 1.45E-03	< 8.12E-03
TOLUENE	2.63E-03	1.08E-03	7.79E-04	1.98E-03	4.49E-03
FORMALDEHYDE	8.32E-03	3.41E-03	7.30E-03	1.12E-03	1.90E-02
NAPHTHALENE	2.92E-01	1.20E-01	1.68E-02	9.64E-03	4.28E-01
ACENAPHTALENE	4.70E-03	1.93E-03	3.72E-04	1.77E-04	6.99E-03
ACENAPHTHENE	1.38E-01	5.64E-02	9.59E-03	4.02E-03	2.04E-01
FLUORENE	6.51E-02	2.67E-02	6.51E-03	2.18E-03	9.82E-02
PHENANTHRENE	6.10E-02	2.50E-02	1.01E-02	3.15E-03	9.60E-02
ANTHRACENE	1.31E-03	5.38E-04	8.64E-04	8.86E-05	2.71E-03
FLUORANTHENE	3.15E-03	1.29E-03	6.84E-04	1.85E-04	5.13E-03
PYRENE	5.84E-04	2.39E-04	1.83E-04	1.29E-05	1.01E-03
BENZ[A]ANTHRACENE	< 2.92E-05	< 1.20E-05	< 1.20E-05	< 8.27E-06	< 5.32E-05
CHRYSENE	< 2.92E-05	< 1.20E-05	< 1.20E-05	< 8.27E-06	< 5.32E-05
BENZO[B]FLUORANTHENE	< 2.92E-05	< 1.20E-05	< 1.20E-05	< 8.27E-06	< 5.32E-05
BENZO[K]FLUORANTHENE	< 2.92E-05	< 1.20E-05	< 1.20E-05	< 8.27E-06	< 5.32E-05
BENZO[A]PYRENE	< 2.92E-05	< 1.20E-05	< 1.20E-05	< 8.27E-06	< 5.32E-05
BENZO[GHI]PERYLENE	< 2.92E-05	< 1.20E-05	< 1.20E-05	< 8.27E-06	< 5.32E-05
DIBENZ[AH]ANTHRACENE	< 2.92E-05	< 1.20E-05	< 1.20E-05	< 8.27E-06	< 5.32E-05
INDENO[1,2,3,-CD]PYRENE	< 2.92E-05	< 1.20E-05	< 1.20E-05	< 8.27E-06	< 5.32E-05
TOTAL PAHs (EXCL. METHYL	< 5.65E-01	< 2.32E-01	< 4.52E-02	< 1.95E-02	< 8.42E-01
CREOSOTES	< 5.65E-01	< 2.32E-01	< 4.52E-02	< 1.95E-02	< 8.42E-01
2-METHYLNAPTHALENE	< 2.92E-01	< 1.20E-01	< 2.04E-02	< 8.04E-03	< 4.32E-01

Table 5

ONE-HOUR PLANT EMISSIONS
SUMMARY (G/S)

SPECIES		AWAITING TRANSPORT		CYLINDER DISCHARGE			TOTAL
BENZENE		5.58E-04		1.23E-04	*		6.81E-04
CRESOLS	<	8.12E-03	<	1.79E-03	*	<	9.91E-03
PHENOL	<	8.12E-03	<	1.79E-03	*	<	9.91E-03
TOLUENE		4.49E-03		9.92E-04	*		5.48E-03
FORMALDEHYDE		1.90E-02		4.21E-03	*		2.32E-02
NAPHTHALENE		4.28E-01		9.47E-02			5.23E-01
ACENAPHTALENE		6.99E-03		1.55E-03	*		8.54E-03
ACENAPHTHENE		2.04E-01		4.50E-02	*		2.49E-01
FLUORENE		9.82E-02		2.17E-02	*		1.20E-01
PHENANTHRENE		9.60E-02		2.12E-02	*		1.17E-01
ANTHRACENE		2.71E-03		6.00E-04			3.31E-03
FLUORANTHENE		5.13E-03		1.13E-03	*		6.26E-03
PYRENE		1.01E-03		2.22E-04	*		1.23E-03
BENZ[A]ANTHRACENE	<	5.32E-05	<	1.18E-05	*	<	6.49E-05
CHRYSENE	<	5.32E-05	<	1.18E-05	*	<	6.49E-05
BENZO[B]FLUORANTHENE	<	5.32E-05	<	1.18E-05	*	<	6.49E-05
BENZO[K]FLUORANTHENE	<	5.32E-05	<	1.18E-05	*	<	6.49E-05
BENZO[A]PYRENE	<	5.32E-05	<	1.18E-05	*	<	6.49E-05
BENZO[GHI]PERYLENE	<	5.32E-05	<	1.18E-05	*	<	6.49E-05
DIBENZ[AH]ANTHRACENE	<	5.32E-05	<	1.18E-05	*	<	6.49E-05
INDENO[1,2,3,-CD]PYRENE	<	5.32E-05	<	1.18E-05	*	<	6.49E-05
TOTAL PAHs (EXCL. METHYL	<	8.42E-01	<	1.86E-01	*	<	1.03E+0
CREOSOTES	<	8.42E-01	<	1.86E-01	*	<	1.03E+0
2-METHYLNAPTHALENE	<	4.32E-01	<	9.55E-02	*	<	5.27E-01

*Based on napthalene emissions calculation.

Table 6

Air Emissions Due To
Opening Cylinder (Retort) Doors
After Boultanizing (Treatment)

Species	Emission (mg/charge)	Emission Rate* (mg/hr)	(g/s)
napthalene	170,000	340,000	9.47E-02
anthracene	109	218	6.00E-05

* Average emission rate over 1 hour, based on two charges unloaded during the hour.

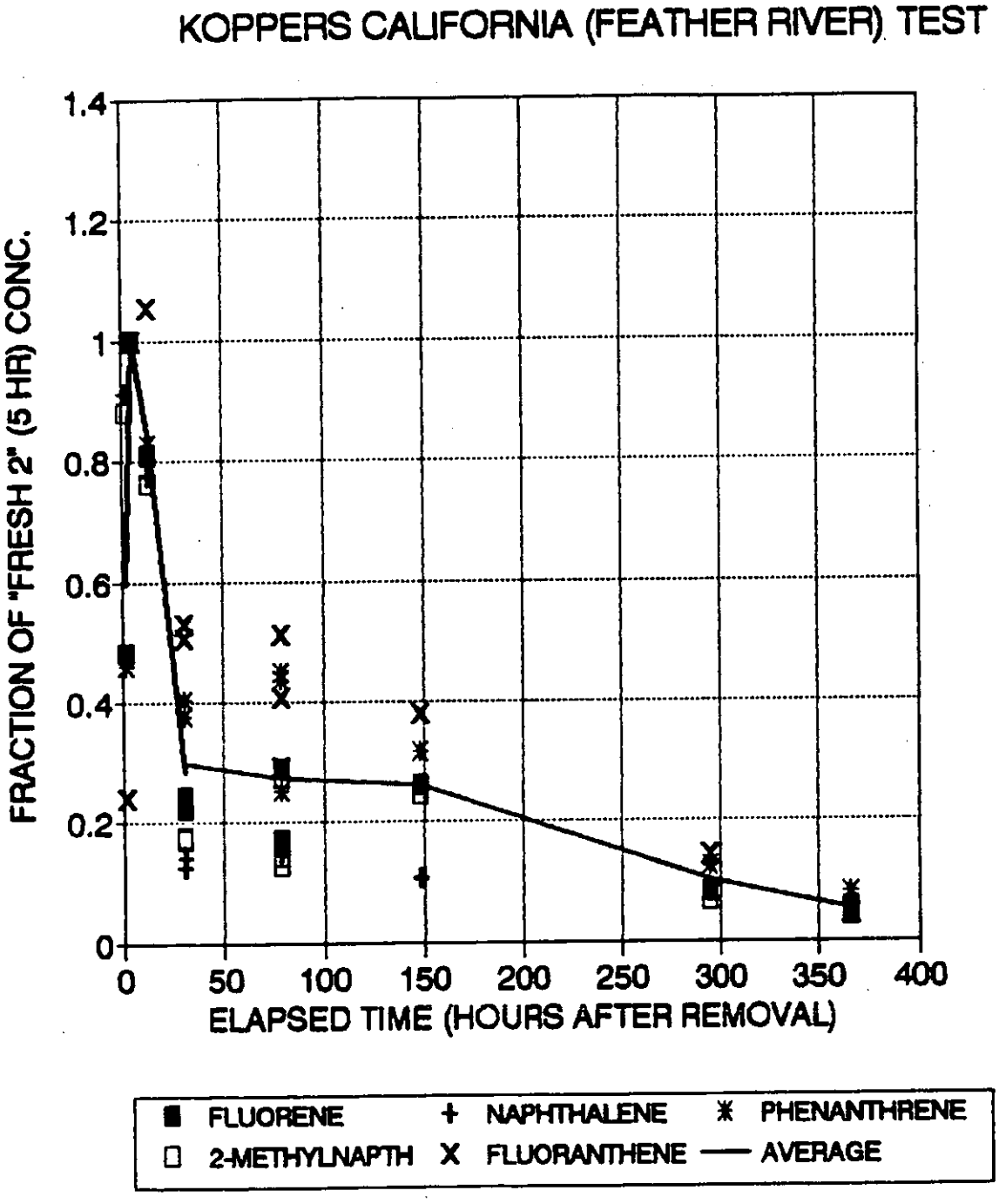
KOPPERS CALIFORNIA (FEATHER RIVER) TEST
FRACTION OF "FRESH 2" (5 HR) CONC.
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
ELAPSED TIME (HOURS AFTER REMOVAL)
FLUORENE
NAPHTHALENE
PHENANTHRENE
2-METHYLNAPTH
FLUORANTHENE
AVERAGE

Figure 1

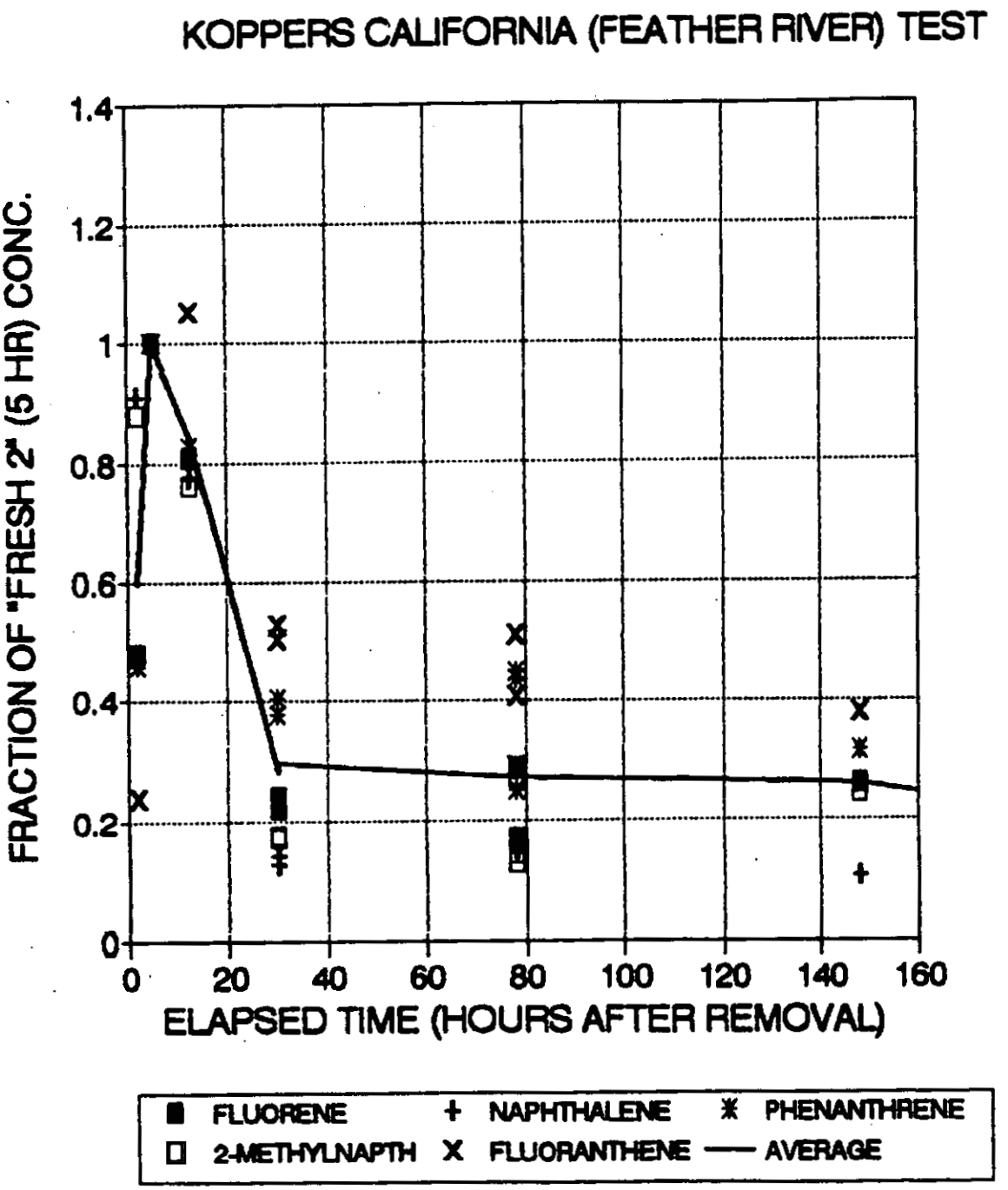
KOPPERS CALIFORNIA (FEATHER RIVER) TEST
FRACTION OF "FRESH 2" (5 HR) CONC.
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
140
160
ELAPSED TIME (HOURS AFTER REMOVAL)
FLUORENE
2-METHYLNAPTH
NAPHTHALENE
FLUORANTHENE
PHENANTHRENE
AVERAGE

Figure 2

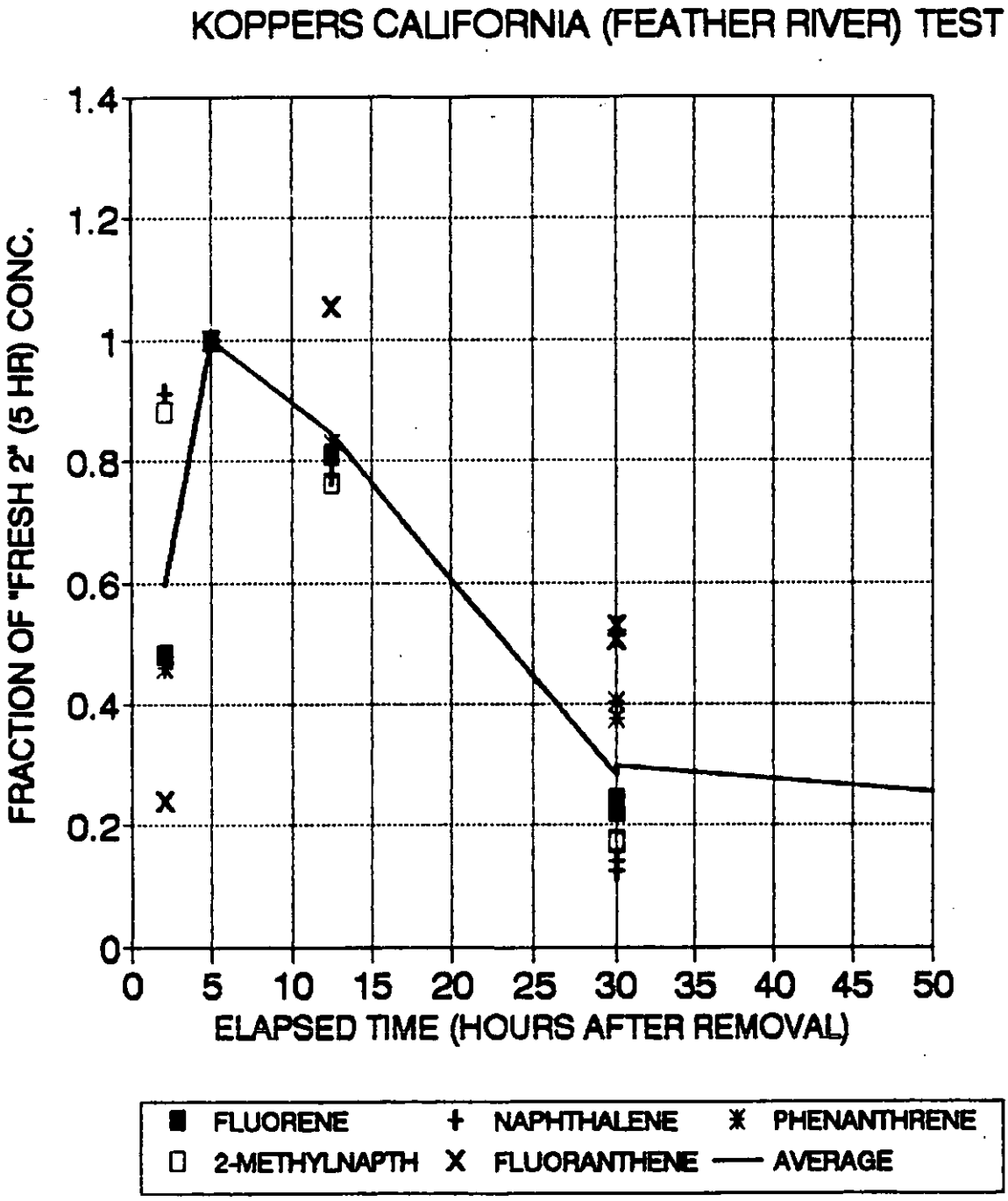
KOPPERS CALIFORNIA (FEATHER RIVER) TEST
FRACTION OF "FRESH 2" (5 HR) CONC.
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0 5 10 15 20 25 30 35 40 45 50
ELAPSED TIME (HOURS AFTER REMOVAL)
FLUORENE
NAPHTHALENE
PHENANTHRENE
2-METHYLNAPTH
FLUORANTHENE
AVERAGE

Figure 3

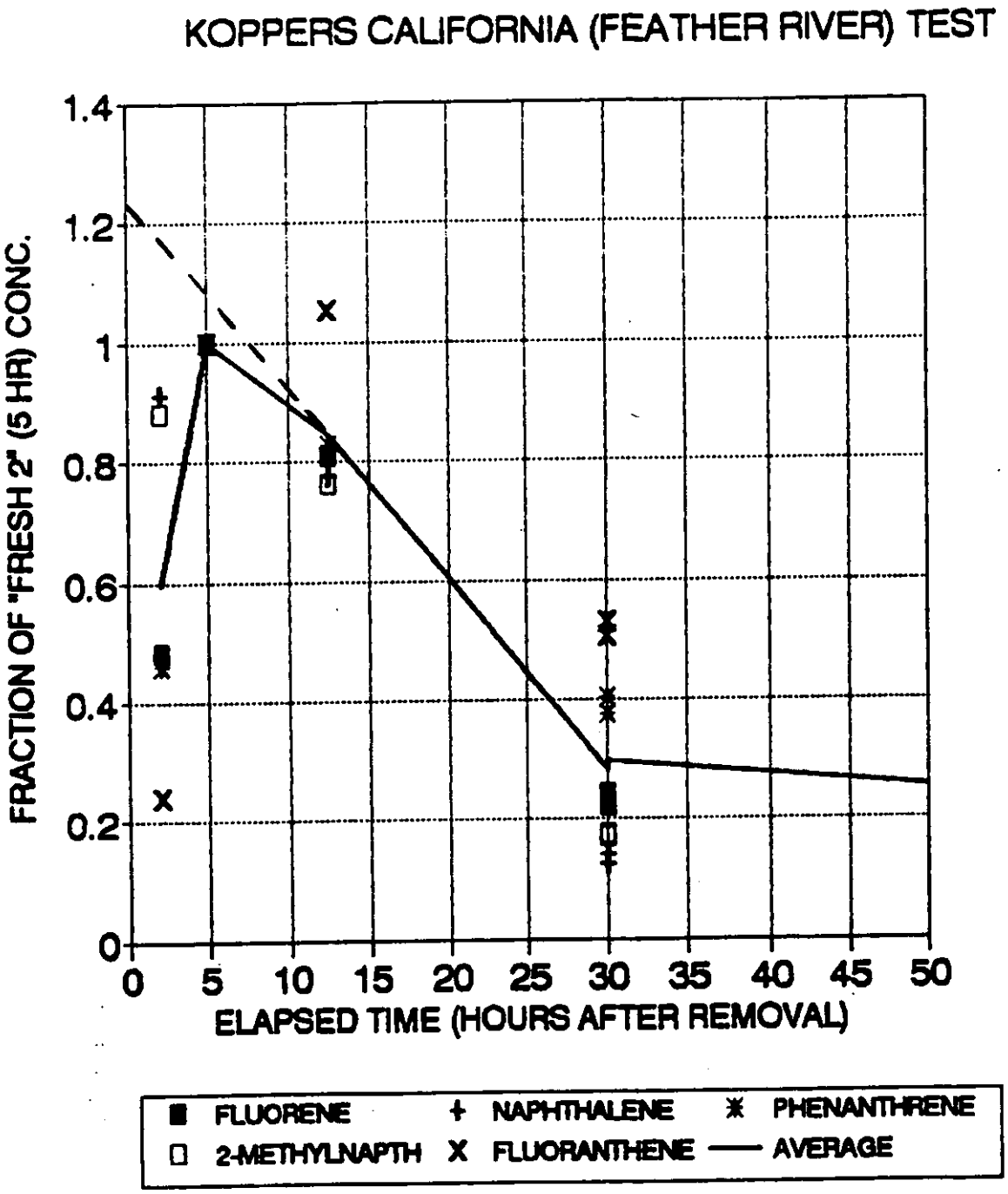
KOPPERS CALIFORNIA (FEATHER RIVER) TEST
FRACTION OF "FRESH 2" (5 HR) CONC.
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
35
40
45
50
ELAPSED TIME (HOURS AFTER REMOVAL)
FLUORENE
NAPHTHALENE
PHENANTHRENE
2-METHYLNAPTH
FLUORANTHENE
AVERAGE

Figure 4

APPENDIX A

KOPPERS' FEATHER RIVER, CALIFORNIA RESEARCH TEST RESULTS

CE ID:	S-8	Average cubic feet of wood treated per day in 1989	2840
RIPTION:	STORAGE YARD EMISSIONS		
S FOR CALCULATIONS:	SOURCE TESTING		

Test number	cubic ft of wood in test	days (hours) represented by test	total hours represented	multiplicity factor (average daily wood/wood in test)
Fresh 1	163.8	hrs. 1-3	3	17.34
Fresh 2	163.8	hrs. 4-6	3	17.34
Fresh 3	163.8	hrs. 7-18	12	17.34
1(1)	163.8	days 1-2	48	17.34
1(2)	163.8	days 1-2	"	17.34
1(3)	163.8	days 1-2	"	17.34
4(1)	157	days 3-5	72	18.09
4(2)	157	days 3-5	"	18.09
4(3)	157	days 3-5	"	18.09
7	163.8	days 6-9	96	17.34
12	183.8	days 10-20	264	15.45
30	163.8	days 21-40	480	17.34

Measured Emission Rates (mg/hr)

ies	Fresh 1	Fresh 2	Fresh 3	1 day (1)	1 day (2)	1 day (3)	4 day (1)	4 day (2)	4 day (3)	7 day
zene *	23.77	26.02	20.19	1.64	3.29	3.65	3.88	3.96	4.31	2.78
ols	< 320	< 298	< 388	< 418	< 391	< 330	< 329	< 378	< 516	< 239
ol	< 320	< 298	< 388	< 418	< 391	< 330	< 329	< 378	< 516	< 239
ene	170	180	190	110	130	130	100	110	120	120
aldehyde	0	569	1069	177	1443	1218	327	712	435	550
thalene	18241	19972	15492	1257	2526	2803	2979	3040	3306	2132.9
naphthylene	282.3	321.4	231.3	< 20	56.4	62.1	47.7	73	64.2	77.3
naphthene	7165.6	9414.6	7331.1	558.7	1437.9	1601.9	1290.7	1864.6	1850.5	1866.3
orene	2136.8	4451.8	3600.2	319.3	991	1086.5	756.8	1281.3	1279.5	1159.8
nanthrene	1922.7	4172.3	3459.4	459.9	1566.8	1682	1054.4	1824	1866.8	1319.7
hracene	438.1	89.8	144.8	441	87.4	144.2	29.8	99.3	48.2	34.8
oranthene	51.54	215.6	227.28	7.78	109.01	114.14	62.75	110.05	87.551	81.32
ene	19.82	39.93	48.27	3.59	45.28	30.51	3.77	45.4	15.36	24.53
z(a)anthracene	< 1.98	< 2	< 2.01	< 2	< 1.94	< 2	< 1.99	< 2.03	< 1.94	< 1.34
ysene	< 1.98	< 2	< 2.01	< 2	< 1.94	< 2	< 1.99	< 2.03	< 1.94	< 1.34
zo(b)fluoranthene	< 1.98	< 2	< 2.01	< 2	< 1.94	< 2	< 1.99	< 2.03	< 1.94	< 1.34
zo(k)fluoranthene	< 1.98	< 2	< 2.01	< 2	< 1.94	< 2	< 1.99	< 2.03	< 1.94	< 1.34
zo(a)pyrene	< 1.98	< 2	< 2.01	< 2	< 1.94	< 2	< 1.99	< 2.03	< 1.94	< 1.34
zo(ghi)perylene	< 1.98	< 2	< 2.01	< 2	< 1.94	< 2	< 1.99	< 2.03	< 1.94	< 1.34
enz(ah)anthracene	< 1.98	< 2	< 2.01	< 2	< 1.94	< 2	< 1.99	< 2.03	< 1.94	< 1.34
eno(1,2,3-cd)pyrene	< 1.98	< 2	< 2.01	< 2	< 1.94	< 2	< 1.99	< 2.03	< 1.94	< 1.34
al PAHs (excl. methylnaph)	< 30273.7	< 38693.43	< 30550.43	< 3083.27	< 6835.31	< 7540.35	< 6240.84	< 8353.89	< 8533.631	< 6707.37
osotes	< 30273.7	< 38693.43	< 30550.43	< 3083.27	< 6835.31	< 7540.35	< 6240.84	< 8353.89	< 8533.631	< 6707.37
ethylnaphthalene	17646	19972	15290	1077	3498	3404	2582	2836	5445	4932

* Species Quantified based upon Creosote liquid concentrations since all measurements were below detectable limits.

cies		12 day		30 day		Total Yearly Emissions (lb/yr)		background levels (mg/hr)
zene *		2.10		1.25		31	<	30
sole	<	242	<	257	<	3605	<	365
nol	<	242	<	257	<	3605	<	365
iene		330		190		2758		150
maldehyde		187		0		2699.3		245
hthalene		1610.1		962.9		23490		19.3
naphthylene		29.5		16.5		470	<	1.4
naphthene		670.9		453.9		12217		5.2
orene		363.9		250.9		7002		3.9
nanthrene		526		330.1		9017		5.2
thracene		14.8		15.1		454	<	1.4
oranthene		30.86		9.35		464	<	1.38
ene		2.15		3.03		111	<	1.38
z[a]anthracene	<	1.38	<	1.38	<	19.5	<	1.38
rysene	<	1.38	<	1.38	<	19.5	<	1.38
zo[b]fluoranthene	<	1.38	<	1.38	<	19.5	<	1.38
zo[k]fluoranthene	<	1.38	<	1.38	<	19.5	<	1.38
zo[a]pyrene	<	1.38	<	1.38	<	19.5	<	1.38
zo[ghi]perylene	<	1.38	<	1.38	<	19.5	<	1.38
benz[ah]anthracene	<	1.38	<	1.38	<	19.5	<	1.38
leno[1,2,3-cd]pyrene	<	1.38	<	1.38	<	19.5	<	1.38
tal PAHs (excl. methylnaph)	<	3259.25	<	2052.82	<	53380.9	<	50.2
eosotes	<	3259.25	<	2052.82	<	53380.9		
ethylnaphthalene		1342		839		26316		14

* Species Quantified based upon Creosote liquid concentrations since all measurements were below detectable limits.