Project Operations Plan

North Cavalcade Street Site

Volume II

Appendices

R E M II

PERFORMANCE OF REMEDIAL RESPONSE ACTIVITIES AT UNCONTROLLED HAZARDOUS WASTE SITES

U.S. EPA CONTRACT NO. 68-01-6939

CAMP DRESSER & McKEE INC.
PRIME CONTRACTOR

CONTENTS

APPENDIX I

BIBLIOGRAPHY

BIBLIOGRAPHY

(1) Cavalcade Contaminant Survey Engineering Report Camp Dresser & McKee, July 11, 1983.

(2) Documentation of Threshold Limit Values, 4th Edition, American Conference of Governmental Industrial Hygenists, 1980.

(3) NIOSH/OSHA Pocket Guide to Chemical Hazards U.S Department of Health and Human Services, September 1978.

(4) North Cavalcade Site Work Plan Memorandum Camp Dresser & McKee Inc., February 1985.

(5) North Cavalcade Site Work Plan Camp Dresser & McKee Inc., April 1, 1985.

(6) Response Safety Decision Making Workshop Manual U.S. Environmental Protection Agency, March 1983.

(7) South Cavalcade Site Project Operations Plan Camp Dresser & Mckee Inc., February 22, 1985.

(8) Site Investigation Protocol for Uncontrolled Hazardous Waste Sites Camp Dresser & McKee Inc., December, 1984.

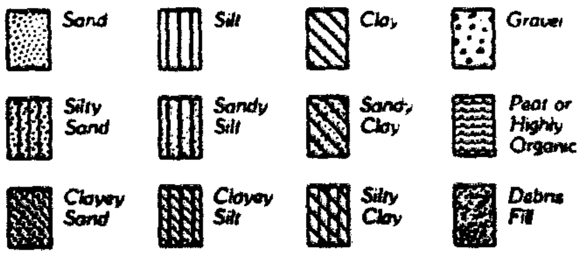
(9) Technical Operations Manual Camp Dresser & McKee Inc., January 1985.

APPENDIX II

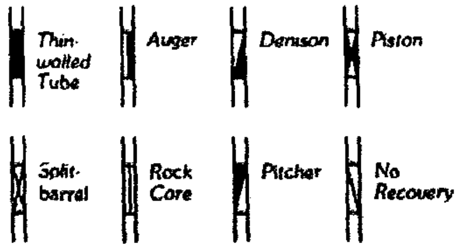
BORING/WELL LOGS FROM PREVIOUS INVESTIGATIONS

TERMS AND SYMBOLS USED ON BORING LOGS

SOIL TYPES

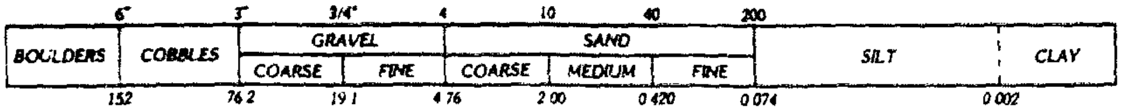


SAMPLER TYPES



SOIL GRAIN SIZE

U.S. STANDARD SIEVE



SOIL GRAIN SIZE IN MILLIMETERS

STRENGTH OF COHESIVE SOILS(1)

Consistency	Undrained Shear Strength, Kips Per Sq Ft
Very Soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	greater than 4.00

DENSITY OF GRANULAR SOILS(2,3)

Descriptive Term	*Relative Density, %
Very Loose	less than 15
Loose	15 to 35
Medium Dense	35 to 65
Dense	65 to 85
Very Dense	greater than 85

*Estimated from sampler driving record

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

Note: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

SOIL STRUCTURE(1)

Slickensided	Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the ease of breaking along these planes.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.

REFERENCES :

(1) ASTM D 2488
(2) ASCE Manual 56 (1976)
(3) ASTM D 2049

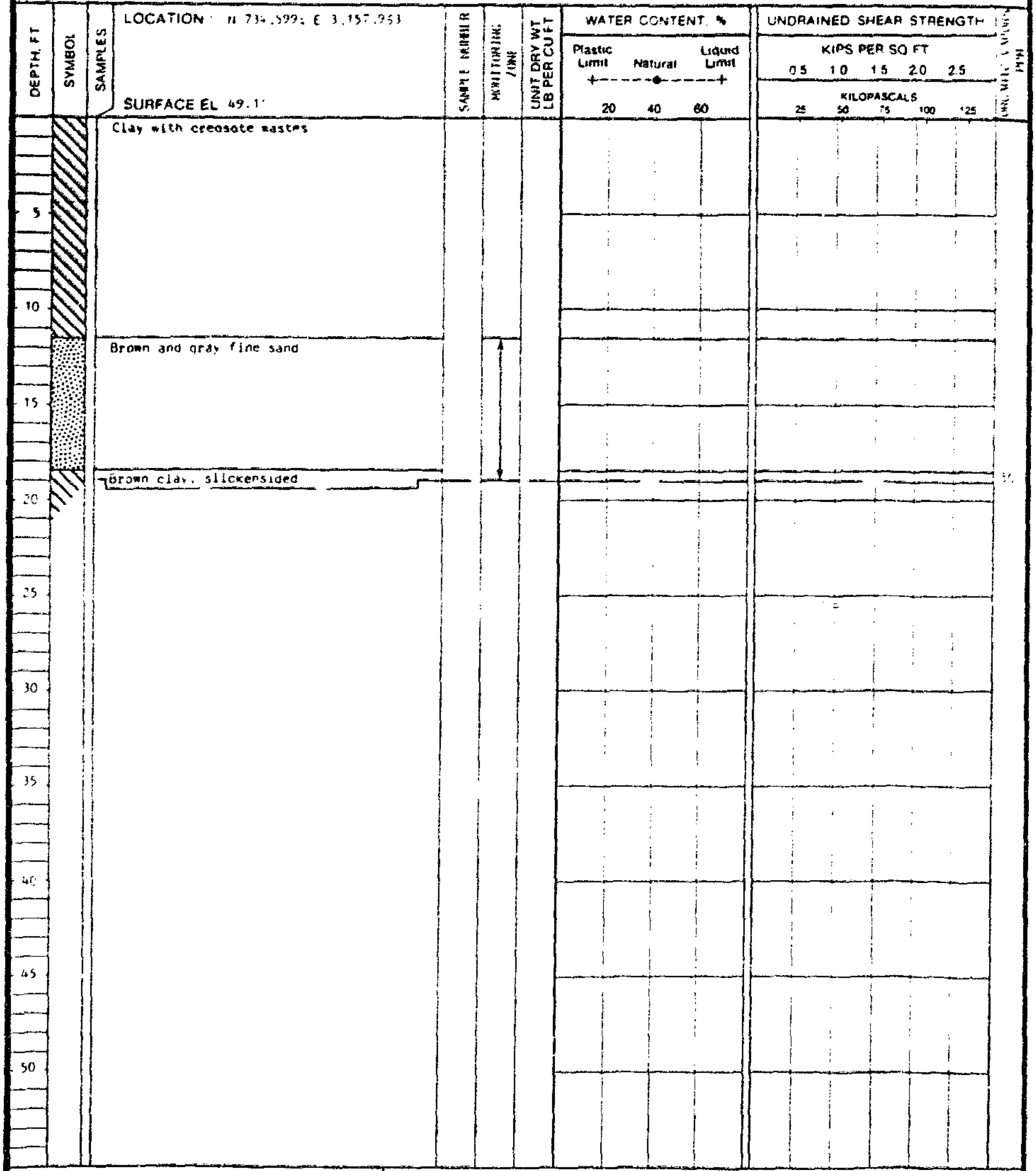
Information on each boring log is a compilation of subsurface conditions and soil or rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.

LOG OF BORING NO. CAV-OW-03

CAVALCADE CONTAMINANT SURVEY
METRO-STAGE ONE, REGIONAL RAIL SYSTEM
HOUSTON, TEXAS

LOCATION : N 734,599; E 3,157,953

SURFACE EL 49.1'



Clay with creosote wastes

Brown and gray fine sand

Brown clay, slickensided

JOB NO. : 0183-0008 COMPLETION DEPTH 19.0' DATE : February 7, 1983 DEPTH TO WATER IN BORING : 1.7' DATE : May 17, 1983	SAMPLER : No samples taken DRILLING METHOD : Wet Rotary	STRENGTH LEGEND ● Unconfined Compression ▲ Unconsolidated-Undrained Triaxial Compression ✦ Miniature Vane (open symbols above indicate remolded tests) ◇ Torvane ☒ Hand Penetrometer

McCLELLAND
ENGINEERS
CAMP DRESSER & McKEE

PLATE

LOG OF BORING NO. CAV-OW-04

CAVALCADE CONTAMINANT SURVEY
METRO-STAGE ONE, REGIONAL RAIL SYSTEM
HOUSTON, TEXAS

DEPTH, FT	SYMBOL	SAMPLES	LOCATION N 734.773; E 3.157.676 SURFACE EL 51.1'	SAMPLE NUMBER	MONITORING ZONE	UNIT DRY WT LB PER CU FT	WATER CONTENT, % Plastic Limit / Natural / Liquid Limit 20 40 60	UNDRAINED SHEAR STRENGTH KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5 KILOPASCALS 25 50 75 100 125	ORGANIC VAPORS PPM
			Clay with creosote wastes						
5									
10									
			Brown and gray fine sand						
15									
			Brown clay						
20									
25									
30									
35									
40									
45									
50									

JOB NO. : 0193-0008

COMPLETION DEPTH 19.5'
DATE : February 6, 1983

DEPTH TO WATER IN BORING : 4.8'

DATE : May 17, 1983

SAMPLER : No samples taken

DRILLING METHOD : Wet Rotary

STRENGTH LEGEND
- ● Unconfined Compression
- ▲ Unconsolidated-Undrained Triaxial Compression
- ✦ Miniature Vane

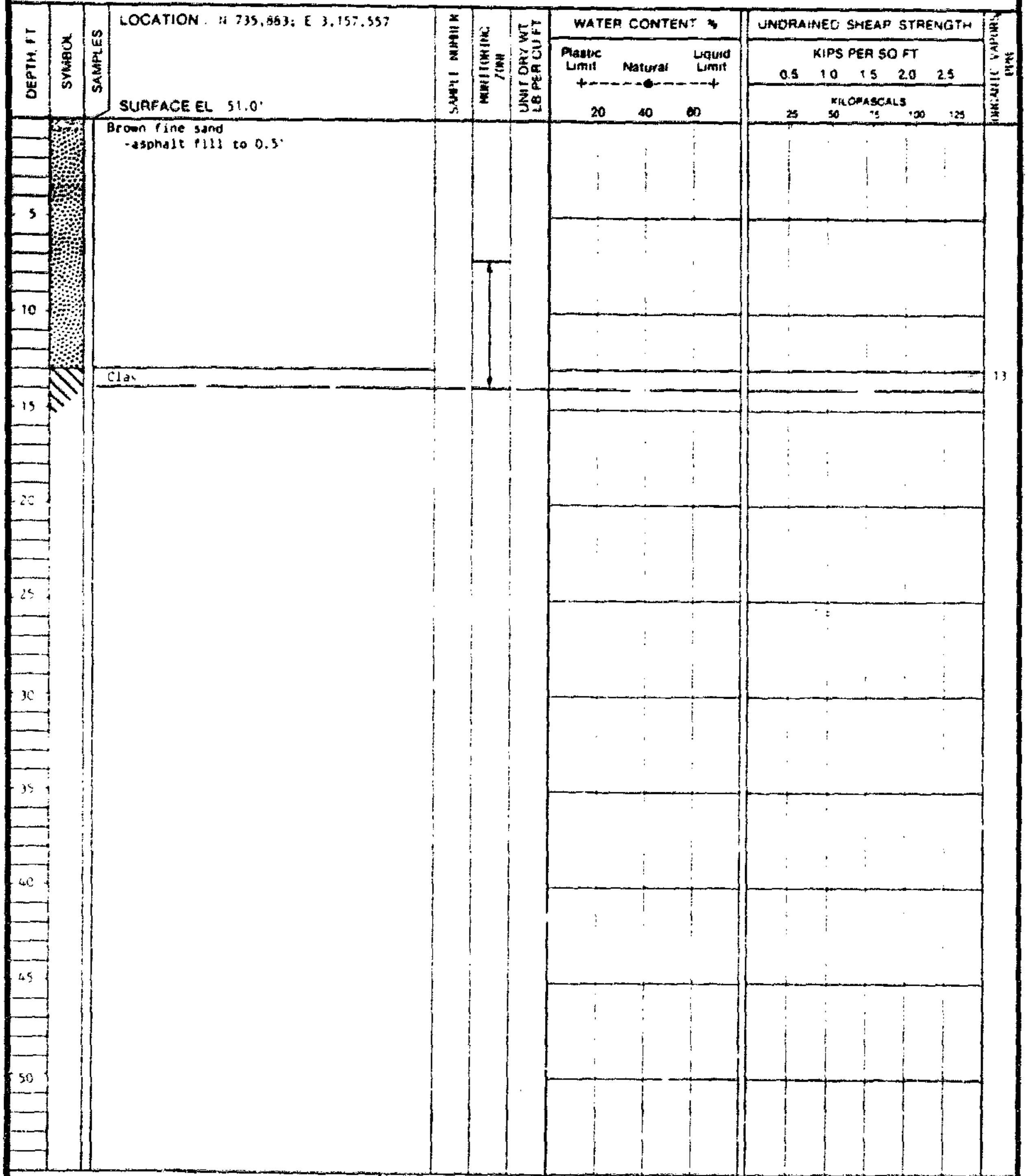
(open symbols above indicate remolded tests)
- ✧ Torvane
- ☒ Hand Penetrometer

McCLELLAND ENGINEERS
CAMP DRESSER & McKEE

PLATE

LOG OF BORING NO. CAV-OW-05

CAVALCADE CONTAMINANT SURVEY
METRO-STAGE ONE, REGIONAL RAIL SYSTEM
HOUSTON, TEXAS



LOCATION: N 735,863; E 3,157,557

SURFACE EL 51.0'

Depth, ft	Description	Organic Vapors PPM
0	Brown fine sand -asphalt fill to 0.5'	
13	Clay	13

JOB NO.: 0183-0008

COMPLETION DEPTH: 14.0'

DATE February 7, 1983

DEPTH TO WATER IN BORING: 4.9'

DATE: May 17, 1983

SAMPLER: No samples taken

DRILLING METHOD: Wet Rotary

STRENGTH LEGEND
- ● Unconfined Compression
- ▲ Unconsolidated-Undrained Triaxial Compression
- ✦ Miniature Vane

(open symbols above indicate remolded tests)
- ✧ Torvane
- ⊠ Hand Penetrometer

McCLELLAND
ENGINEERS
CAMP DRESSER & McKEE

PLATE

LOG OF BORING NO. CAV-SL-05

CAVALCADE CONTAMINANT SURVEY
METRO-STAGE ONE, REGIONAL RAIL SYSTEM
HOUSTON, TEXAS

LOCATION N 734,650; E 3,157,622

SURFACE EL 50.3'

DEPTH FT	LOCATION / DESCRIPTION	SAMPLE NUMBER	% PASSING NO 200 SIEVE	UNIT DRY WT LB PER CU FT	WATER CONTENT % (Plastic Limit, Natural, Liquid Limit; 20 40 60)	UNDRAINED SHEAR STRENGTH KIPS PER SQ FT (0.5 1.0 1.5 2.0 2.5) KILOPASCALS (25 50 75 100 125)	ORGANIC VAPORS, PPM
	Fill: Brown fine sand and clay	01					6
5	Fill: Intermixed brown fine sand and clay with organic matter	02					
10 15	Gray fine sand, slightly clayey -brown below 10'						
20	Very stiff brown clay, slickensided with sand layers, 19.5' to 21'	03					3
25	-with silt partings and layers, 26' to 32'						
30	-with creosote wastes below 29'	04					15
35		05					7
40							
45							
50							

JOB NO. : 0193-0006
COMPLETION DEPTH 40.0'
DATE February 3, 1983
DEPTH TO WATER IN BORING Grouted upon completion

SAMPLER 3" thin-walled tube

DRILLING METHOD Wet Rotary

STRENGTH LEGEND
- ● Unconfined Compression
- ▲ Unconsolidated-Undrained Triaxial Compression
- ✦ Miniature Vane

(open symbols above indicate remolded tests)
- ✧ Torvane
- ⊠ Hand Penetrometer

McCLELLAND ENGINEERS
CAMP DRESSER & McKEE

PLATE

LOG OF BORING NO. CAV-SL-26

CAVALCADE CONTAMINANT SURVEY
METRO-STAGE ONE, REGIONAL RAIL SYSTEM
HOUSTON, TEXAS

LOCATION N 734,596; E 3,157,385

SURFACE EL 51.2'

DEPTH, FT	SYMBOL	SAMPLES		SAMPLE NUMBER	% PASSING NO 200 SIEVE	UNIT DRY WT LB PER CU FT	WATER CONTENT, % Plastic Limit / Natural / Liquid Limit (20 40 60)	UNDRAINED SHEAR STRENGTH KIPS PER SQ FT (0.5 1.0 1.5 2.0 2.5) KILOPASCALS (25 50 75 100 125)	ORGANIC VAPORS PPM
	▨		Fill: Gravel and sand						
	▨	■	Gray and brown sandy clay	01					1800
5	▨	■		02					2000+
10	▨	■		03					1800
15									
20									
25									
30									
35									
40									
45									
50									

JOB NO. 0183-0090
COMPLETION DEPTH 10.0'
DATE May 7, 1983
DEPTH TO WATER IN BORING Grouted upon completion

SAMPLER : 3" thin-walled tube
DRILLING METHOD Dry Auger

STRENGTH LEGEND
- ● Unconfined Compression
- ▲ Unconsolidated-Undrained Triaxial Compression
- ✦ Miniature Vane
(open symbols above indicate remolded tests)
- ✧ Torvane
- ☒ Hand Penetrometer

McCLELLAND ENGINEERS
CAMP DRESSER & McKEE

PLATE

LOG OF BORING NO. CAV-SL-27

CAVALCADE CONTAMINANT SURVEY
METRO-STAGE ONE, REGIONAL RAIL SYSTEM
HOUSTON, TEXAS

LOCATION : N 734,900; E 3,157,354

SURFACE EL 50.9'

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION	SAMPLE NUMBER	% PASSING NO 200 SIEVE	UNIT DRY WT LB PER CU FT	WATER CONTENT, % (Plastic Limit / Natural / Liquid Limit; 20 40 60)	UNDRAINED SHEAR STRENGTH (KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5; KILOPASCALS 25 50 75 100 125)	ORGANIC VAPORS PPM
			Fill: Gravel and dark gray sandy clay	01					1300
			Gray and brown sandy clay						
5				02					1200
10				03					400
15									
20									
25									
30									
35									
40									
45									
50									

JOB NO. : 0183-0090
COMPLETION DEPTH : 10.0'
DATE : May 7, 1983
DEPTH TO WATER IN BORING Grouted upon completion

SAMPLER : 3" thin-walled tube

DRILLING METHOD : Dry Auger

STRENGTH LEGEND
● Unconfined Compression
▲ Unconsolidated-Undrained Triaxial Compression
◆ Miniature Vane
(open symbols above indicate remolded tests)
◇ Torvane
☒ Hand Penetrometer

McCLELLAND ENGINEERS
CAMP DRESSER & McKEE

PLATE

KEY TO DESCRIPTION AND
CLASSIFICATION OF SUBSURFACE MATERIALS

[illegible]

COMPONENT DEFINITIONS BY GRADATION

Material	Definitions	Fractions	Sieve Limit Upper	Sieve Limit Lower
Boulders	[illegible]			
Cobbles	[illegible]			
Gravel	[illegible]	Coarse Fine	3 in. 3/4 in.	3/4 in. No. 4
Sand	[illegible]	Coarse Medium Fine	No. 4 No. 10 No. 40	No. 10 No. 40 No. 200
Silt	[illegible]		No. 200	
Clay	[illegible]		No. 200	

DESCRIPTIVE TERMINOLOGY DENOTING COMPONENT PROPORTIONS

Descriptive Terms	Range of Proportions
[illegible]	[illegible]
[illegible]	[illegible]
Trace [illegible]	1 - 10%
[illegible]	[illegible]

OTHER DESCRIPTIVE TERMS

[illegible]

TYPICAL DESCRIPTIONS

[illegible]

DENSITY OR CONSISTENCY

COHESIVE SOIL

Consistency of Cohesive Soils	Undrained Shear Strength (ksf)	Penetration Resistance (Blows per foot)
Very soft	Below 0.25	0 - 2
Soft	0.25 to 0.5	2 - 4
Firm	0.5 to 1.0	4 - 8
Stiff	1.0 to 2.0	8 - 15
Very stiff	2.0 to 4.0	15 - 30
Hard	Over 4.0	Over 30

[illegible]

COHESIONLESS SOIL

Density of Cohesionless Soils	Penetration Resistance (Blows per foot)
Very loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	Over 50

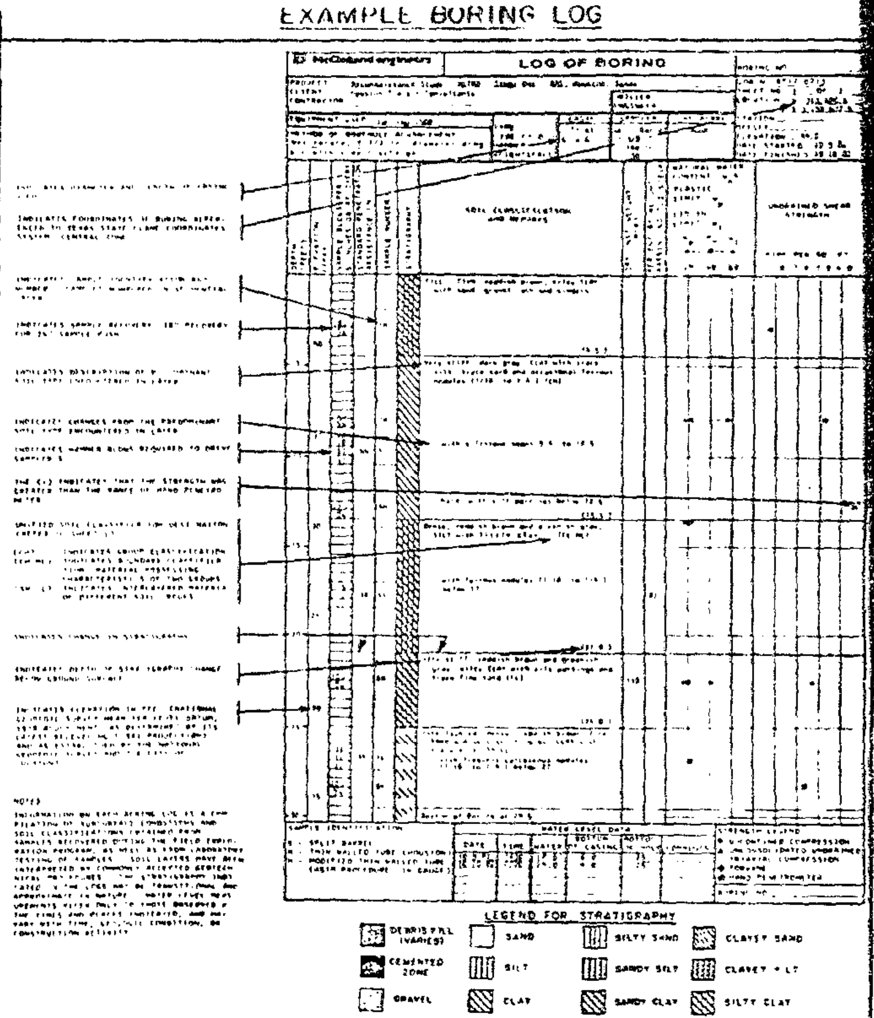
Penetration Resistance

[illegible]

TERMINOLOGY RELATED TO STRATIFIED SOILS

[illegible]

EXAMPLE BORING LOG



METRO-STAGE ONE, RRS

RECONNAISSANCE STUDY
KEY TO DESCRIPTION AND
CLASSIFICATION
OF SUBSURFACE MATERIALS

3

000777

McClelland engineers

LOG OF BORING

BORING NO. BH-8

PROJECT Reconnaissance Study - METRO - Stage One, RRS - Houston, Texas
CLIENT Houston Transit Consultants
DRILLING BY McClelland Engineers

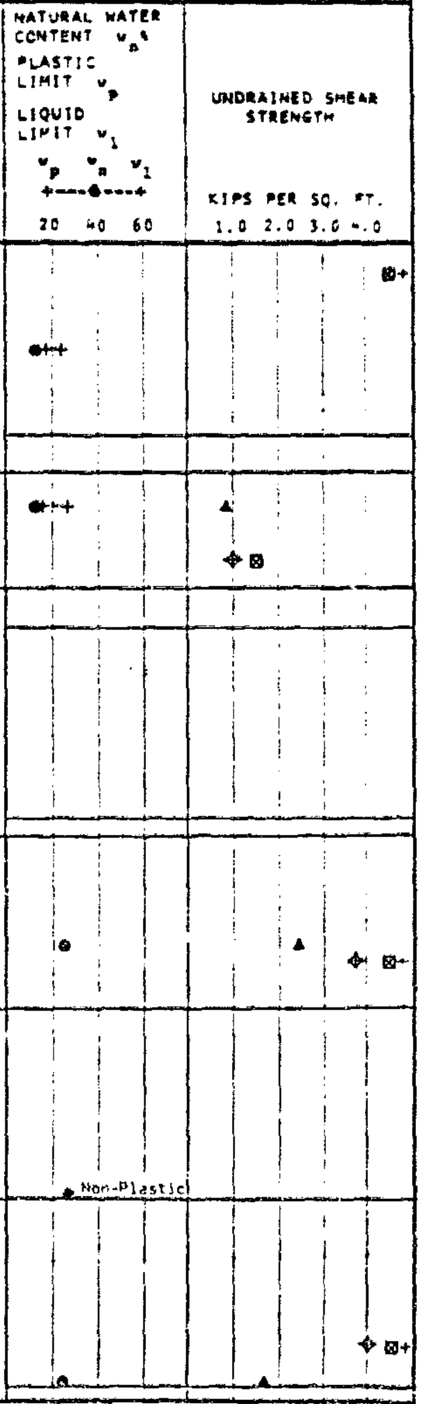
JOB NO. 0152-0282
SHEET NO. 1 OF 2
LOCATION N 734,265.9
E 3,159,031.

EQUIPMENT USED Failing 36, truck mounted
METHOD OF BOREHOLE ADVANCEMENT
Wet Rotary - 3 7/8" bottom discharge bit

	CASING	DRILL CREW	
TYPE	Steel	DRILLER	R. Martin
SIZE	4" x 5'	ENGINEER	C. Rivette
HAMMER WEIGHT&FALL	Push		

STATION
OFFSET
ELEVATION 51.4
DATE STARTED 12-13-82
DATE FINISHED 12-13-82

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
		12"/19"		1H	FILL: Dark gray, silty SAND with little clay -hard, dark gray, CLAY, sand, CLAY and SAND with occasional bricks and gravel (1/8" to 1/2") to 2'		
		19"/24"		2H			
5		19"/24"		3H	(6.0')		
		19"/24"		4H	Firm, light brown and brownish yellow, sandy CLAY (CL)	112	
		20"/24"		5H	(9.0')		
10					Medium dense, light gray, fine SAND with trace silt (SP-SM) -with trace to little clay to 12'		
		9 12 15	27	6S	(15.5')		7
15					Very stiff, reddish brown and greenish gray, CLAY with frequent calcareous nodules (1/8" to 1/2") (CH)		
		16"/18"		7H	-with frequent silt and sand seams below 19' (20.0')	102	
20					Dense, reddish brown and light gray, SILT with occasional clay seams (ML)		
		19 20 23	43	8S	(25.0')		
25					Interlayered, stiff, silty CLAY and CLAY with numerous silt and sand partings (CH/CL)		
		24"/24"		9H	-slickensided at 30'	94	
30							



SAMPLE IDENTIFICATION:

S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

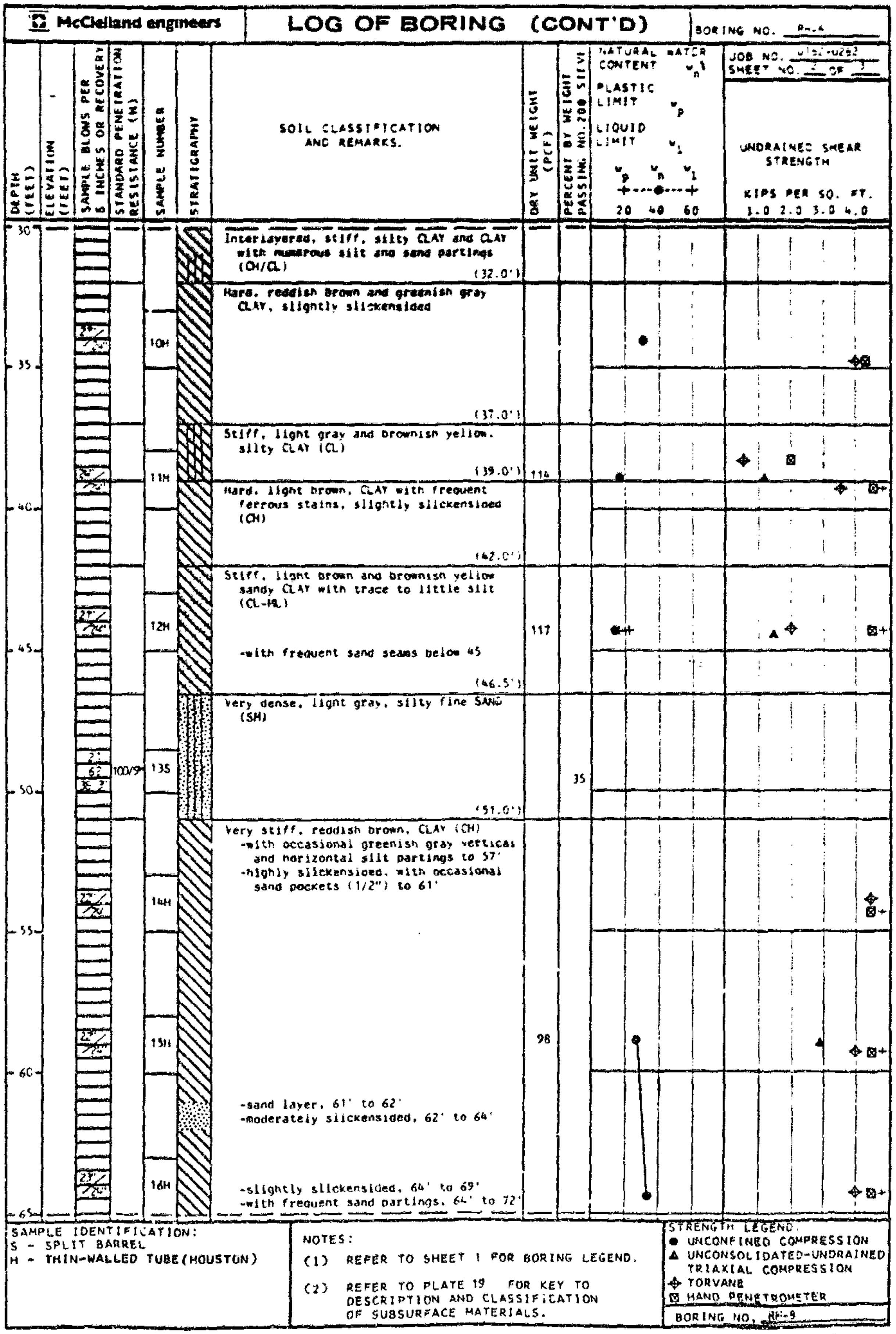
WATER LEVEL DATA

DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
12-17-82	-	6.5'		10.7'	-
12-14-82	1500	[illegible]		[illegible]	-
12-20-82	-	6.5'		10.3'	Sealed

STRENGTH LEGEND:
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
✥ TORVANE
⊠ HAND PENETROMETER

BORING NO. BH-8

PLATE 11a



McClelland engineers

LOG OF BORING (CONT'D)

BORING NO. [illegible]

JOB NO. [illegible]
SHEET NO. 2 OF 3

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	SOIL CLASSIFICATION AND REMARKS.	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
30					Interlayered, stiff, silty CLAY and CLAY with numerous silt and sand partings (CH/CL) (32.0')		
		24"/24"		10H	Hard, reddish brown and greenish gray CLAY, slightly slickensided (37.0')		
35							
					Stiff, light gray and brownish yellow, silty CLAY (CL) (39.0')	114	
		22"/24"		11H	Hard, light brown, CLAY with frequent ferrous stains, slightly slickensided (CH) (42.0')		
40							
		21"/24"		12H	Stiff, light brown and brownish yellow sandy CLAY with trace to little silt (CL-ML) -with frequent sand seams below 45 (46.5')	117	
45							
		21 62 35 2"	100/9"	13S	Very dense, light gray, silty fine SAND (SM) (51.0')		35
50							
		22"/24"		14H	Very stiff, reddish brown, CLAY (CH) -with occasional greenish gray vertical and horizontal silt partings to 57' -highly slickensided, with occasional sand pockets (1/2") to 61'		
55							
		22"/24"		15H		98	
60					-sand layer, 61' to 62' -moderately slickensided, 62' to 64'		
		23"/24"		16H	-slightly slickensided, 64' to 69' -with frequent sand partings, 64' to 72'		
65							

SAMPLE IDENTIFICATION:
S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

NOTES:
(1) REFER TO SHEET 1 FOR BORING LEGEND.
(2) REFER TO PLATE 19 FOR KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS.

STRENGTH LEGEND
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
⯐ TORVANE
⊠ HAND PENETROMETER

BORING NO. RF-9

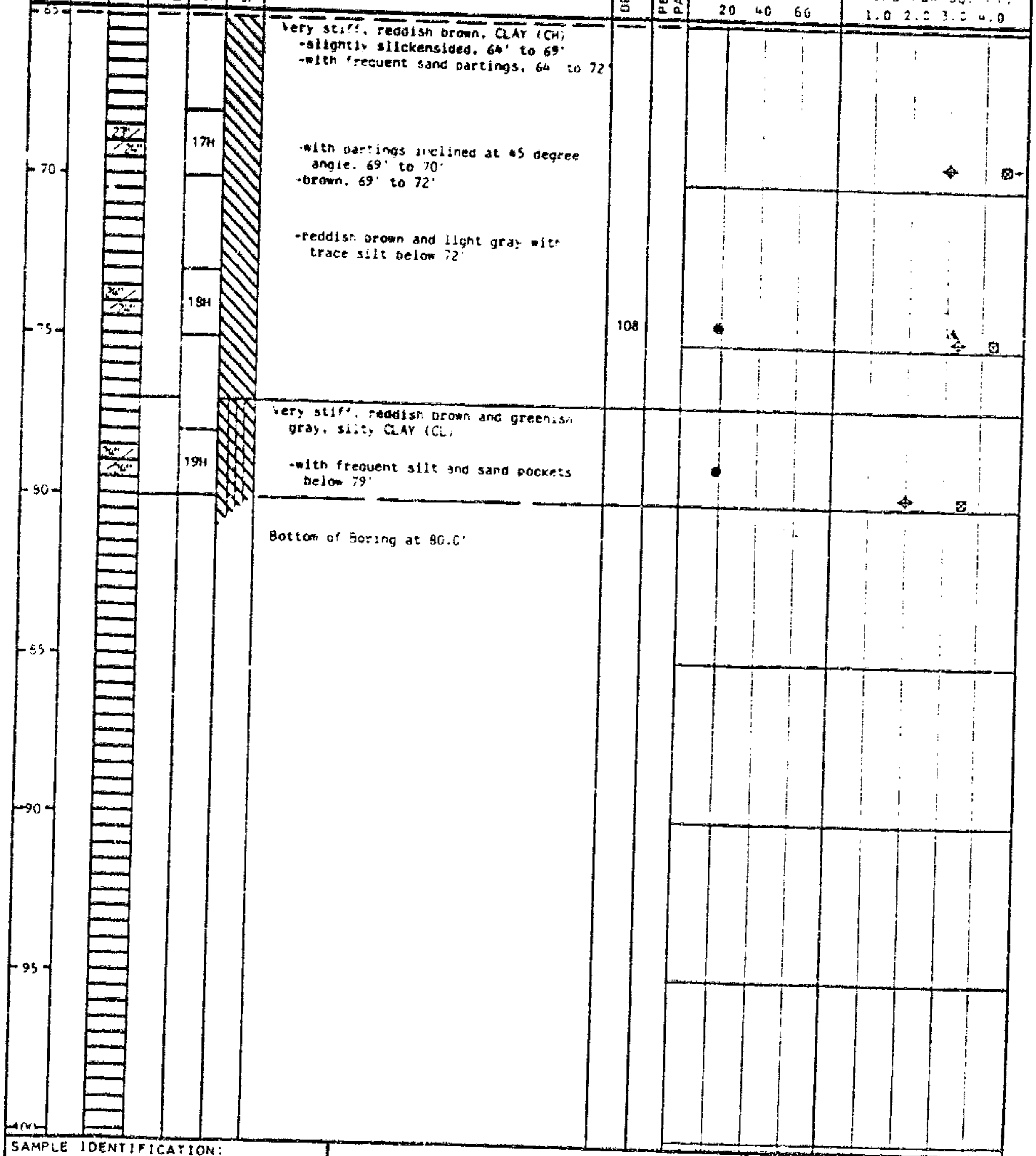
PLATE 11b

McClelland engineers

LOG OF BORING (CONT'D)

BORING NO. [illegible]-8

JOB NO. 0152-0252
SHEET NO. 3 OF 3



DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	SOIL CLASSIFICATION AND REMARKS.	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
65					Very stiff, reddish brown, CLAY (CH) -slightly slickensided, 64' to 69' -with frequent sand partings, 64' to 72'		
		23"/24"		17H	-with partings inclined at 45 degree angle, 69' to 70' -brown, 69' to 72'		
70							
					-reddish brown and light gray with trace silt below 72'		
		24"/24"		19H			
75						108	
					Very stiff, reddish brown and greenish gray, silty CLAY (CL) -with frequent silt and sand pockets below 79'		
		24"/24"		19H			
80					Bottom of Boring at 80.0'		
85							
90							
95							
100							

SAMPLE IDENTIFICATION:
S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

NOTES:
(1) REFER TO SHEET 1 FOR BORING LEGEND.
(2) REFER TO PLATE 19 FOR KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS.

STRENGTH LEGEND.
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
✧ TORVANE
☒ HAND PENETROMETER

BORING NO. [illegible]-8

PLATE 11c

McClelland engineers

LOG OF BORING

BORING NO. RH-9

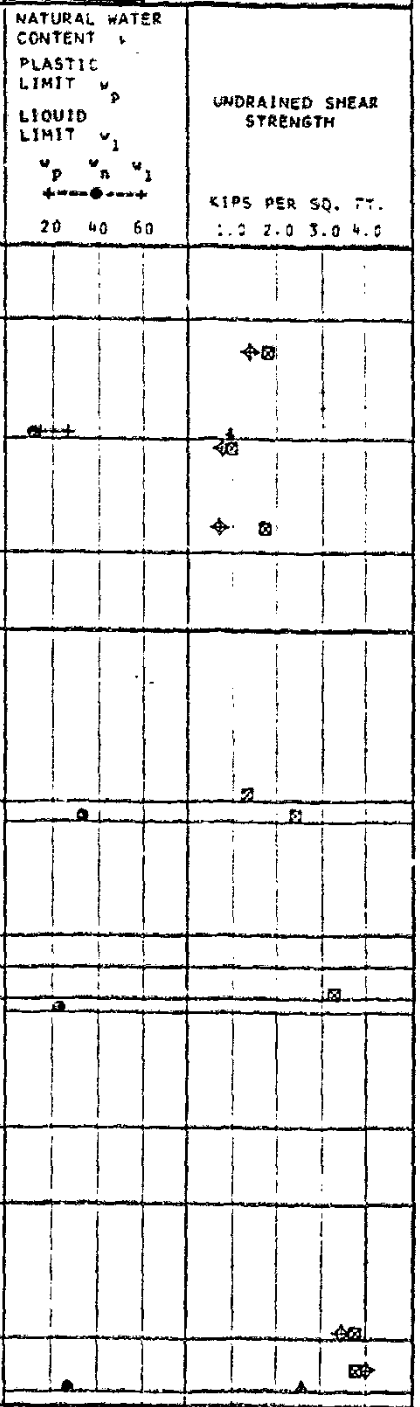
PROJECT Reconnaissance Study - METRO - Stage One, RRS - Houston, Texas
CLIENT Houston Transit Consultants
DRILLING BY McClelland Engineers

JOB NO. 0152-0252
SHEET NO. 1 OF 3
LOCATION N 734,297.2
E 3,157,911.9
STATION
OFFSET
ELEVATION 50.0
DATE STARTED 12-12-82
DATE FINISHED 12-12-82

EQUIPMENT USED Failing 36, truck mounted
METHOD OF BOREHOLE ADVANCEMENT
Wet Rotary - 3 7/8" bottom discharge bit

	CASING	DRILL CREW	
TYPE	Steel	DRILLER	D. Mooney
SIZE	6" x 2.5'	ENGINEER	D. Lourie
HAMMER WEIGHT & FALL	Push		

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
		[illegible]/4"		1H	FILL: Dark gray and brown, silty fine SAND with little fine to medium gravel and shells and roots (2.0')		
		19"/24"		2H	Firm, dark gray and brownish yellow, sandy CLAY (CL)		
5		19"/24"		3H	-with crawfish hole, 5' to 6'	111	
		24"/24"		4H	-light gray and brownish yellow with frequent sand pockets and ferrous nodules (1/8" to 1/4") below 6' -stiff below 7' (8.0')		
		24"/24"		5H	Light gray and brownish yellow clayey SAND with frequent ferrous nodules (1/8" to 1/4") (SC) (10.0')		36
10					Light gray, fine SAND with trace silt (SP)		
		5 7 14	21	6S	-greenish gray, silty clay seam below 14.3' (14.5')		
15					Very stiff, reddish brown and greenish gray CLAY (CH) (18.0')		
					Reddish brown and greenish gray SILT with trace to little clay (18.8')		
		12 17 21	38	7S	Very stiff, reddish brown, silty CLAY with trace sand and frequent calcareous nodules (1/8") (CL) (19.7')		
20					Very stiff, reddish brown, CLAY with frequent calcareous nodules (1/4") (CH) (23.0')		
		14"/24"		8H	Reddish brown and greenish gray, silty fine SAND (SM) (25.0')		26
25					Very stiff, reddish brown, silty CLAY (CL) (28.5')		
30		24"/24"		9H	Very stiff, reddish brown and brownish yellow, CLAY with frequent silt partings and calcareous nodules (1/8" to 1/4") (CH)	92	



SAMPLE IDENTIFICATION:
S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

WATER LEVEL DATA

DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
12-14-82	1500	6.3'	-	10.4'	-
12-17-82	-	5.8'		9.1'	-
12-20-82	-	5.9'		5.4'	Sealed

STRENGTH LEGEND:
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
✧ TORVANE
☒ HAND PENETROMETER

BORING NO. RH-9

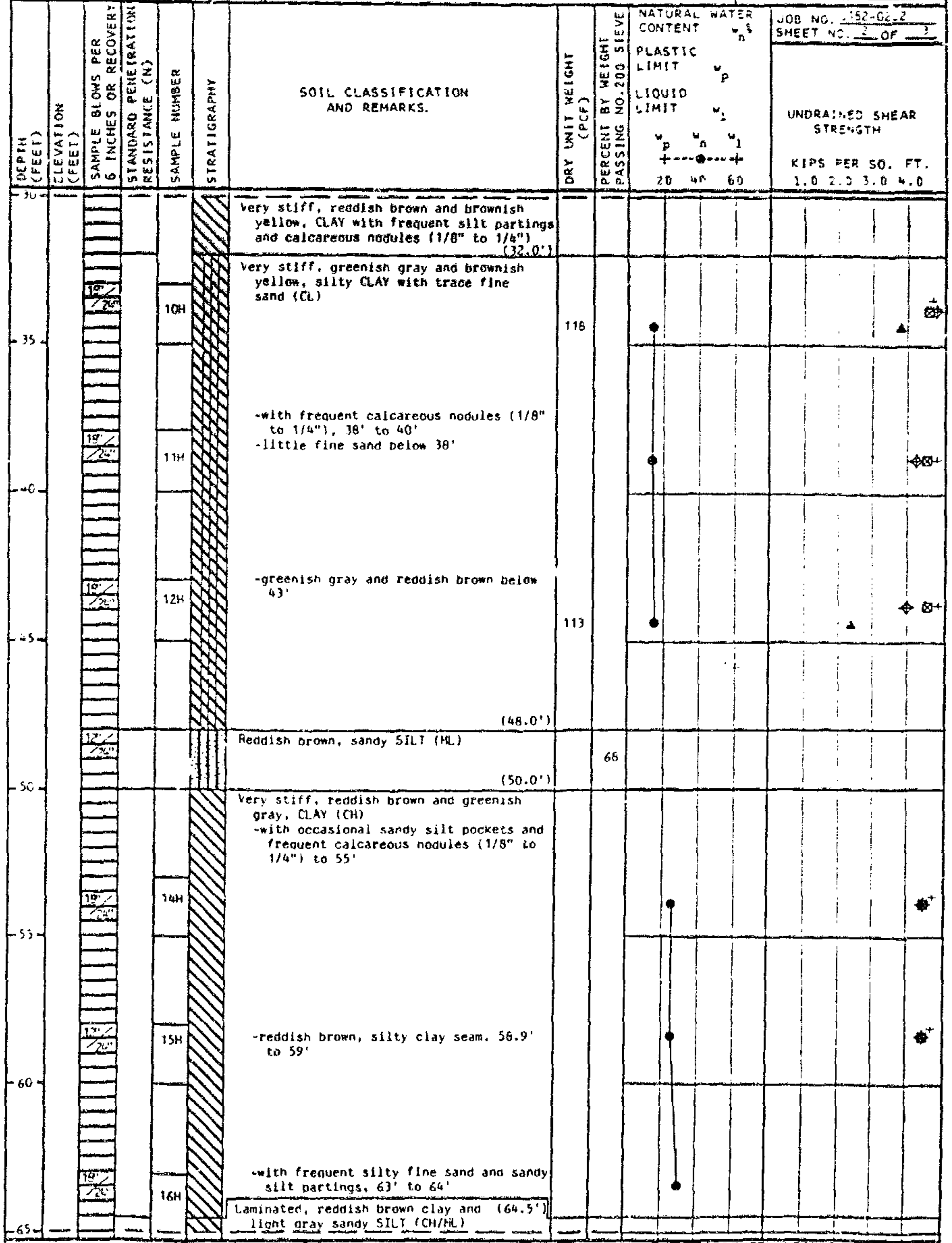
PLATE 12a

McClelland engineers

LOG OF BORING (CONT'D)

BORING NO. RH-9

JOB NO. 152-02-2
SHEET NO. 2 OF 3



Depth (ft)	Sample recovery	Sample number	Soil classification and remarks	Dry unit weight (pcf)	Percent passing No. 200 sieve
30 – 32.0			Very stiff, reddish brown and brownish yellow, CLAY with frequent silt partings and calcareous nodules (1/8" to 1/4") (32.0')		
32.0 – 48.0	19"/24"	10H	Very stiff, greenish gray and brownish yellow, silty CLAY with trace fine sand (CL)	118	
	19"/24"	11H	-with frequent calcareous nodules (1/8" to 1/4"), 38' to 40' -little fine sand below 38'		
	19"/24"	12H	-greenish gray and reddish brown below 43' (48.0')	113	
48.0 – 50.0	12"/24"		Reddish brown, sandy SILT (ML) (50.0')		66
50.0 – 64.5	19"/24"	14H	Very stiff, reddish brown and greenish gray, CLAY (CH) -with occasional sandy silt pockets and frequent calcareous nodules (1/8" to 1/4") to 55'		
	17"/24"	15H	-reddish brown, silty clay seam, 58.9' to 59'		
	19"/24"	16H	-with frequent silty fine sand and sandy silt partings, 63' to 64' (64.5')		
64.5 – 65			Laminated, reddish brown clay and light gray sandy SILT (CH/ML)		

SAMPLE IDENTIFICATION:
S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

NOTES:

(1) REFER TO SHEET 1 FOR BORING LEGEND.

(2) REFER TO PLATE 19 FOR KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS.

STRENGTH LEGEND:
- ● UNCONFINED COMPRESSION
- ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- ✦ TORVANE
- ☒ HAND PENETROMETER

BORING NO. RH-9

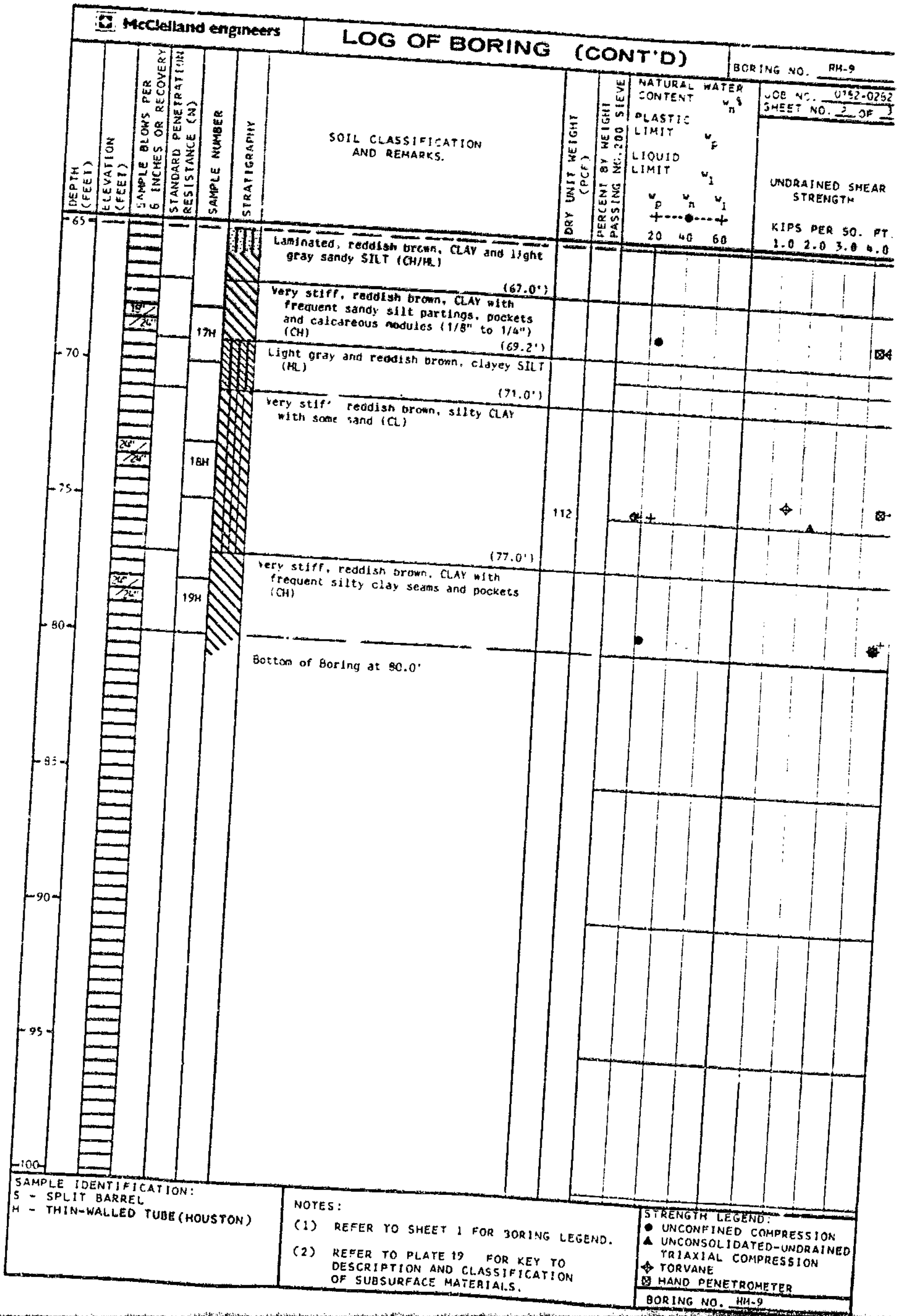
PLATE 12b

McClelland engineers

LOG OF BORING (CONT'D)

BORING NO. RH-9

JOB NO. 0152-0252
SHEET NO. 2 OF 3



SAMPLE BLOWS PER 6 INCHES OR RECOVERY	SAMPLE NUMBER	SOIL CLASSIFICATION AND REMARKS.	DRY UNIT WEIGHT (PCF)
		Laminated, reddish brown, CLAY and light gray sandy SILT (CH/HL) (67.0')	
19"/24"	17H	Very stiff, reddish brown, CLAY with frequent sandy silt partings, pockets and calcareous nodules (1/8" to 1/4") (CH) (69.2')	
		Light gray and reddish brown, clayey SILT (HL) (71.0')	
24"/24"	18H	Very stiff, reddish brown, silty CLAY with some sand (CL) (77.0')	112
24"/24"	19H	Very stiff, reddish brown, CLAY with frequent silty clay seams and pockets (CH)	
		Bottom of Boring at 80.0'	

SAMPLE IDENTIFICATION:
S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

NOTES:

(1) REFER TO SHEET 1 FOR BORING LEGEND.

(2) REFER TO PLATE 19 FOR KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS.

STRENGTH LEGEND:
- ● UNCONFINED COMPRESSION
- ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- ✧ TORVANE
- ⊠ HAND PENETROMETER

BORING NO. RH-9

McClelland engineers

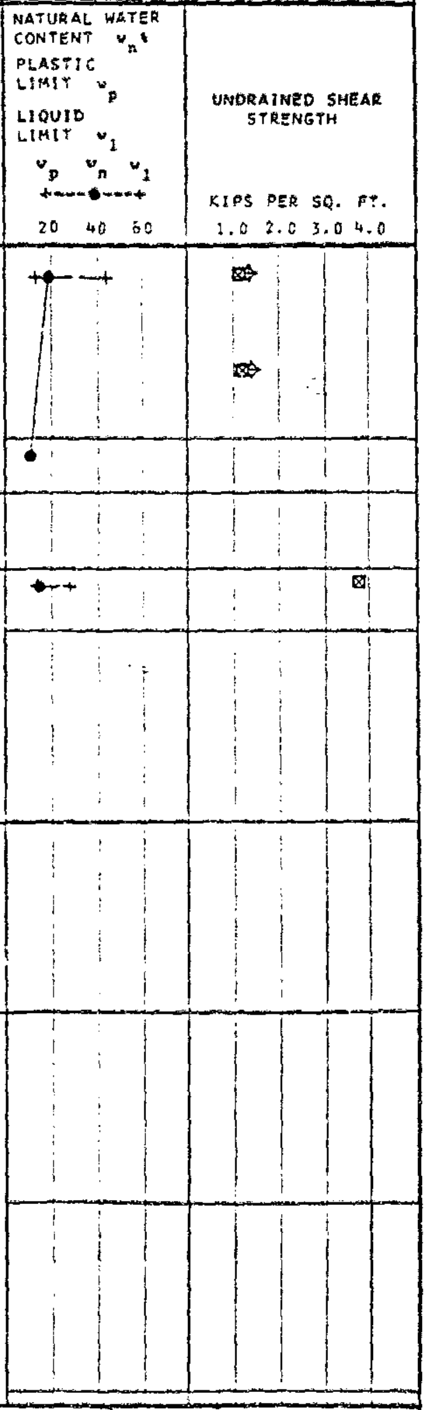
LOG OF BORING

BORING NO.	RH-10
PROJECT	Reconnaissance Study - METRO - Stage One, RRS - Houston, Texas
CLIENT	Houston Transit Consultants
DRILLING BY	McClelland Engineers
JOB NO.	0152-0282
SHEET NO.	1 OF 1
LOCATION	N 734,565.9 E 3,157,996.5
EQUIPMENT USED	Mayhew 250, buggy mounted
METHOD OF BOREHOLE ADVANCEMENT	Wet Rotary - 3 7/8" bottom discharge bit
STATION	
OFFSET	
ELEVATION	51.5
DATE STARTED	12-9-82
DATE FINISHED	12-9-82

	CASING
TYPE	Steel
SIZE	6" x 2.5'
HAMMER WEIGHT&FALL	Push

DRILL CREW	
DRILLER	D. Mooney
ENGINEER	D. Lourie

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	STRATIGRAPHY	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
		12"/24"		1H	▨	FILL: Intermixed, reddish brown, dark gray and greenish gray CLAY and dark gray sandy CLAY with frequent cinders, glass and shell fragments -with roots to 1' -dark gray, sandy clay with some silt and little gravel, 2' to 4' -dark gray to dark brown silty fine sand with roots and creosote odor below 4'		
		19"/24"		2H	▨			
5				3H	▨	(6.5')		
		4 4	11	4S	▨	Medium dense, dark gray clayey SAND with roots and creosote odor (SC) (8.5')		54
10		19"/24"		5H	▨	Very stiff, light gray and brownish yellow, sandy CLAY with frequent vertical sand partings, creosote odor and occasional ferrous nodules (1/2") (CL)		
15		13	19	6S	▨	(15.0')		
					░	Light gray, fine SAND with little silt and creosote odor (SM)		
20		20"/24"		7H	░			13
						Bottom of Boring at 20.0'		
25								
30								



SAMPLE IDENTIFICATION:

S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

WATER LEVEL DATA

DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
12-11-82	-	7.0'	-	15.2'	-
12-17-82	-	7.3'	-	14.3'	Sealed

STRENGTH LEGEND:
- ● UNCONFINED COMPRESSION
- ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- ⊕ TORVANE
- ☒ HAND PENETROMETER

BORING NO. RH-10

PLATE 13

McClelland engineers

LOG OF BORING

BORING NO. RH-11

PROJECT Reconnaissance Study - METRO - Stage One, RRS - Houston, Texas
CLIENT Houston Transit Consultants
DRILLING BY McClelland Engineers

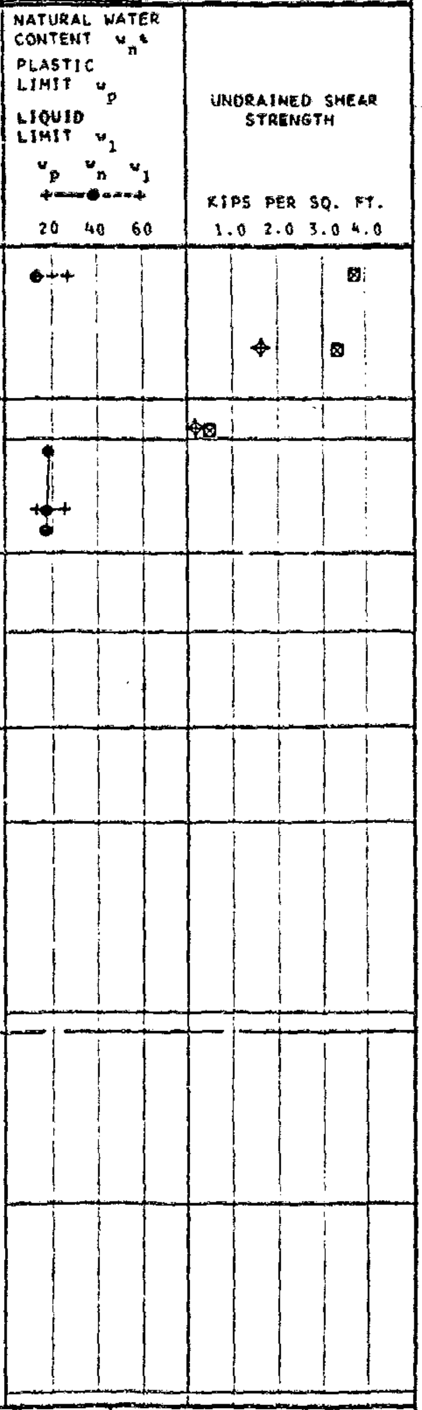
JOB NO. 0152 0252
SHEET NO. 1 OF 1
LOCATION N 734,649.4
E 3,157,622.2
STATION
OFFSET
ELEVATION 49.0
DATE STARTED 12-9-52
DATE FINISHED 12-9-52

EQUIPMENT USED Mayhew 250, buggy mounted

METHOD OF BOREHOLE ADVANCEMENT
Wet Rotary - 3 7/8" bottom discharge bit

	CASING	DRILL CREW	
TYPE	Steel	DRILLER	D. Mooney
SIZE	6" x 2.5'	ENGINEER	D. Lourie
HAMMER			
WEIGHT&FALL	Push		

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	STRATIGRAPHY	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
		19"/24"		1H	▨	FILL: Dark brown, sandy CLAY with frequent shell fragments, roots and sand pockets -silty fine sand to 0.3' -with shells and gravel, 1' to 2' -dark brown and dark gray, sandy clay below 2' (4.0')		
		19"/24"		2H	▨			54
5		19"/24"		3H	▨	Firm, light gray and brownish yellow, sandy CLAY with roots and frequent sand pockets (CL) -dark brown and brownish yellow to 6' -with frequent ferrous nodules (1/4" to 1/2") below 6' (8.0')	109	58
		19"/24"		4H	▨		114	
10		2 3 4	7	5S		Intermixed, clayey SAND and fine SAND with some clay and frequent ferrous nodules (1/4") to 1/2") (12.5')		
15		19 25 38	63	6S		Very dense, light gray, fine SAND with little silt and frequent ferrous nodules (1/2") (SM)		17
20		21 41 59/5"	100/11"	7S		-with occasional sandy clay pockets below 19'		
						Bottom of Boring at 20.5'		
25								
30								



SAMPLE IDENTIFICATION:

S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

WATER LEVEL DATA

DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
12-11-52	-	5.5'	-	12.5'	-
12-17-52	-	3.2'	-	11.0'	Sealed

STRENGTH LEGEND:
- ● UNCONFINED COMPRESSION
- ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- ✢ TORVANE
- ☒ HAND PENETROMETER

BORING NO. RH-11

PLATE 14

McClelland engineers

LOG OF BORING

BORING NO. RM-12

PROJECT Reconnaissance Study - METRO - Stage One, RRS - Houston, Texas
CLIENT Houston Transit Consultants
DRILLING BY McClelland Engineers

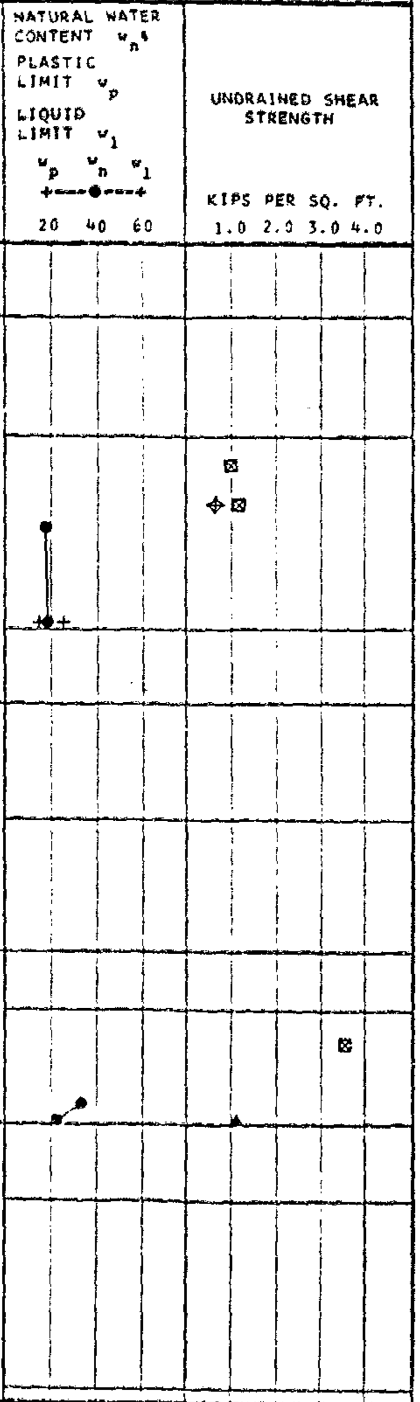
JOB NO. 0152-0252
SHEET NO. 1 OF 1
LOCATION N 725,328.7
E 3,157,750.7

EQUIPMENT USED Maynew 250, buggy mounted
METHOD OF BOREHOLE ADVANCEMENT
Wet Rotary - 3 7/8" bottom discharge bit

	CASING	DRILL CREW	
TYPE	Steel	DRILLER	D. Mooney
SIZE	5" x 2.5'	ENGINEER	C. Rivette
HAMMER WEIGHT&FALL	Push		

STATION
OFFSET
ELEVATION 45.4
DATE STARTED 12-6-62
DATE FINISHED 12-6-62

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
		12"/24"		1H	Dark gray, silty fine SAND with roots (2.0')		43
		3 2 2	[illegible]	2S	Firm to stiff, dark gray, sandy CLAY (CL)		48
5		2 2 4	[illegible]	3S			
		19"/24"		4H		114	
10		3 3 6	[illegible]	5S	-light gray and brownish yellow below 8' (12.0')		44
15		10 15 21	39	6S	Dense, light gray, fine SAND with little clay and occasional clay seams (SM) -with occasional calcareous nodules (1/8") and sand seams below 13.5' (18.5')		16
20		20"/24"		7H	Stiff, greenish gray, CLAY with frequent sandy silt pockets and occasional clayey silt partings (CH) -slickensided at 23'	101	
25					Bottom of Boring at 23.0'		
30							



SAMPLE IDENTIFICATION:

S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

WATER LEVEL DATA

DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
12-9-62	-	5.0'	-	7.0'	-
12-20-62	-	4.9'	-	5.5'	Sealed

STRENGTH LEGEND:
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
⊕ TORVANE
☒ HAND PENETROMETER

BORING NO. RM-12

PLATE 15

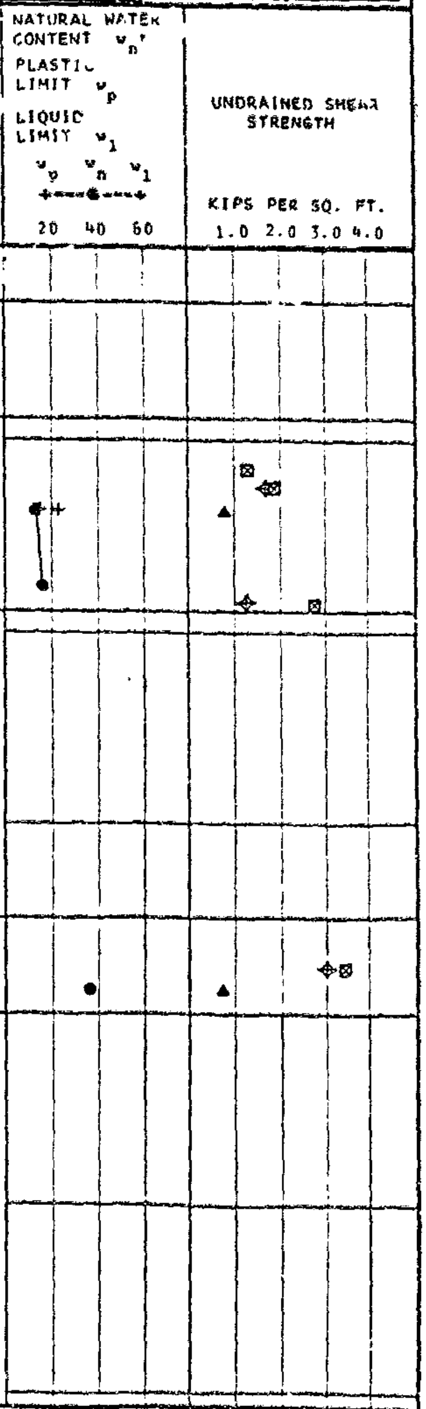
McClelland engineers

LOG OF BORING

PROJECT Reconnaissance Study - METRO - Stage One, RRS - Houston, Texas	BORING NO. RM-13
CLIENT Houston Transit Consultants	JOB NO. 0152-0252
DRILLING BY McClelland Engineers	SHEET NO. 1 OF 1
	LOCATION N 735,511.2 E 3,157,599.0

EQUIPMENT USED Mayhew 250, buggy mounted		CASING	DRILL CREW		STATION
METHOD OF BOREHOLE ADVANCEMENT Wet Rotary - 3 7/8" bottom discharge bit	TYPE	Steel	DRILLER	D. Mooney	OFFSET
	SIZE	6" x 2.5'	ENGINEER	D. Lourie	ELEVATION 45.9
	HAMMER WEIGHT&FALL	Push			DATE STARTED
					DATE FINISHED

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	STRATIGRAPHY	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
		6"/24"		1H		Dark gray to black, silty fine SAND with roots -trace gravel (1") to 1' (1.5')		
		12"/24"		2H		Very loose, dark gray, clayey fine SAND (SC) -with roots to 3' (4.5')		42
5		1 3 5	8	3S		Firm, light gray and brownish yellow, sandy CLAY intermixed with clayey sand and sand (CL/SC/SP)		
		12"/24"		4H		-with frequent ferrous nodules (1/8" to 3/8") below 6' -with vertical sand seam at 7'	113	
		24"/24"		5H		-light gray and brownish yellow with frequent clayey sand and sand partings and seams below 8' (9.5')		
10						Reddish brown, fine SAND with little to some clay (SP-SM) -with occasional sandy clay pockets to 14' -with little silt below 10.5'		
		19 35 40	75	6S		-light gray below 14'		
15						(17.5')		11
		24"/24"		7H		Very stiff, reddish brown and greenish gray CLAY (CH) -moderately slickensided to 19.5' -frequent clayey silt seams below 19.5'	86	
20						Bottom of Boring at 20.0'		
25								
30								



SAMPLE IDENTIFICATION:

S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

WATER LEVEL DATA

DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
12-9-82	-	6.5'	-	10.0'	-
12-11-82	-	4.3'	-	7.5'	-
12-20-82	-	5.6'	-	5.6'	Sealed

STRENGTH LEGEND:
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
⌖ TORVANE
⊠ HAND PENETROMETER

BORING NO. RM-13

PLATE 16

McClelland engineers

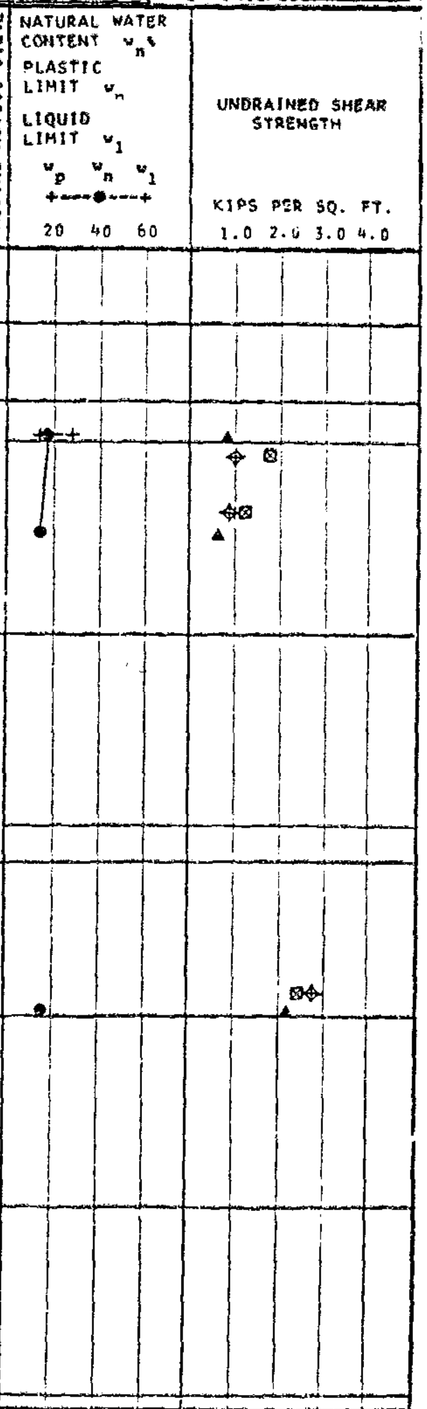
LOG OF BORING

BORING NO. RM-14
JOB NO. 0152-0252
SHEET NO. 1 OF 1
LOCATION N 736,155.9
E 3,157,564.5
STATION
OFFSET
ELEVATION 49.4
DATE STARTED 12-8-82
DATE FINISHED 12-6-82

PROJECT Reconnaissance Study - METRO - Stage One, RRS - Houston, Texas
CLIENT Houston Transit Consultants
DRILLING BY McClelland Engineers
EQUIPMENT USED Haynes 250, buggy mounted
METHOD OF BOREHOLE ADVANCEMENT
Wet rotary - 3 7/8" bottom discharge bit

	CASING	DRILL CREW	
TYPE	Steel	DRILLER	D. Mooney
SIZE	6" x 2.5'	ENGINEER	D. Laurie
HAMMER WEIGHT&FALL	Push		

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	STRATIGRAPHY	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
		6"/24"		1H		Dark gray, silty fine SAND with roots (SM) (2.0')		
		1 2 2	4	2S		Dark gray, clayey SAND (SC) (4.0')		
5		19"/24"		3H		Firm, light gray and brownish yellow, sandy CLAY with frequent ferrous nodules (1/8") (CL)	111	
		19"/24"		4H			111	
		4 5 9	14	5S		(10.0')		
10						Light gray, fine SAND with little silt and frequent brownish yellow sandy clay pockets (SM)		
		12 24 50	74	6S				18
15						(16.0')		
		20"/20"		7H		Very stiff, light gray and brownish yellow, silty CLAY with little sand	113	
20						Bottom of Boring at 20.0'		
25								
30								



SAMPLE IDENTIFICATION:
S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

WATER LEVEL DATA

DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
12-9-82	-	6.0'	-	9.2'	-
12-20-82	-	5.5'	-	8.8'	-
12-23-82		6.2'		7.4'	-
7-6-83		-		-	Sealed

STRENGTH LEGEND:
- ● UNCONFINED COMPRESSION
- ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- ✦ TORVANE
- ☒ HAND PENETROMETER

BORING NO. RM-14

PLATE 17

McClelland engineers

LOG OF BORING

BORING NO. RH-15

PROJECT Reconnaissance Study - METRO - Stage One, ARS - Houston, Texas
CLIENT Houston Transit Consultants
DRILLING BY McClelland Engineers

JOB NO. 0152-0252
SHEET NO. 1 OF 1
LOCATION N 736,962.9
E 3,157,363.4

EQUIPMENT USED Mayhew 250, buggy mounted
METHOD OF BOREHOLE ADVANCEMENT
Wet Rotary - 3 7/8" bottom discharge bit

	CASING	DRILL CREW	
TYPE	Steel	DRILLER	D. Mooney
SIZE	6" x 2.5'	ENGINEER	D. Lourie
HAMMER WEIGHT&FALL	Push		

STATION
OFFSET
ELEVATION 51.2
DATE STARTED 12-6-62
DATE FINISHED 12-6-62

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	STRATIGRAPHY	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE	NATURAL WATER CONTENT w_n % PLASTIC LIMIT w_p LIQUID LIMIT w_l (w_p w_n w_l) 20 40 60	UNDRAINED SHEAR STRENGTH KIPS PER SQ. FT. 1.0 2.0 3.0 4.0
		12"/24"		1H		Dark gray, silty fine SAND with roots and frequent clay pockets (SM) (2.0')				
		18"/24"		2H		Dark gray, clayey SAND with roots (SC) (4.0')		50		⊠
5		19"/24"		3H		Stiff, dark gray and brownish yellow, sandy CLAY with roots, frequent ferrous nodules (1/8") and vertical fine sand seams (CL) (6.0') -with crawfish hole to 5.5'	111		●+-+	◈⊠ ▲
		24"/24"		4H		Light gray and brownish yellow, clayey SAND with frequent fine sand partings (8.0')				
		5 7 8	15	5S		Light gray and brownish yellow, fine SAND with little clay (SM) -with light gray, fine sand seams to 12'		13		
10						-light gray below 12'				
		4 15 23	38	6S				11		
15						Bottom of Boring at 15.0'				
20										
25										
30										

SAMPLE IDENTIFICATION:

S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

WATER LEVEL DATA

DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
12-9-62	-	3.2'	-	9.2'	-
12-20-62	-	3.0'	-	9.1'	Sealed

STRENGTH LEGEND:
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
◈ TORVANE
⊠ HAND PENETROMETER

BORING NO. RH-15

PLATE 18

McClelland engineers

LOG OF BORING

BORING NO. RN-16
JOB NO. 0152-0252
SHEET NO. 1 OF 3
LOCATION N 734,256.5
E 3,157,405.2

PROJECT Reconnaissance Study - METRO - Stage One, HRS - Houston, Texas
CLIENT Houston Transit Consultants
DRILLING BY McClelland Engineers

EQUIPMENT USED Failing 36, truck mounted
METHOD OF BOREHOLE ADVANCEMENT Auger to 1'; Wet Rotary below 1':
[illegible] bottom discharge bit

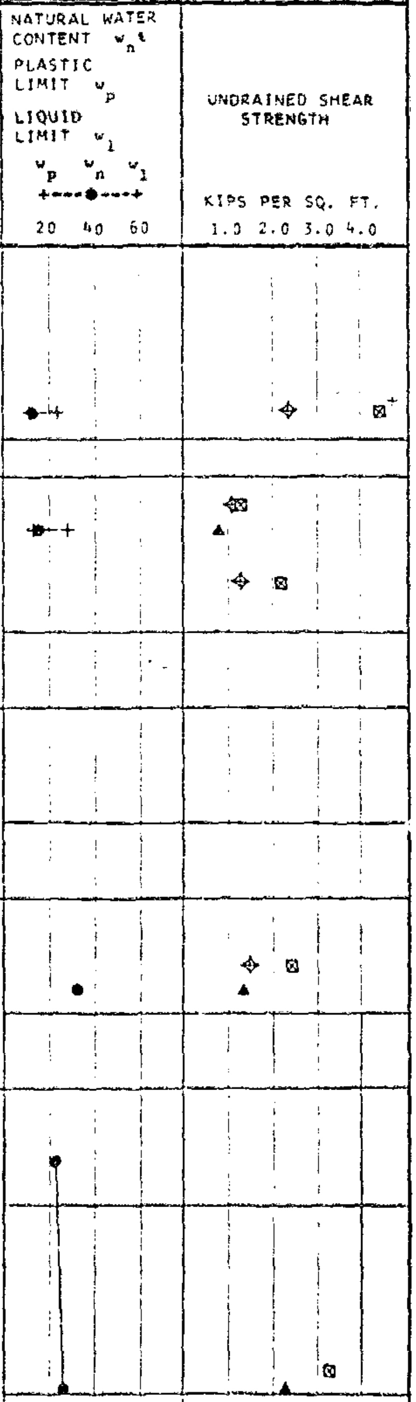
	CASING	DRILL CREW	
TYPE	Steel	DRILLER	W. Martin
SIZE	4" x 2'	ENGINEER	D. Lourie
HAMMER WEIGHT&FALL	Push		

STATION
OFFSET
ELEVATION 52.5
DATE STARTED 11-23-82
DATE FINISHED 11-23-82

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
0 – 5	50			1H 2H 3H	FILL: GRAVEL and CINDERS to 0.2' -dark brown sandy SILT with frequent clay pockets and roots, 0.2' to 2' -dark brown, silty fine SAND with some clay, 2' to 4' -hard, dark brown, sandy CLAY to clayey SAND with frequent sand seams and roots below 4' (6.0')		
5 – 10	45			4H 5H	Stiff, dark gray and brownish yellow, sandy CLAY (CL) -with frequent sand seams and pockets to 8' -with crawfish hole to 10' -very stiff, light gray and brownish yellow below 8' (12.0')	110	
10 – 15	40	5 [illegible] 15	12	6S	Medium dense, brownish yellow and light gray, fine SAND with little silt (SP) (17.0')		14
15 – 20	35			7H	Stiff, reddish brown and light gray, CLAY with frequent fine sand partings (CH) (22.0')	91	
20 – 30	30 25			8H 9H	Interlayered, reddish brown, brownish yellow and greenish gray, SILT, CLAY and clayey SILT (ML/CH) -with frequent vertical calcareous nodules (1/16" to 1/4") and fine sand partings to 26' -interlayered sandy SILT, silty fine SAND and very stiff CLAY below 26'	97	

NATURAL WATER CONTENT w_n%
PLASTIC LIMIT w_p
LIQUID LIMIT w_l

UNDRAINED SHEAR STRENGTH
KIPS PER SQ. FT.



SAMPLE IDENTIFICATION:

S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

WATER LEVEL DATA					
DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
11-24-82	1505	11.5	-	23.5	-
[illegible]	-	-	-	11.0	-
12-17-82	-	-	-	9.7	Sealed

STRENGTH LEGEND:
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
✥ TORVANE
☒ HAND PENETROMETER

BORING NO. RN-16

PLATE A-16a

McClelland engineers

LOG OF BORING (CONT'D)

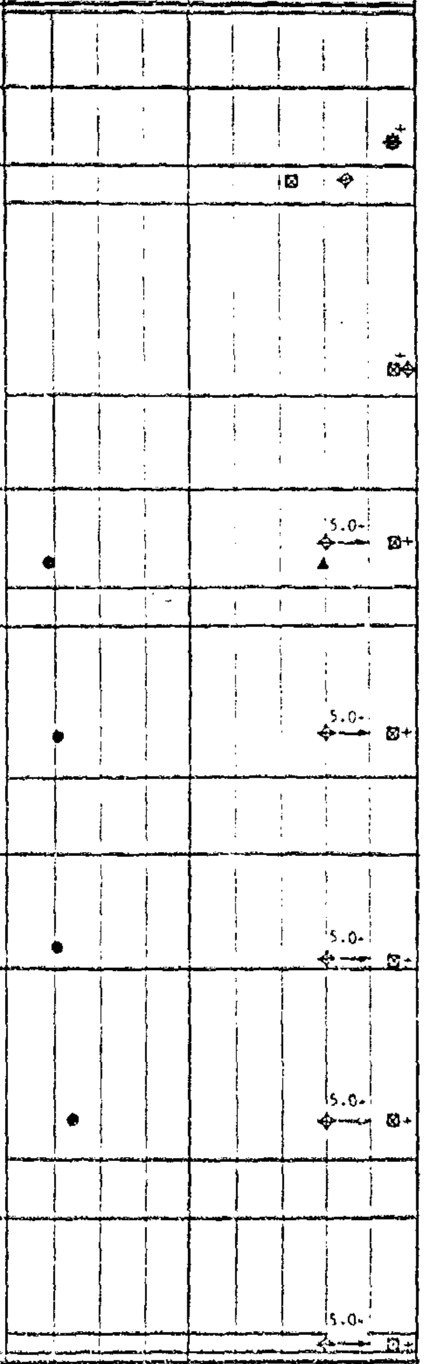
BORING NO. RN-16

JOB NO. 0152-0252
SHEET NO. 2 OF 3

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	SOIL CLASSIFICATION AND REMARKS.	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO.200 SIEVE
30					Interlayered, reddish brown, brownish yellow, and greenish gray, sandy SILT, silty fine SAND and CLAY (ML/SM/CH) (32.0')		
	20	19"/24"		10H	Hard, reddish brown and greenish gray, CLAY, heavily slickensided (CH) (34.0')		
35 40	15	24"/24"		11H	Very stiff, brownish yellow and greenish gray, silty CLAY with some sand (CL) -with frequent sand partings to 37' -hard, light gray and brownish yellow below 37' (42.5')		
45	10	19"/24"		12H	Intermixed, hard, reddish brown, CLAY and light gray sandy CLAY with frequent calcareous nodules (1/8" to 1/4"), slightly slickensided (CH/CL) (46.0')	113	
50	5	19"/24"		13H	Hard, reddish brown and greenish gray, CLAY, moderately slickensided with frequent silt pockets (CH) (52.0')		
	0	12 22 30	52	14S	Interlayered, reddish brown SILT, clayey SILT and hard CLAY (ML/CH) (55.0')		
55 60	-5	19"/24"		15H	Hard, reddish brown, CLAY, highly slickensided (CH) -with frequent calcareous nodules (1/16" to 1/4") and siltstone seams, 58' to 58.5' (61.5')		
	-10	43 [illegible] 33	50	16S	Dense, reddish brown, SILT with little sand (ML) (64.5')		99
65					Hard, reddish brown, CLAY with frequent calcareous nodules (1/16" to 1/8") (CH)		

NATURAL WATER CONTENT w_n %
PLASTIC LIMIT w_p
LIQUID LIMIT w_l
w_p w_n w_l
20 40 60

UNDRAINED SHEAR STRENGTH
KIPS PER SQ. FT.
1.0 2.0 3.0 4.0



SAMPLE IDENTIFICATION:
S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

NOTES:
(1) REFER TO SHEET 1 FOR BORING LEGEND.
(2) REFER TO PLATE A-28 FOR KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS.

STRENGTH LEGEND.
⊕ UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
⊕ TORVANE
⊠ HAND PENETROMETER

BORING NO. RN-16

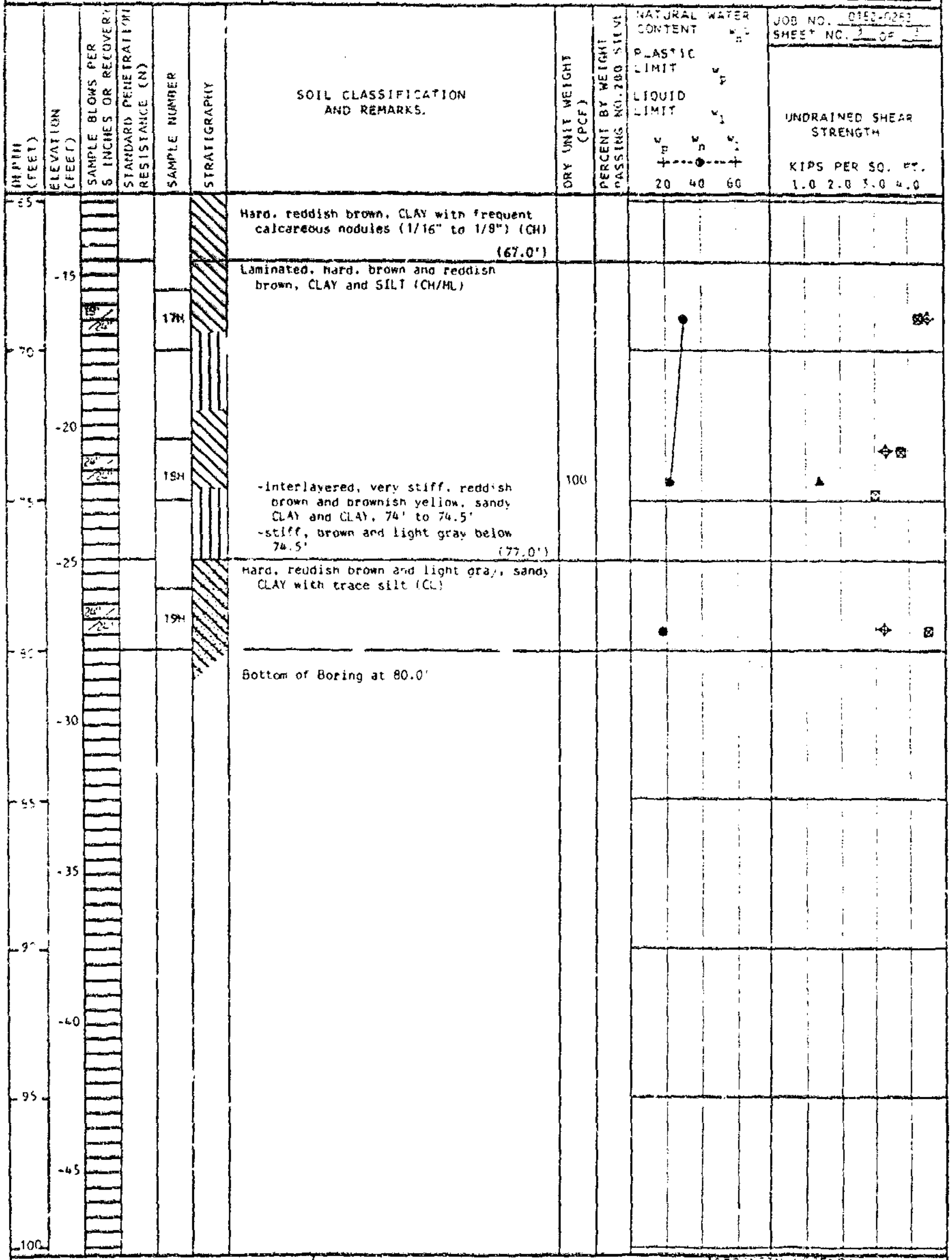
PLATE A-16b

McClelland engineers

LOG OF BORING (CONT'D)

BORING NO. RN-16

JOB NO. 0152-0252
SHEET NO. 2 OF 2



DEPTH (FEET)	ELEVATION (FEET)	SAMPLE BLOWS PER 6 INCHES OR RECOVERY	STANDARD PENETRATION RESISTANCE (N)	SAMPLE NUMBER	STRATIGRAPHY	SOIL CLASSIFICATION AND REMARKS.	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE	NATURAL WATER CONTENT w_n / PLASTIC LIMIT w_p / LIQUID LIMIT w_l (20 40 60)	UNDRAINED SHEAR STRENGTH KIPS PER SQ. FT. (1.0 2.0 3.0 4.0)
65						Hard, reddish brown, CLAY with frequent calcareous nodules (1/16" to 1/8") (CH) (67.0')				
	-15					Laminated, hard, brown and reddish brown, CLAY and SILT (CH/ML)				
		19"/24"		17H						
70										
	-20									
		24"/22"		18H		-interlayered, very stiff, reddish brown and brownish yellow, sandy CLAY and CLAY, 74' to 74.5' -stiff, brown and light gray below 74.5' (77.0')	100			
75										
	-25					Hard, reddish brown and light gray, sandy CLAY with trace silt (CL)				
		24"/22"		19H						
80						Bottom of Boring at 80.0'				
	-30									
85										
	-35									
90										
	-40									
95										
	-45									
100										

SAMPLE IDENTIFICATION:
S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

NOTES:

(1) REFER TO SHEET 1 FOR BORING LEGEND.

(2) REFER TO PLATE A-20 FOR KEY TO DESCRIPTION AND CLASSIFICATION OF SUBSURFACE MATERIALS.

STRENGTH LEGEND:
- ● UNCONFINED COMPRESSION
- ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- ✧ TORVANE
- ⊠ HAND PENETROMETER

BORING NO. RN-16

PLATE A-16c

McClelland engineers

LOG OF BORING

BORING NO. [illegible]

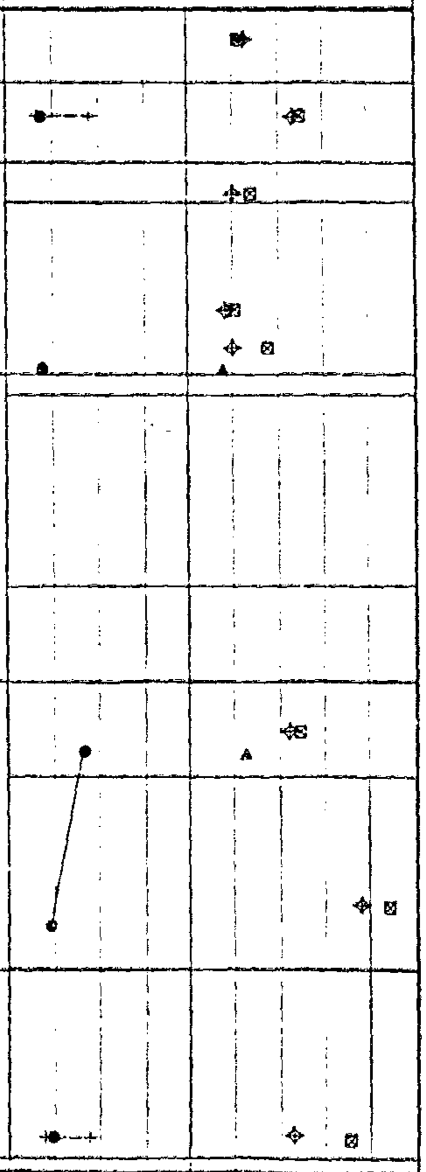
PROJECT Reconnaissance Study - METRO - Stage One, RRS - Houston, Texas
CLIENT Houston Transit Consultants
DRILLING BY McClelland Engineers

JOB NO. [illegible]
SHEET NO. [illegible] OF [illegible]
LOCATION [illegible]
STATION
OFFSET
ELEVATION [illegible]
DATE STARTED [illegible]
DATE FINISHED [illegible]

EQUIPMENT USED Failing Jo. truck mounted
METHOD OF BOREHOLE ADVANCEMENT
Wet Rotary - [illegible] bottom discharge bit

	CASING	DRILL CREW	
TYPE	Steel	DRILLER	W. Martin
SIZE	[illegible]	ENGINEER	D. Lourie
HAMMER WEIGHT&FALL	Push		

DEPTH (FEET)	ELEVATION (FEET)	SAMPLE NUMBER	STANDARD PENETRATION RESISTANCE (N)	SOIL CLASSIFICATION AND REMARKS	DRY UNIT WEIGHT (PCF)	PERCENT BY WEIGHT PASSING NO. 200 SIEVE
		1H		FILL: Stiff, dark gray, sandy CLAY with little silt, frequent shell fragments, occasional calcareous nodules (1/4") and roots (2.0')		
	45	2H		Very stiff, dark gray, silty CLAY with some sand, frequent calcareous nodules (1/16" to 1/2"), ferrous stains and roots (CL) (4.0')		
5	40	3H 4H 5H		Firm, dark gray, light gray and brownish yellow, sandy CLAY (CL) -with vertical clayey sand seams below 6' -light gray and brownish yellow below 9' (9.5')	113	
10 15	35	6S	31	Dense, light gray, fine SAND with trace silt (SP-SM) -clayey sand to 10' (17.5')		10
20	30 25	7H 8H		Stiff, reddish brown and greenish gray, CLAY (CH) -highly slickensided to 23' -with occasional sandy clay and clayey silt pockets, 19.5' to 20' -with frequent silt layers and sandy silt partings below 20' -very stiff and moderately slickensided below 23' (25.0')	99	
25 30	20	9H		Very stiff, reddish brown and light gray, silty CLAY with frequent clayey silt and sandy clay pockets and occasional ferrous nodules (1/16" to 1/8") (CL) Bottom of Boring at 30.0'		



SAMPLE IDENTIFICATION:
S - SPLIT BARREL
H - THIN-WALLED TUBE (HOUSTON)

WATER LEVEL DATA

DATE	TIME	WATER	BOTTOM OF CASING	BOTTOM OF HOLE	COMMENTS
[illegible]		5.5	-	16.0	-
[illegible]		5.9	-	11.5	Sealed

STRENGTH LEGEND:
● UNCONFINED COMPRESSION
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
✣ TORVANE
☒ HAND PENETROMETER

BORING NO. HH-17

PLATE A-17

APPENDIX III

TOXICOLOGY INFORMATION

CONTENTS

APPENDIX III

- Acenaphtene
- Acenaphthylene
- Anthracene
- Arsenic
- Benzene
- Benzo(A)Pyrene
- 3,4 Benzofluoranthene
- Benzo(k)Fluoranthene
- Beryllium
- Bis(2-ethylhexyl) Phthalate
- Cadmium
- Chromium
- Chrysene
- Copper
- Creosote
- Cyanide
- Dibenz(a,h)Anthracene
- Dibutyl Phthalate
- 2,4-Dimethylphenol
- Ethyl Benzene
- Fluoranthene
- Fluorene
- Lead
- Mercury
- Methylene Chloride
- Naphthalene
- Nickel
- Pentachlorophenol
- Phenanthrene
- Phenol
- Polychlorinated biphenyl
- Polynuclear Aromatic Hydrocarbons
- Pyrene
- Silver
- Toluene
- 1,2,4-Trichlorobenzene
- Zinc - $ZnCl_2$
  $ZnCr_xO_y$

ACENAPHTHENE

- Priority toxic pollutant (EPA)

Description: Acenaphthene, $C_{12}H_{10}$, is a white crystalline solid melting at 95° to 97°C.

Code Numbers: CAS 83-32-9

DOT Designation: –

Synonyms: 1,8-Ethylenenaphthalene, 1,2-dehydroacenaphthalene.

Potential Exposure: Acenaphthene occurs in coal tar produced during the high-temperature carbonization or coking of coal. It is used as a dye intermediate, in the manufacture of some plastics, as an insecticide and fungicide, and has been detected in cigarette smoke and gasoline exhaust condensates.

Permissible Exposure Limits in Air: No standards exist.

Permissible Concentration in Water (1): To protect freshwater aquatic life–1,700 μg/ℓ. To protect saltwater aquatic life–on an acute basis 970 μg/ℓ and on a chronic basis 520 μg/ℓ. To protect human health–20.0 μg/ℓ (based on organoleptic data).

Determination in Water: Gas chromatography or high performance liquid chromatography (EPA Method 610) or gas chromatography and mass spectrometry (EPA Method 625).

Routes of Entry: Ingestion from water or foods, inhalation.

Harmful Effects and Symptoms: Acenaphthene is irritating to skin and mucous membranes and may cause vomiting if swallowed in large quantities. (The most thoroughly investigated effect of acenaphthene is its ability to produce nuclear and cytological changes in microbial and plant species. Most of these changes, such as an increase in cell size and DNA content, are associated with disruption of the spindle mechanism during mitosis and the resulting induction of polyploidy. While there is no known correlation between these effects and the biological impact of acenaphthene on mammalian cells, these effects are reported here because they are the only substantially investigated effects of acenaphthene.)

Points of Attack: Liver, kidneys, skin.

Medical Surveillance: Preplacement and regular physical examinations are indicated for workers having contact with acenaphthene in the workplace.

First Aid: If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, wash with soap immediately. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Prevent repeated or prolonged skin contact. Wear goggles when eye exposure is reasonably probable. Wash skin and change clothing upon contamination.

Respirator Selection: Chemical cartridge respirator, gas mask or supplied air respirator indicator–precise recommendation awaits definition of allowable limits in air.

Disposal Method Suggested: Incineration.

:rystalline solid melting at

acenaphthalene.

al tar produced during the is used as a dye intermedi- cticide and fungicide, and naust condensates.

exist.

:t freshwater aquatic life— acute basis 970 µg/ℓ and ealth—20.0 µg/ℓ (based on

high performance liquid ography and mass spectrom-

halation.

is irritating to skin and allowed in large quantities. aphthene is its ability to l and plant species. Most JA content, are associated mitosis and the resulting correlation between these n mammalian cells, these substantially investigated

hysical examinations are ne in the workplace.

gate immediately. If this y. When this chemical has tities of water and induce

prolonged skin contact. le. Wash skin and change

. gas mask or supplied air definition of allowable

References

(1) U.S. Environmental Protection Agency, *Acenaphthene: Ambient Water Criteria,* Report PB 208-782, Washington, DC (1980).

(2) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 4,* No. 1, 38-41, New York, Van Nostrand Reinhold Co. (1984).

ACENAPHTHYLENE

See "Polynuclear Aromatic Hydrocarbons."

ACETALDEHYDE

- Hazardous substance (EPA)
- Hazardous waste (EPA)

Description: CH_3CHO, acetaldehyde, is a flammable, volatile colorless liquid with a characteristic penetrating, fruit odor. It boils at 20° to 21°C.

Code Numbers: CAS 75-07-0 RTECS AB1925000 UN 1089

DOT Designation: Flammable liquid.

Synonyms: Acetic aldehyde, aldehyde, ethanal, ethyl aldehyde.

Potential Exposure: Acetaldehyde can be reduced or oxidized to form acetic acid, acetic anhydride, acrolein, aldol, butanol, chloral, paraldehyde, and pentaerythritol. It is also used in the manufacture of disinfectants, drugs (A-41), dyes, explosives, flavorings, lacquers, mirrors (silvering), perfume, photographic chemicals, phenolic and urea resins, rubber accelerators and antioxidants, varnishes, vinegar, and yeast. It is also a pesticide intermediate (A-32).

NIOSH estimates that 2,430 workers are exposed to acetaldehyde. Acetaldehyde is the product of most hydrocarbon oxidations; it is a normal intermediate product in the respiration of higher plants: it occurs in traces in all ripe fruits and may form in wine and other alcoholic beverages after exposure to air. Acetaldehyde is an intermediate product in the metabolism of sugars in the body and hence occurs in traces in blood. It has been reported in fresh leaf tobacco as well as in tobacco smoke and in automobile and diesel exhaust (A-5). It has been found in 5 of 10 water supplies surveyed by EPA with the highest concentrations in Philadelphia and Seattle at 0.1 µg/ℓ (A-2).

Incompatibilities: Strong oxidizers, acids, bases, alcohol, ammonia, amines, phenols, ketones, HCN, H_2S.

Permissible Exposure Limits in Air: The Federal standard (TWA) is 200 ppm (360 mg/m^3); however, the ACGIH 1983/84 recommended TLV is 100 ppm (180 mg/m^3). The tentative STEL is 150 ppm (270 mg/m^3) and the IDLH level is 10,000 ppm.

Determination in Air: Acetaldehyde may be collected by impinger or fritted bubbler and then determined colorimetrically (A-8).

Permissible Concentration in Water: Human exposure to acetaldehyde probably antedates recorded history, inasmuch as acetaldehyde is the major metabo-

```
NONE
NO AC[illegible]IENE - 0 - RE HITS IN DATABASE.

ENTER NAME, [illegible], [illegible], CTLA, NAMELIST, HELP, OR QUIT.
NAME
ENTER CHEMICAL NAME
ANTHRACENE
TYPE WHAT INFORMATION YOU REQUIRE
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
?

INVALID OR MISSING OPTION(S)
TYPE WHAT INFORMATION YOU REQUIRE
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
INVALID OR MISSING OPTION
(S)
TYPE WHAT INFORMATION YOU REQUIRE
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
ALL
```

ANTHRACENE

1/17

```
CHEMICAL NAME
  ANTHRACENE

FORMULA
  C14H10

SYNONYMS
  PARANAPHTHALENE
  GREEN OIL
  TETRAOLIVE OIL
  ANTHRACIN
  TETRA OLIVE N2G
  GHS0150[illegible]

PERMISSIBLE EXPOSURE LIMIT
  NONE ESTABLISHED (SEE COAL TAR PITCH VOLATILES)
  MUTAGENIC DATA (RTEC
  ANIMAL CARCINOGEN (RTECS)
  CERCLA HAZARD RATINGS - TOXICITY 0 - IGNITABILITY 1 - REACTIVITY 1
  PERSISTENCE 3

  TOXICOLOGY:  ANTHRACENE IS A SKIN, EYE AND RESPIRATORY IRRITANT.  SKIN
  CONTACT MAY PRODUCE PIGMENTATION AND DERMATITIS.  INGESTION IRRITATES
  THE GASTROINTESTINAL TRACT.  INHALATION IS UNLIKELY AT NORMAL TEMPERA-
  TURE.  AT ELEVATED TEMPERATURES, INHALATION MAY CAUSE COUGHING, SORE
  THROAT, AND DYSPNEA.

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONCENTRATION
  NONE SPECIFIED

PHYSICAL DESCRIPTION
  PALE GREEN SOLID WITH A FAINT AROMATIC ODOR

CHEMICAL AND PHYSICAL PROPERTIES
  MOLECULAR WEIGHT: 178.2
  BOILING POINT AT 1 ATM, F: 644 F
  SOLUBILITY IN WATER, G/100 G WATER AT 20C: INSOLUBLE
  FLASH POINT, CLOSED CUP, F (OF OPEN CUP IF OC): [illegible]
  [illegible]
   MELTING POINT, F: 41[illegible]
   [illegible] VOLUME: SUBLIMES
  [illegible] BY VOLUME: 0.6
  AUTOIGNITION TEMPERATURE [illegible]
  SPECIFIC GRAVITY: 1.2 [illegible]
```

2/17

INCOMPATIBILITIES
STRONG OXIDIZERS
CHROMIC ACID
CALCIUM HYPOCHLORITE

PERSONAL PROTECTIVE EQUIPMENT
NO NIOSH/OSHA DATA; RECOMMEND
PREVENT REPEATED OR PROLONGED SKIN CONTACT
WEAR IMPERVIOUS CLOTHING
WEAR GLOVES
WEAR FACESHIELD (8 INCH MINIMUM)

PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL LAUNDERED OR DISCARDED
IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF CONTAMINANT'S HAZARDOUS PROPERTIES

GOGGLES
PREVENT ANY POSSIBILITY OF EYE CONTACT

WASHING CHEMICALS FROM THE SKIN
AT THE END OF EACH WORK SHIFT WHEN THERE IS REASONABLE PROBABILITY OF CONTACT WITH THE SUBSTANCE

ROUTINE CHANGING OF WORK CLOTHING
AFTER WORK SHIFT

CLOTHING REMOVAL FOLLOWING ACCIDENTAL CONTAMINATION
IMMEDIATELY IF IT IS CONTAMINATED

SPECIFIC EMERGENCY PROVISIONS
EYE-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES' EYES MAY BE EXPOSED TO SUBSTANCE
QUICK DRENCHING FACILITIES WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES MAY BE EXPOSED TO SUBSTANCE
EATING AND SMOKING SHOULD NOT BE PERMITTED IN IMMEDIATE WORK AREA
WATER FOUNTAIN PROHIBITED IN WORK AREA

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITED)

2 MG/M3
- CHEMICAL CARTRIDGE RESPIRATOR
  WITH AN ORGANIC VAPOR CARTRIDGE
  WITH A FUME OR HIGH-EFFICIENCY FILTER
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

10 MG/M3
- CHEMICAL CARTRIDGE RESPIRATOR
  WITH AN ORGANIC VAPOR CANISTER
  WITH A FUME OR HIGH-EFFICIENCY FILTER
  WITH A FULL FACE-PIECE
- GAS MASK
  WITH AN ORGANIC VAPOR CANISTER
  (CHIN-STYLE OR FRONT- OR BACK-MOUNTED CANISTER)
  WITH A FULL FACE-PIECE
  WITH A FUME OR HIGH-EFFICIENCY FILTER
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE, HELMET, OR HOOD
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE

3/17

- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW MODE
- POWERED AIR-PURIFYING RESPIRATOR
  WITH AN ORGANIC VAPOR CARTRIDGE
  WITH A HIGH-EFFICIENCY PARTICULATE FILTER

400 MG/M3
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE, HELMET, OR HOOD
  OPERATED IN PRESSURE DEMAND OR POSITIVE-PRESSURE MODE
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE
  OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW MODE

ESCAPE
- GAS MASK
  WITH AN ORGANIC VAPOR CANISTER
  (CHIN-STYLE OR FRONT- OR BACK-MOUNTED CANISTER)
  WITH A HIGH-EFFICIENCY PARTICULATE FILTER
  INCLUDING PESTICIDE RESPIRATORS
- SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE
  WITH A CANISTER

ROUTE OF ENTRY INTO BODY
INHALATION
INGESTION
SKIN OR EYE CONTACT

SYMPTOMS
EYE IRRITATION
RESPIRATORY IRRITATION
SKIN PIGMENTATION
DERMATITIS
BRONCHITIS
COUGHING
DYSPNEA
PHARYNGITIS
VISUAL DISTURBANCE
ABDOMINAL PAIN
NAUSEA
DIARRHEA
EPITHELIOMA
SENSITIZATION DERMATITIS

FIRST AID PROCEDURES FOR [illegible] EXPOSURE
IF THIS CHEMICAL GETS INTO THE EYES, IMMEDIATELY WASH THE EYES WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE LOWER AND UPPER LIDS. GET MEDICAL ATTENTION IMMEDIATELY. CONTACT LENSES SHOULD NOT BE WORN WHEN WORKING WITH THIS CHEMICAL.

IF THIS CHEMICAL GETS ON THE SKIN, IMMEDIATELY WASH [illegible] SKIN WITH SOAP OR MILD DETERGENT & WATER. IF THIS CHEMICAL SOAKS CLOTHING, IMMEDIATELY REMOVE CLOTHING & WASH SKIN WITH SOAP OR MILD DETERGENT & WATER. GET MEDICAL ATTENTION PROMPTLY.

4/17

IF A PERSON BREATHES IN LARGE AMOUNTS OF THIS CHEMICAL, MOVE THE EXPOSED PERSON TO FRESH AIR AT ONCE. IF BREATHING HAS STOPPED PERFORM ARTIFICIAL RESPIRATION. KEEP THE AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION AS SOON AS POSSIBLE.

ORGANS
  EYES
  SKIN
  RESPIRATORY SYSTEM

STATUS OF REGULATORY ENFORCEMENT
  OSHA STANDARD 29CFR1910.1200 HAZARD COMMUNICATION

REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS HAVING WORKPLACES IN THE MANUFACTURING DIVISION, STANDARD INDUSTRIAL CLASSIFICATION CODES 20 THROUGH 39, TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF HAZARD COMMUNICATION PROGRAMS INCLUDING LABELS, MATERIAL SAFETY DATA SHEETS, TRAINING, AND ACCESS TO WRITTEN RECORDS
48FR53280 11/25/83

FOLLOWING OSHA STANDARDS APPLICABLE TO SUBSTANCES LISTED 29CFR1910, OTHERWISE ADVISE:

OSHA STANDARD 29CFR1910.94   VENTILATION

OSHA STANDARD 29CFR1910.134 RESPIRATORY PROTECTION

OSHA STANDARD 29CFR1910.1000 AIR CONTAMINANTS
TABLE Z-1

OSHA STANDARD 29CFR1910.20   ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL RECORDS

OSHA STANDARD 29CFR1910.1002 COAL TAR PITCH VOLATILES

OSHA STANDARD 29CFR1910.132 PERSONAL PROTECTIVE EQUIPMENT

OSHA STANDARD 29CFR1910.141 SANITATION

OSHA STANDARD 29CFR1910.151 MEDICAL SERVICES AND FIRST AID

OSHA STANDARD 29CFR1910.133 EYE AND FACE PROTECTION

[illegible] RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT

REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT ALLEGED TO HAVE BEEN CAUSED BY A SUBSTANCE OR MIXTURE. EPA MAY INSPECT AND REQUIRE REPORTING OF SUCH RECORDS.

SUBSTANCE LISTED AS TOXIC POLLUTANT UNDER CLEAN WATER ACT (CWA) SECTION 307(A)

SUBSTANCE LISTED TOXIC SUBSTANCES CONTROL ACT INVENTORY

#21 5/17

SUBSTANCE LISTED AS TOXIC POLLUTANT UNDER CLEAN WATER ACT (CWA) SECTION 307(A)

THIS SUBSTANCE TESTED FOR SYSTEMIC/ORGAN TOXICITY
BY THE FOOD AND DRUG ADMINISTRATION (FDA)

THIS SUBSTANCE TESTED FOR PHARMACOKINETICS/METABOLISM
BY THE FOOD AND DRUG ADMINISTRATION (FDA)

THIS SUBSTANCE TESTED FOR BIOCHEMICAL/CELLULAR/TISSUE EFFECTS
BY THE FOOD AND DRUG ADMINISTRATION (FDA)

RISK DOCUMENTATION ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

ANALYTICAL METHODS DEVELOPMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)

MONITORING LEVELS MEASUREMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED ENERGY RESEARCH AND DEVELOPMENT ACT (ERDA)
CONTROL TECHNOLOGY DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT (CWA)

MONITORING LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

REGULATION PROPOSED TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION [illegible](A)

SUBSTANCE LISTED HAZARDOUS
STATE OF CALIFORNIA ADMINISTRATIVE CODE
TITLE 22. SOCIAL SECURITY
DIVISION 4. ENVIRONMENTAL HEALTH
CHAPTER 30. MINIMUM STANDARDS FOR MANAGEMENT OF HAZARDOUS AND EXTREMELY HAZARDOUS WASTES

SUBSTANCES LISTED APPENDIX A - CONSENT DECREE LIST OF INDUSTRIES AND TOXIC POLLUTANTS. SETTLEMENT AGREEMENT BETWEEN U.S. EPA AND NATIONAL RESOURCES DEFENSE COUNCIL, ET AL U.S. DISTRICT COURT DISTRICT OF COLUMBIA, JUNE 7, 1976. SITE 8ERC2120, DEC 1977. MODIFIED MARCH 9, 1979, SITE 12ERC1833, DEC 1979 AND AGAIN ON OCTOBER 26, 1982.
SUBSTANCE SUBJECT TO REQUIREMENTS OF GENERAL INDUSTRY SAFETY ORDER (GISO) 5194 OF TITLE 8 OF CALIFORNIA ADMINISTRATIVE CODE AND DIVISION 5, CHAPTER 2.5 OF CALIFORNIA LABOR CODE

NATIONAL TOXICOLOGY PROGRAM (NTP) IN VITRO TESTING DEMONSTRATED POSITIVE MUTAGENIC RESPONSE IN L5178Y MOUSE LYMPHOMA CELLS EXPOSED TO THIS SUBSTANCE

SUBSTANCE DETERMINED [illegible] MUTAGEN IN SALMONELLA [illegible] T[illegible]
[illegible] THE NATIONAL TOXICOLOGY PROGRAM (NTP

ADDITIONAL [illegible] POLLUTANT DISCHARGE ELIMINATION SYSTEM
PERMIT APPLICAT

```
49FR14153 04/01/83                                              4/77

49CFR172.101  TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION,
PROPER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER RE-
QUIREMENTS
  DESIGNATED IN HAZARDOUS MATERIALS TABLE AS HAZARDOUS MATER-
IAL (UNDER N.O.S CATEGORY) FOR THE PURPOSE OF TRANSPORTATION.
41FR15996 04/15/76
45FR34588 05/22/80 (AMENDMENT)
45FR46420 07/10/80 (AMENDMENT)
45FR62090 09/18/80 (AMENDMENT)
45FR74649 11/10/80 (AMENDMENT)
46FR17739 03/19/81 (AMENDMENT)
46FR19235 03/30/81 (AMENDMENT)

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K022: DISTILLATION BOTTOM
TARS FROM THE PRODUCTION OF PHENOL/ACETONE FROM CUMENE. (T)

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K024: DISTILLATION BOTTOMS
FROM THE PRODUCTION OF PHTHALIC ANHYDRIDE FROM NAPHTHALENE. (T)

15CFR399.2, SUPPLEMENT 1 - COMMODITY INTERPRETATION 24: CHEMICALS
  VALIDATED LICENSE REQUIRED FOR EXPORT TO LIBYA, NORTH KOREA, VIETNAM,
KAMPUCHEA, OR CUBA
45FR85942 12/30/80
46FR23942 04/29/81
47FR143   01/05/82
47FR41512 09/21/82
47FR51860 11/17/82
47FR58124 12/29/82

SUBSTANCE LISTED WEST VIRGINIA DEPARTMENT OF LABOR LISTING OF
HAZARDOUS SUBSTANCES



MEDICAL SURVEILLANCE REQUIRED
  GENERAL MEDICAL HISTORY
  40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES
  CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
    TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES
  MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES
  TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR
  30 YEARS
  48FR38197 09/22/83
  49FR39225 08/30/83 (EFFECTIVE DATE CORRECTION)
  RESPIRATORY HISTORY
  PRE-PLACEMENT AND ANNUAL EXAMS
  PHYSICIAN EXAMINATION
  INDUSTRIAL EXPOSURE HISTORY
  CARDIOVASCULAR DISEASE
  CHRONIC RESPIRATORY DISEASE
  14 BY 17 CHEST P.A. X-RAY
  SKIN EXAM
  SPUTUM CYTOLOGY
  URINE CYTOLOGY
  PULMONARY FUNCTION
  [illegible]
  URINALYSIS
  COMPLETE BLOOD COUNT
  RENAL AND LIVER FUNCTIONS
```

WARNING: PREGNANT WOMEN. SUBSTANCE ASSOCIATED WITH COAL TAR PITCH
VOLATILES
BLOOD CHEMISTRY
ATTENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS

9[4]
7/11

CERTIFICATIONS
HEALTH STATUS CLASSIFICATION
NUCLEAR REG. 0041

OSHA RESPIRATOR CERTIFICATION 29CFR1910.134

DEPARTMENT OF TRANSPORTATION IF OPERATES HEAVY EQUIPMENT

EMPLOYEE HAZARDOUS MATERIALS EDUCATION RECEIPT

EMPLOYEE MEDICAL RECORDS RECEIPT

TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS. CONTACT: JACK P. MCCARTHY, OFFICE OF TOXIC SUBSTANCES, EPA (800)424-1404. 48FR38178 8 22,83

UICC OR ILO X-RAY INTERPRETATION

MEDICAL WARNING REQUIRED FOR MEDICAL EXAM REFUSAL SIGNED BY EMPLOYEE

SPECIAL DIAGNOSTIC TESTS
NONE IN COMMON USE

LEAKS AND SPILL PROCEDURES
A REPORTABLE QUANTITY OF ONE POUND APPLIES TO THIS SUBSTANCE ESTABLISHED BY SECTIONS 101(14) AND 102(B) OR ADJUSTED UNDER SECTION 102(A) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (CERCLA). SECTIONS 103(A) AND 103(B) REQUIRE THAT PERSONS IN CHARGE OF A VESSEL OR FACILITY FROM WHICH A HAZARDOUS SUBSTANCE HAS BEEN RELEASED IN A QUANTITY EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THAT SUBSTANCE IMMEDIATELY NOTIFY THE NATIONAL RESPONSE CENTER (800) 424-8802; IN THE WASHINGTON, D.C. METROPOLITAN AREA (202) 426-2675 50FR13456 04/04/85

* * *

DEPARTMENT OF TRANSPORTATION HAZARD CLASS
49CFR172.101 HAZARDOUS MATERIALS TABLE

HAZARDOUS SUBSTANCE, LIQUID OR SOLID, N.O.S.
ORM-E
UN 9188

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS
49CFR172.101 [illegible] ADDITIONAL HANDLING [illegible]
[illegible]

NONE

8/17

```
INTERGOVERNMENTAL MARITIME ORGANIZATION HAZARD CLASS
  49CFR172.102 OPTIONAL HAZARDOUS MATERIALS TABLE

NONE


**********************************************************************

FOLLOWING INFORMATION FROM BUREAU OF EXPLOSIVES 'EMERGENCY HANDLING OF
  HAZARDOUS MATERIALS':

  HAZARDOUS SUBSTANCE, LIQUID OR SOLID, N.O.S.
ORM-E
IF MATERIAL ON FIRE OR INVOLVED IN FIRE:
 * EXTINGUISH USING SUITABLE MATERIAL TO SURROUND FIRE
IF MATERIAL IS NOT ON FIRE AND IS NOT INVOLVED IN FIRE:
 * KEEP MATERIAL OUT OF WATER SOURCES AND SEWERS
 * BUILD DIKES TO CONTAIN FLOW AS NECESSARY
PERSONAL DANGER SITUATION PROTECTION:
 * KEEP UPWIND
 * WEAR BOOTS, PROTECTIVE GLOVES AND GAS TIGHT GOGGLES
 * AVOID BREATHING VAPORS OR DUST
 * WASH AWAY ANY MATERIAL WHICH MAY HAVE CONTACTED THE
   BODY WITH COPIOUS AMOUNTS OF WATER OR SOAP AND WATER
LAND SPILL
 * DIG PIT, POND TO HOLD MATERIAL
 * COVER SOLIDS WITH A PLASTIC SHEET TO PREVENT DISSOLVING
   IN RAIN OR FIREFIGHTING WATER
WATER SPILL
 * IF DISSOLVED, APPLY ACTIVATED CARBON AT 10 TIMES SPILLED
   AMOUNT AT 10 PPM OR GREATER CONCENTRATION
 * REMOVE TRAPPED MATERIAL WITH SUCTION HOSES
 * USE MECHANICAL DREDGES OR LIFTS TO REMOVE IMMOBILIZED MASSES
   OF POLLUTION AND PRECIPITATES
**********************************************************************

FOLLOWING INFORMATION FROM DEPARTMENT OF TRANSPORTATION/U.S. COAST GUARD
'CHEMICAL RESPONSE INFORMATION SYSTEM', REGARDING WATER SPILLS:

 * CONTAIN SURFACE SLICKS
 * SKIM SURFACE SLICK
 * USE MECHANICAL DREDGES OR LIFTS TO REMOVE IMMOBILIZED MASSES
   OF POLLUTION AND PRECIPITATES
 * HIGHLY VOLATILE, AVOID INHALATION, VAPORS OR DUST ARE IRRITATING OR
   TOXIC
 * SUBSTANCE SINKS IN WATER

WASTE
  THIS MATERIAL LISTED AS HAZARDOUS SUBSTANCE, AS DEFINED IN SECTION
  101(14) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND
  LIABILITY ACT (CERCLA) OF 1980, PURSUANT TO ONE OR MORE OF THE
  FOLLOWING:

   * FEDERAL WATER POLLUTION CONTROL ACT (FWPCA) SECTION 311(B)(2)(A)
   * SOLID WASTE DISPOSAL ACT SECTION 3001
   * CLEAN WATER ACT (CWA) SECTION 307(A)
   * CLEAN AIR ACT (CAA) SECTION 112
   * TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION [illegible]
   * COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY
     ACT (CERCLA) [illegible]
```

```
[illegible]
  CARCINOGEN

BULLETINS
  NATIONAL TOXICOLOGY PROGRAM TESTS REVEAL POSITIVE LYMPHOMAS
  IN MICE. FURTHER TESTING RESULTS EXPECTED SOON.

SPECIAL INFORMATION
TYPE WHAT INFORMATION YOU REQUIRE
 ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), HELP/, OR NONE/.

CHEMICAL NAME
  ANTHRACENE

FORMULA
  C14H10

SYNONYMS
  PARANAPHTHALENE
  GREEN OIL
  TETRA[illegible] OIL
  ANTHRACIN
  TETRA OLIVE N2G
  OHS01550

PERMISSIBLE EXPOSURE LIMIT
  NONE ESTABLISHED (SEE COAL TAR PITCH VOLATILES)
  MUTAGENIC DATA (RTECS)
  ANIMAL CARCINOGEN (RTECS)
  [illegible] HAZARD RATING - TOXICITY 0 - IGNITABILITY 1 - REACTIVITY 1
  PERSISTENCE [illegible]

  TOXICOLOGY: ANTHRACENE IS A SKIN, EYE AND RESPIRATORY IRRITANT.  SKIN
  CONTACT MAY RESULT IN PIGMENTATION AND DERMATITIS.  INGESTION IRRITATES
  THE GASTROINTESTINAL TRACT.  INHALATION IS UNLIKELY AT NORMAL TEMPERA-
  TURES.  AT ELEVATED TEMPERATURES, INHALATION MAY CAUSE COUGHING, SORE
  THROAT, AND DYSPNEA.

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONCENTRATION
  NONE SPECIFIED

PHYSICAL DESCRIPTION
  PALE GREEN SOLID WITH A FAINT AROMATIC ODOR

CHEMICAL AND PHYSICAL PROPERTIES
  MOLECULAR WEIGHT: 178.2
  BOILING POINT AT 1 ATM, F: 644 F
  SOLUBILITY IN WATER, G/100 G WATER AT 20C: INSOLUBLE
  FLASH POINT, CLOSED CUP, F OR OPEN CUP IF OC : [illegible]F
  VAPOR PRESSURE @ [illegible] F, MMHG: 1 MM
  MELTING POINT, F: 417-421 F
  UPPER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: SUBLIMES
  LOWER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: 0.6%
  AUTOIGNITION TEMPERATURE: 1004 F
  SPECIFIC GRAVITY: 1.283 AT 77 F
  VAPOR DENSITY (AIR=1): 6.15
  OCTANOL WATER PARTITION COEFFICIENT: 4.45

INCOMPATIBILITIES
  STRONG OXIDIZERS
  CHROMIC ACID
  CALCIUM HYPOCHLORITE

[illegible] PROTECTIVE EQUIPMENT
```

SEA 9/17

PREVENT REPEATED OR PROLONGED SKIN CONTACT

10/17

WEAR IMPERVIOUS CLOTHING
WEAR GLOVES
WEAR FACESHIELD (8 INCH MINIMUM)

PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL LAUNDERED OR DISCARDED

IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF CONTAMINANT'S HAZARDOUS PROPERTIES

GOGGLES

PREVENT ANY POSSIBILITY OF EYE CONTACT

WASHING CHEMICALS FROM THE SKIN

AT THE END OF EACH WORK SHIFT WHEN THERE IS REASONABLE PROBABILITY OF CONTACT WITH THE SUBSTANCE

ROUTINE CHANGING OF WORK CLOTHING

AFTER WORK SHIFT

CLOTHING REMOVAL FOLLOWING ACCIDENTAL CONTAMINATION

IMMEDIATELY IF IT IS CONTAMINATED

SPECIFIC EMERGENCY PROVISIONS

EYE-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES' EYES MAY BE EXPOSED TO SUBSTANCE

QUICK DRENCHING FACILITIES WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES MAY BE EXPOSED TO SUBSTANCE

EATING AND SMOKING SHOULD NOT BE PERMITTED IN IMMEDIATE WORK AREA

WATER FOUNTAIN PROHIBITED IN WORK AREA

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

2 MG/M3

- CHEMICAL CARTRIDGE RESPIRATOR
  WITH AN ORGANIC VAPOR CARTRIDGE
  WITH A FUME OR HIGH-EFFICIENCY FILTER
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

10 MG/M3

- CHEMICAL CARTRIDGE RESPIRATOR
  WITH AN ORGANIC VAPOR CANISTER
  WITH A FUME OR HIGH-EFFICIENCY FILTER
  WITH A FULL FACE-PIECE
- GAS MASK
  WITH AN ORGANIC VAPOR CANISTER
  (CHIN-STYLE OR FRONT- OR BACK-MOUNTED CANISTER)
  WITH A FULL FACE-PIECE
  WITH A FUME OR HIGH-EFFICIENCY FILTER
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE, HELMENT, OR HOOD
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE

200 MG/M3

- [illegible] RESPIRATOR
- [illegible]
  OPERATED IN [illegible] DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW MODE
- POWERED AIR-PURIFYING RESPIRATOR
  WITH AN ORGANIC VAPOR CARTRIDGE

400 MG/M3
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACEPIECE, HELMENT, OR HOOD
  OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACEPIECE
  OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW MODE

11/17

ESCAPE
- GAS MASK
  WITH AN ORGANIC VAPOR CANISTER
  (CHIN-STYLE OR FRONT- OR BACK-MOUNTED CANISTER)
  WITH A HIGH-EFFICIENCY PARTICULATE FILTER
  INCLUDING PESTICIDE RESPIRATORS
- SELF-CONTAINED BREATHING APPARATUS

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACEPIECE
  WITH A CANISTER

ROUTE OF ENTRY INTO BODY
INHALATION
INGESTION
SKIN OR EYE CONTACT

SYMPTOMS
EYE IRRITATION
RESPIRATORY IRRITATION
SKIN PIGMENTATION
DERMATITIS
BRONCHITIS
COUGHING
DYSPNEA
PHARYNGITIS
VISUAL DISTURBANCE
ABDOMINAL PAIN
NAUSEA
DIARRHEA
EPITHELIOMA
SENSITIZATION DERMATITIS

FIRST AID PROCEDURES FOLLOWING EXPOSURE

IF THIS CHEMICAL GETS INTO THE EYES, IMMEDIATELY WASH THE EYES WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE LOWER AND UPPER LIDS. GET MEDICAL ATTENTION IMMEDIATELY. CONTACT LENSES SHOULD NOT BE WORN WHEN WORKING WITH THIS CHEMICAL.

IF THIS CHEMICAL GETS ON THE SKIN, IMMEDIATELY WASH CONTAMINATED SKIN WITH [illegible] WATER. IF THIS CHEMICAL [illegible] MEDICAL ATTENTION [illegible]

IF A PERSON BREATHES IN LARGE AMOUNTS OF THIS CHEMICAL, MOVE THE EXPOSED PERSON TO FRESH AIR AT ONCE. IF BREATHING HAS STOPPED

12/17

ORGANS
  EYES
  SKIN
  RESPIRATORY SYSTEM

STATUS OF REGULATORY ENFORCEMENT
  OSHA STANDARD 29CFR1910.1200 HAZARD COMMUNICATION
    REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS HAVING WORKPLACES IN THE MANUFACTURING DIVISION, STANDARD INDUSTRIAL CLASSIFICATION CODES 20 THROUGH 39, TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF HAZARD COMMUNICATION PROGRAMS INCLUDING LABELS, MATERIAL SAFETY DATA SHEETS, TRAINING, AND ACCESS TO WRITTEN RECORDS
  48FR53280 11/25/83

  FOLLOWING OSHA STANDARDS APPLICABLE TO SUBSTANCES LISTED 29CFR1910, OTHERWISE ADVISE:

  OSHA STANDARD 29CFR1910.94   VENTILATION

  OSHA STANDARD 29CFR1910.134 RESPIRATORY PROTECTION

  OSHA STANDARD 29CFR1910.1000 AIR CONTAMINANTS
  TABLE Z-1

  OSHA STANDARD 29CFR1910.20   ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL RECORDS

  OSHA STANDARD 29CFR1910.1002 COAL TAR PITCH VOLATILES

  OSHA STANDARD 29CFR1910.132 PERSONAL PROTECTIVE EQUIPMENT

  OSHA STANDARD 29CFR1910.141 SANITATION

  OSHA STANDARD 29CFR1910.151 MEDICAL SERVICES AND FIRST AID

  OSHA STANDARD 29CFR1910.133 EYE AND FACE PROTECTION

  40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
    REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT ALLEGED TO HAVE BEEN CAUSED BY A SUBSTANCE OR MIXTURE. EPA MAY INSPECT AND REQUIRE REPORTING OF SUCH RECORDS.
  48FR38178 08/22/83

  SUBSTANCE LISTED AS TOXIC POLLUTANT UNDER CLEAN WATER ACT (CWA) SECTION 307(A)

  SUBSTANCE LISTED TOXIC SUBSTANCES CONTROL ACT INVENTORY

13/17

THIS SUBSTANCE TESTED FOR TARGET ORGAN TOXICITY BY THE FOOD AND DRUG ADMINISTRATION (FDA)

THIS SUBSTANCE TESTED FOR PHARMACOKINETICS METABOLISM BY THE FOOD AND DRUG ADMINISTRATION (FDA)

THIS SUBSTANCE TESTED FOR BIOCHEMICAL CELLULAR/TISSUE EFFECTS BY THE FOOD AND DRUG ADMINISTRATION (FDA)

RISK DOCUMENTATION/ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

ANALYTICAL METHODS DEVELOPMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)

MONITORING LEVELS MEASUREMENT COMPLETED/PUBLISHED ENERGY RESEARCH AND DEVELOPMENT ACT (ERDA)

CONTROL TECHNOLOGY ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT (CWA)

MONITORING LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

REGULATION PROPOSED TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(A)

SUBSTANCE LISTED HAZARDOUS
STATE OF CALIFORNIA ADMINISTRATIVE CODE
TITLE 22. SOCIAL SECURITY
DIVISION 4. ENVIRONMENTAL HEALTH
CHAPTER 30. MINIMUM STANDARDS FOR MANAGEMENT OF HAZARDOUS AND
EXTREMELY HAZARDOUS WASTES

SUBSTANCES LISTED APPENDIX A - CONSENT DECREE LIST OF INDUSTRIES AND TOXIC POLLUTANTS. SETTLEMENT AGREEMENT BETWEEN U.S. EPA AND NATIONAL RESOURCES DEFENSE COUNCIL, ET AL U.S. DISTRICT COURT DISTRICT OF COLUMBIA. JUNE 7, 1976. SITE 8ERC2120, DDC 1976. MODIFIED MARCH 9, 1979, SITE 12ERC1833, DDC 1979 AND AGAIN ON OCTOBER 26, 1982.

SUBSTANCE SUBJECT TO REQUIREMENTS OF GENERAL INDUSTRY SAFETY ORDER (GISO) 5194 OF TITLE 8 OF CALIFORNIA ADMINSTRATIVE CODE AND DIVISION 5, CHAPTER 2.5 OF CALIFORNIA LABOR CODE

NATIONAL TOXICOLOGY PROGRAM (NTP) IN VITRO TESTING DEMONSTRATED POSITIVE MUTAGENIC RESULTS IN L5178Y MOUSE LYMPHOMA CELLS EXPOSED TO THIS SUBSTANCE

SUBSTANCE DETERMINED POSITIVE MUTAGEN IN SALMONELLA TYPHIMURIUM BY THE NATIONAL TOXICOLOGY PROGRAM (NTP)

40CFR122, APPENDIX D - NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT APPLICATION TESTING REQUIREMENTS
TABLE II [illegible] OF FOUR FRACTIONS IN
[illegible] GAS CHROMATOGRAPHY/MASS SPECTROSCOPY [illegible]
[illegible]

49CFR172.101 TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION, PROPER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER RE-

14/17

IAL (UNDER N.O.S CATEGORY) FOR THE PURPOSE OF TRANSPORTATION.
41FR15996 04/[illegible]
45FR34588 05/22/80 (AMENDMENT)
45FR46420 07/10/80 (AMENDMENT)
45FR62080 09/18/80 (AMENDMENT)
45FR74649 11/10/80 (AMENDMENT)
46FR17739 03/19/81 (AMENDMENT)
46FR19235 03/30/81 (AMENDMENT)

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K022: DISTILLATION BOTTOM
TARS FROM THE PRODUCTION OF PHENOL/ACETONE FROM CUMENE. (T)

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K024: DISTILLATION BOTTOMS
FROM THE PRODUCTION OF PHTHALIC ANHYDRIDE FROM NAPHTHALENE. (T)

15CFR399.2, SUPPLEMENT 1 - COMMODITY INTERPRETATION 24: CHEMICALS
VALIDATED LICENSE REQUIRED FOR EXPORT TO LIBYA, NORTH KOREA, VIETNAM,
KAMPUCHEA, OR CUBA
45FR85942 12/30/80
46FR23942 04/29/81
47FR143 01/05/82
47FR41512 09/21/82
47FR51860 11/18/82
47FR58124 12/29/82

SUBSTANCE LISTED WEST VIRGINIA DEPARTMENT OF LABOR LISTING OF
HAZARDOUS SUBSTANCES

MEDICAL SURVEILLANCE REQUIRED
GENERAL MEDICAL HISTORY
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES
CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES
MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES
TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR
30 YEARS
48FR38187 08/22/83
48FR39225 08/30/83 (EFFECTIVE DATE CORRECTION)
RESPIRATORY HISTORY
PRE-PLACEMENT AND ANNUAL EXAMS
PHYSICIAN EXAMINATION
INDUSTRIAL EXPOSURE HISTORY
CARDIOVASCULAR DISEASE
CHRONIC RESPIRATORY DISEASE
14 BY 17 CHEST P.A. X RAY
SKIN EXAM
SPUTUM CYTOLOGY
URINE CYTOLOGY
PULMONARY FUNCTIONS
VISION TEST
URINALYSIS
COMPLETE BLOOD COUNT
RENAL AND LIVER FUNCTIONS

[illegible]
[illegible] PREGNANT [illegible] ASSOCIATED WITH COAL TAR PITCH
VOLATILES
BLOOD CHEMISTRY

8437
15/17

CERTIFICATIONS
HEALTH STATUS CLASSIFICATION

NUCLEAR REG. 0041

OSHA RESPIRATOR CERTIFICATION 29CFR1910.134

DEPARTMENT OF TRANSPORTATION IF OPERATES HEAVY EQUIPMENT

EMPLOYEE HAZARDOUS MATERIALS EDUCATION RECEIPT

EMPLOYEE MEDICAL RECORDS RECEIPT

TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS. CONTACT: JACK P. MCCARTHY, OFFICE OF TOXIC SUBSTANCES, EPA (800)424-1404. 49FR35179 8/22/83

UICC OR ILO X-RAY INTERPRETATION

MEDICAL WARNING REQUIRED FOR MEDICAL EXAM REFUSAL SIGNED BY EMPLOYEE

SPECIAL DIAGNOSTIC TEST
NONE IN COMMON USE

LEAKS AND SPILL PROCEDURES
A REPORTABLE QUANTITY OF ONE POUND APPLIES TO THIS SUBSTANCE ESTABLISHED BY SECTIONS 101(14) AND 102(B) OR ADJUSTED UNDER SECTION 102(A) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (CERCLA). SECTIONS 103(A) AND 103(B) REQUIRE THAT PERSONS IN CHARGE OF A VESSEL OR FACILITY FROM WHICH A HAZARDOUS SUBSTANCE HAS BEEN RELEASED IN A QUANTITY EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THAT SUBSTANCE IMMEDIATELY NOTIFY THE NATIONAL RESPONSE CENTER (800) 424-8802 OR IN THE WASHINGTON, D.C. METROPOLITAN AREA (202) 426-2675 50FR13456 04 01 85

++

DEPARTMENT OF TRANSPORTATION HAZARD CLASS
49CFR172.101 HAZARDOUS MATERIALS TABLE
HAZARDOUS SUBSTANCE, LIQUID OR SOLID, N.O.S.
ORM-E
UN 9188

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS
49CFR172.101 (SUBJECT TO ADDITIONAL LABELING REQUIREMENTS OF 49CFR172.402)

NONE

++

T[illegible] TRANSPORTATION HAZARD CLASS
49CFR172.102 OPTIONAL HAZARDOUS MATERIALS TABLE

16/17

```
***************************************************************************

FOLLOWING INFORMATION FROM BUREAU OF EXPLOSIVES 'EMERGENCY HANDLING OF
  HAZARDOUS MATERIALS':

  HAZARDOUS SUBSTANCE, LIQUID OR SOLID, N.O.S.
ORM-E
IF MATERIAL ON FIRE OR INVOLVED IN FIRE:
 * EXTINGUISH USING SUITABLE MATERIAL TO SURROUND FIRE
IF MATERIAL IS NOT ON FIRE AND IS NOT INVOLVED IN FIRE:
 * KEEP MATERIAL OUT OF WATER SOURCES AND SEWERS
 * BUILD DIKES TO CONTAIN FLOW AS NECESSARY
PERSONAL DANGER SITUATION PROTECTION:
 * KEEP UPWIND
 * WEAR BOOTS, PROTECTIVE GLOVES AND GAS TIGHT GOGGLES
 * AVOID BREATHING VAPORS OR DUST
 * WASH AWAY ANY MATERIAL WHICH MAY HAVE CONTACTED THE
   BODY WITH COPIOUS AMOUNTS OF WATER OR SOAP AND WATER
LAND SPILL
 * DIG PIT, POND TO HOLD MATERIAL
 * COVER SOLIDS WITH A PLASTIC SHEET TO PREVENT DISSOLVING
   IN RAIN OR FIREFIGHTING WATER
WATER SPILL
 * IF DISSOLVED, APPLY ACTIVATED CARBON AT 10 TIMES SPILLED
   AMOUNT AT 10 PPM OR GREATER CONCENTRATION
 * REMOVE TRAPPED MATERIAL WITH SUCTION HOSES
 * USE MECHANICAL DREDGES OR LIFTS TO REMOVE IMMOBILIZED MASSES
   OF POLLUTION AND PRECIPITATES

***************************************************************************

FOLLOWING INFORMATION FROM DEPARTMENT OF TRANSPORTATION/U.S. COAST GUARD
'CHEMICAL RESPONSE INFORMATION SYSTEM', REGARDING WATER SPILLS:

 * CONTAIN SURFACE SLICKS
 * SKIM SURFACE SLICK
 * USE MECHANICAL DREDGES OR LIFTS TO REMOVE IMMOBILIZED MASSES
   OF POLLUTION AND PRECIPITATES
 * HIGHLY VOLATILE, AVOID INHALATION, VAPORS OR DUST ARE IRRITATING OR
   TOXIC
 * SUBSTANCE SINKS IN WATER

WASTE
  THIS MATERIAL LISTED AS HAZARDOUS SUBSTANCE, AS DEFINED IN SECTION
  101(14) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND
  LIABILITY ACT (CERCLA) OF 1980, PURSUANT TO ONE OR MORE OF THE
  FOLLOWING:

   * FEDERAL WATER POLLUTION CONTROL ACT (FWPCA) SECTION 311(B)(2)(A)
   * SOLID WASTE DISPOSAL ACT SECTION 3001
   * CLEAN WATER ACT (CWA) SECTION 307(A)
   * CLEAN AIR ACT (CAA) SECTION 112
   * TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 7
   * COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY
     ACT (CERCLA) SECTION 102



CAS NUMBER
  [illegible]

REGISTRY TOXIC CHEMICAL NUMBER
```

```
  NATIONAL TOXICOLOGY PROGRAM TESTS SEVERAL POSSIBLE [illegible]
  IN MICE. [illegible] TESTING RESULTS EXPECTED SOON.

SPECIAL INFORMATION
TYPE WHAT INFORMATION YOU REQUIRE
 ALL/, SPECIFIC INFORMATION BY 1-LETTER COMMAND, HELP/, OR NONE/.
NONE
```

11/11

DOT Designation: Nonflammable gas.

Potential Exposures: Argon is used as an inert gas shield in arc welding; it is used to fill electric lamps. It is used as a blanketing agent in metals refining (especially titanium and zirconium).

Permissible Exposure Limits in Air: There is no Federal standard. ACGIH lists argon as a simple asphyxiant with no specified TLV.

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation and possibly skin contact with liquid argon.

Harmful Effects and Symptoms: The gas is a simple asphyxiant as noted above. The liquid can cause frostbite.

Disposal Method Suggested: Vent to atmosphere.

References

(1) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 1,* No. 5, 36-37, New York, Van Nostrand Reinhold Co. (1981).

ARSENIC AND ARSENIC COMPOUNDS

- Carcinogen (IARC) (11)
- Hazardous substances (Some compounds, EPA)
  Arsenic compounds classified by EPA as hazardous substances are: arsenic disulfide, arsenic pentoxide, arsenic trichloride, arsenic trioxide and arsenic trisulfide. Also the EPA has issued rebuttable presumptions against registration (RPAR's) for several arsenic-containing pesticides as follows: arsenic acid, cacodylic acid, calcium arsenate, DSMA, lead arsenate, MSMA and sodium arsenite.
- Hazardous waste constituents (EPA)
- Priority toxic pollutant (EPA)

Description: As, elemental arsenic, occurs to a limited extent in nature as a steel-gray metal that is insoluble in water. Arsenic in this discussion includes the element and any of its inorganic compounds excluding arsine. Arsenic trioxide (As_2O_3), the principal form in which the element is used, is frequently designated as arsenic, white arsenic, or arsenous oxide. Arsenic is present as an impurity in many other metal ores and is generally produced as arsenic trioxide as a by-product in the smelting of these ores, particularly copper. Most other arsenic compounds are produced from the trioxide.

Code Numbers: (Element) CAS 7440-38-2 RTECS CG0525000 UN 1558

Type of Compound/Label Designation: Poison.

Synonyms: None.

Potential Exposure: Arsenic compounds have a variety of uses. Arsenates and arsenites are used in agriculture as insecticides, herbicides, larvicides, and pesticides. Arsenic trichloride is used primarily in the manufacture of pharmaceuticals. Other arsenic compounds are used in pigment production, the manufacture of glass as a bronzing or decolorizing agent, the manufacture of opal glass and enamels, textile printing, tanning, taxidermy, and antifouling paints. They are also used to control sludge formation in lubricating oils. Metallic arsenic is used as an alloying agent to harden lead shot and in lead-base bearing materials. It is also alloyed with copper to improve its toughness and corrosion resistance.

EPA estimates that more than 6 million people living within 12 miles of major sources—copper, zinc, and lead smelters—may be exposed to 10 times the average U.S. atmospheric levels of arsenic. The agency says that 40,000 people living near some copper smelters may be exposed to 100 times the national atmospheric average.

Permissible Exposure Limits in Air: The Federal standard for arsenic and its compounds was previously 0.5 mg/m^3 of air as As. In 1973, NIOSH proposed (1) the lower recommended standard of 0.05 mg As/m^3 of air determined as a time-weighted average (TWA) exposure for up to a 10-hour workday, 40-hour workweek. Then, in November 1975, OSHA proposed a workplace exposure limit for inorganic arsenic at 4 μg/m^3 (8-hour, TWA). The economic impact of such a standard has been assessed (2). The previous standard of 500 μg/m^3 for all forms of arsenic would remain in effect only for organic forms.

A 1975 NIOSH document (3) proposed that inorganic arsenic be controlled so that no worker is exposed to a concentration of arsenic in excess of 0.002 mg/m^3 (2.0 μg) as determined by a 15-minute sampling period. Finally in 1978 a standard was promulgated (4) which limits occupational exposure to inorganic arsenic to 10 μg/m^3 (μg/m^3 of air) based on an 8-hour time-weighted average.

The ACGIH (1983/84) TWA value for arsenic and soluble compounds (as As) is 0.2 mg/m^3. Arsenic trioxide production is categorized as "suspect of carcinogenic potential for man." As a first step toward regulating industrial emissions of inorganic arsenic, EPA has listed the substance as a hazardous air pollutant, as defined under the Clean Air Act and the agency's proposed airborne carcinogen policy.

Determination in Air: Collection on a filter and analysis by atomic absorption spectrometry (A-1). See also (A-10).

Permissible Concentration in Water: To protect freshwater aquatic life—total recoverable trivalent inorganic arsenic never to exceed 440 μg/ℓ. To protect saltwater aquatic life—508 μg/ℓ on an acute basis. To protect human health—preferably zero. A value of 0.02 μg/ℓ corresponds to a human health risk of 1 in 100,000. EPA has established a maximum arsenic level of 0.05 mg/ℓ. This does not address carcinogenicity and is under review.

Allowable arsenic levels in drinking water have also been set as follows (A-65):

South African Bureau of Standards	0.05 mg/ℓ
World Health Organization	0.05 mg/ℓ
Federal Republic of Germany (1975)	0.04 mg/ℓ

Determination in Water: Total arsenic may be determined by digestion followed by silver diethyldithiocarbamate; an alternative is atomic absorption; another is inductively coupled plasma (ICP) optical emission spectrometry.

Routes of Entry: Inhalation and ingestion of dust and fumes.

Harmful Effects and Symptoms: *Local* — Trivalent arsenic compounds are corrosive to the skin. Brief contact has no effect, but prolonged contact results in a local hyperemia and later vesicular or pustular eruption. The moist mucous membranes are most sensitive to the irritant action. Conjunctiva, moist and macerated areas of the skin, eyelids, the angles of the ears, nose, mouth, and respiratory mucosa are also vulnerable to the irritant effects. The wrists are common sites of dermatitis, as are the genitalia if personal hygiene is poor. Perforations of the nasal septum may occur. Arsenic trioxide and pentoxide are capable of producing skin sensitization and contact dermatitis. Arsenic is also capable of producing keratoses, especially of the palms and soles. Arsenic has been cited as a cause of skin cancer, but the incidence is low.

Systemic – The acute toxic effects of arsenic are generally seen following ingestion of inorganic arsenical compounds. This rarely occurs in an industrial setting. Symptoms develop within ½ to 4 hours following ingestion and are usually characterized by constriction of the throat followed by dysphagia, epigastric pain, vomiting, and watery diarrhea. Blood may appear in vomitus and stools. If the amount ingested is sufficiently high, shock may develop due to severe fluid loss, and death may ensue in 24 hours. If the acute effects are survived, exfoliative dermatitis and peripheral neuritis may develop.

Cases of acute arsenical poisoning due to inhalation are exceedingly rare in industry. When it does occur, respiratory tract symptoms–cough, chest pain, dyspnea–giddiness, headache, and extreme general weakness precede gastrointestinal symptoms. The acute toxic symptoms of trivalent arsenical poisoning are due to severe inflammation of the mucous membranes and greatly increased permeability of the blood capillaries.

Chronic arsenical poisoning due to ingestion is rare and generally confined to patients taking prescribed medications. However, it can be a concomitant of inhaled inorganic arsenic from swallowed sputum and improper eating habits. Symptoms are weight loss, nausea and diarrhea alternating with constipation, pigmentation and eruption of the skin, loss of hair, and peripheral neuritis. Chronic hepatitis and cirrhosis have been described. Polyneuritis may be the salient feature, but more frequently there are numbness and paresthesias of "glove and stocking" distribution. The skin lesions are usually melanotic and keratotic and may occasionally take the form of an intradermal cancer of the squamous cell type, but without infiltrative properties. Horizontal white lines (striations) on the fingernails and toenails are commonly seen in chronic arsenical poisoning and are considered to be a diagnostic accompaniment of arsenical polyneuritis.

Inhalation of inorganic arsenic compounds is the most common cause of chronic poisoning in the industrial situation. This condition is divided into three phases based on signs and symptoms.

First Phase: The worker complains of weakness, loss of appetite, some nausea, occasional vomiting, a sense of heaviness in the stomach, and some diarrhea.

Second Phase: The worker complains of conjunctivitis, and a catarrhal state of the mucous membranes of the nose, larynx, and respiratory passages. Coryza, hoarseness, and mild tracheobronchitis may occur. Perforation of the nasal septum is common, and is probably the most typical lesion of the upper respiratory tract in occupational exposure to arsenical dust. Skin lesions, eczematoid and allergic in type, are common.

Third Phase: The worker complains of symptoms of peripheral neuritis, initially of hands and feet, which is essentially sensory. In more severe cases, motor paralyses occur; the first muscles affected are usually the toe extensors and the peronei. In only the most severe cases will paralysis of flexor muscles of the feet or of the extensor muscles of hands occur.

Liver damage from chronic arsenical poisoning is still debated, and as yet the question is unanswered. In cases of chronic and acute arsenical poisoning, toxic effects to the myocardium have been reported based on EKG changes. These

findings, however, are now largely discounted and the EKG changes are ascribed to electrolyte disturbances concomitant with arsenicalism. Inhalation of arsenic trioxide and other inorganic arsenical dusts does not give rise to radiological evidence of pneumoconiosis. *Arsenic does have a depressant effect upon the* bone marrow, with disturbances of both erythropoiesis and myelopoiesis. Evidence is now available incriminating arsenic compounds as a cause of lung cancer as well as skin cancer.

Skin cancer in humans is causally associated with exposure to inorganic arsenic compounds in drugs, drinking water and the occupational environment. The risk of lung cancer was increased 4 to 12 times in certain smelter workers who inhaled high levels of arsenic trioxide. However, the influence of other constituents of the working environment cannot be excluded in these studies. Case reports have suggested an association between exposure to arsenic compounds and blood dyscrasias and liver tumours (14).

Points of Attack: Skin, eyes, respiratory system.

Medical Surveillance: In preemployment physical examinations, particular attention should be given to allergic and chronic skin lesions, eye disease, *psoriasis, chronic eczematous dermatitis, hyperpigmentation of skin, keratosis* and warts, baseline weight, baseline blood and hemoglobin count, and baseline urinary arsenic determinations. In annual examinations, the worker's general health, weight, and skin condition should be checked, and the worker observed for any evidence of excessive exposure or absorption of arsenic. Chest x-rays and lung function should be evaluated; analysis of urine, hair, or nails for arsenic should be made every 60 days as long as exposure continues. See also reference (10).

First Aid: Irrigate eyes with water. Wash contaminated areas of body with soap and water.

Personal Protective Methods: Workers should be trained in personal hygiene and sanitation, the use of personal protective equipment, and early recognition of symptoms of absorption, skin contact irritation, and sensitivity. With the exception of arsine and arsenic trichloride, the compounds of arsenic do not *have odor or warning qualities. In case of emergency or areas of high dust* or spray mist, workers should wear respirators that are supplied-air or self-contained positive-pressure type with fullface mask. Where concentrations are less than 100 x standard, workers may be able to use halfmask respirators with replaceable dust or fume filters. Protective clothing, gloves, goggles and a hood for head and neck should be provided. When liquids are processed, impervious clothing should be supplied. Clean work clothes should be supplied daily and the workers should shower prior to changing to street clothes.

Respirator Selection: See reference (1).

Disposal Method Suggested (A-31): Arsenic—elemental arsenic wastes should be placed in long-term storage or returned to suppliers or manufacturers for reprocessing. Arsenic pentaselenide—wastes should be placed in long-term storage or returned to suppliers or manufacturers for reprocessing. Arsenic trichloride—hydrolyze to arsenic trioxide utilizing scrubbers for hydrogen chloride abatement. The trioxide may then be placed in long-term storage. Arsenic trioxide—long-term storage in large siftproof and weatherproof silos. This compound may also be dissolved, precipitated as the sulfide and returned to the suppliers (A-38).

References

(1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Arsenic,* NIOSH Doc. No. 74-110, Washington, DC (1973).

(2) U.S. Department of Labor, *Inflationary Impact Statement: Inorganic Arsenic,* Washington, DC, Occupational Safety and Health Administration (undated, presumed 1975).

(3) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Inorganic Arsenic (Revised),* NIOSH Doc No. 75-149, Washington, DC (1975).

(4) *Federal Register,* 43, No. 88, 19584-19631 (May 5, 1978).

(5) U.S. Environmental Protection Agency, *Arsenic: Ambient Water Quality Criteria,* Washington, DC (1979).

(6) U.S. Environmental Protection Agency, *Status Assessment of Toxic Chemicals: Arsenic,* Report No. EPA-600/2-79-210B, Washington, DC (December 1979).

(7) U.S. Environmental Protection Agency, *Toxicology of Metals, Vol II: Arsenic,* Report EPA-600/1-77-022, Research Triangle Park, NC, pp 30-70 (May 1977).

(8) National Academy of Sciences, *Medical and Biological Effects of Environmental Pollutants: Arsenic,* Washington, DC (1977).

(9) U.S. Environmental Protection Agency, *Arsenic,* Health and Environmental Effects Profile No. 11, Office of Solid Waste, Washington, DC (April 30, 1980).

(10) National Inst. for Occup. Safety and Health, *A Guide to the Work Relatedness of Disease,* Revised Edition, DHEW (NIOSH) Publication No. 79-116, Cincinnati, OH, pp 40-53, (January 1979).

(11) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans,* Lyon, France, 2, 48 (1973).

(12) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 1,* No. 3, 32-34, New York, Van Nostrand Reinhold Co. (1981).

(13) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 2,* No. 3, 56-63, New York, Van Nostrand Reinhold Co. (1982). (Arsenic Acid, Arsenic Pentoxide, Arsenic Tribromide).

(14) See Reference (A-62). Also Reference (A-64).

(15) See Reference (A-60) for Arsenic Trichloride and Arsenic Trioxide.

(16) Lederer, W.H. and Fensterheim, R.J., *Arsenic: Industrial, Biomedical and Environmental Perspectives,* New York, Van Nostrand Reinhold Co. (1983).

(17) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 3,* No. 5, 44-50, New York, Van Nostrand Reinhold Co. (1983). (Arsenic Sulfide).

(18) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 3,* No. 5, 50-58, New York, Van Nostrand Reinhold Co. (1983). (Arsenic Trioxide).

(19) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety* Third Edition, Vol. 1, pp 179-182, Geneva, International Labour Office (1983).

(20) United Nations Environment Programme, *IRPTC Legal File 1983,* Vol. I, pp VII/50-55, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

ARSINE

Description: AsH_3, arsine, is a colorless gas with a slight garliclike odor which cannot be considered a suitable warning property in concentrations below 1 ppm.

Code Numbers: CAS 7784-42-1 RTECS CG6475000 UN 2188

DOT Designation: Poison gas and flammable gas.

Synonyms: Hydrogen arsenide, arseniuretted hydrogen, arsenic trihydride.

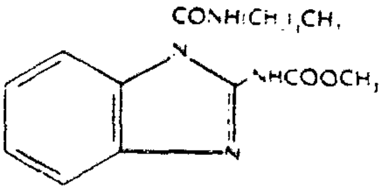
BENOMYL

Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate; Benlate

$C_{14}H_{18}N_4O_4$

TLV, 10 mg/m³

STEL, 15 mg/m³



Benomyl is a white crystalline solid, which has a molecular weight of 290.32. It decomposes without melting and has a negligible vapor pressure, indicating exposure would be in particulate form. Very slightly soluble in water, it is soluble in xylene, acetone, dimethylformamide and chloroform.[1] *Fluorometric and colorimetric*[2] *and liquid chromatographic*[3] *procedures for determining residues of benomyl have been published.*

Benomyl is the common name for this fungicide and ascaricide.

The acute oral LD_{50} for the rate is ≥10 000 mg/kg. The acute skin absorption LD_{50} for the rabbit is ≥10 000 mg/kg. Application to the shaved intact skin of ten male guinea pigs, at each level as aqueous suspensions containing 5, 12.5 and 25% benomyl as the active ingredient in a 50% wettable powder, resulted in negligible irritation. One of ten guinea pigs had mild erythema two days after application at the high rate. All guinea pigs at the two lower rates and in a control showed no irritation after two days.[4] Instillation into the eyes of rabbits of 10 mg of dry 50% powder or 0.1 mL of 10% suspension in mineral oil caused only temporary mild conjunctival irritation.[4] The acute inhalation LC_{50} is ≥2000 mg/m³ (≥ 2 mg/L) for rat[4] and is equivalent to ≥825 mg/m³ (≥ 0.825 mg/L) for dog[4] for four-hour exposures. Histologically, there was reduction of spermatogenic activity in some animals. With regard to this activity, no-effect levels for benomyl for four-hour exposures are equivalent to ≥100 ≤410 mg/m³ (≥ 0.1 ≤0.41 mg/L) for the rat and ≥325 ≤825 mg/m³ (≥ 0.325 ≤0.825 mg/L) for the dog. Additionally fifteen four-hour inhalation exposures at the equivalent of 100 mg/m³ (0.1 mg/L) of benomyl over a period of three weeks produced no clinical or histopathologic indication of accumulative effects in the rat.[4]

A low order of toxicity has been found in chronic studies. In two-year feeding studies no-effect levels in the diet are 2500 ppm (0.25%) for rats (highest level fed) and 500 ppm (0.05%) for dogs. Pesticide residue tolerances have been established in many food crops. They are as high as 15 ppm for stone fruits and food additive tolerances are as high as 50 ppm for raisins.[1] In a three-generation rat reproduction study no compound-related reproduction or lactation differences were observed among control and test groups even at 2500 ppm (0.25%), the highest dietary level fed. In a teratogenic study in rat neither the outcome of pregnancy nor embryonal development was affected even at 5000 ppm (0.50%), the highest dietary level fed. In a dominant lethal mutagenic study in the rat, benomyl was not mutagenic at 2500 ppm (0.25%), the highest dietary level fed.[5]

Gardiner et al[6] showed that rat and dog eliminated ≥99% of single, oral doses of 2-¹⁴C benomyl via the urine and feces within 72 hours. The major metabolite was methyl 5-hydroxy-2-benzimidazole-carbamate which was present in the urine as glucuronide and/or sulfate conjugates. Residue data on dog and rat tissues from two-year chronic feeding studies demonstrated that benomyl and its metabolites do not accumulate in animal tissues.

In view of the low order of acute and chronic toxicity the TLV of 10 mg/m³ and the STEL of 15 mg/m³ appear appropriate.

References:

1. **E.I. du Pont de Nemours & Co., Inc.:** Technical data sheet (June 1974).
2. **Pease, H.L., Holt, R.F.:** *J Assoc Offic Anal Chem* 54(6):1399-1402 (1971).
3. **Kirkland, J.J., Holt, R.F., Pease, H.L.:** *J Agr Food Chem* 21(3):368-371 (1973).
4. **E.I. du Pont de Nemours & Co., Inc.:** Unpublished data.
5. **Sherman, H., Culik, R., Jackson, R.A.:** *Tox Appl Pharm* 32:305-315 (1975).
6. **Gardiner, J.A., Kirkland, J.J., Klopping H.L.:** *J Agr Food Chem* 22(3):419-427 (1974).

BENZENE

C_6H_6

TLV, 10 ppm (≈ 30 mg/m³), Appendix A2 — Suspected Carcinogen

STEL, 25 ppm (≈ 75 mg/m³), Appendix A2

Benzene is a colorless, non-polar liquid, with an odor characteristic of aromatic hydrocarbons. It has a molecular weight of 78.11, a boiling point of 80.1° C, a melting point of 5.5° C, a vapor pressure of 75 mm Hg at 20° C and a specific gravity of 0.87865 at the same temperature. Benzene has a flash point of −11.1° C (closed cup, 12° F), making it a dangerous fire hazard. It was formerly derived almost exclusively by distillation of coal tar, but now comes primarily from petroleum, either by extraction or by dealkylation of toluene. Benzene is slightly soluble in water but soluble in all proportions in alcohol, acetone and ether.

At one time benzene was an important solvent, especially for rubber, as a diluent in lacquers and in paint removers. At present such uses are minimal; most benzene is consumed in the chemical industry, as a raw material for numerous organic chemicals. It is found in gasoline from trace amounts to as much as [illegible]% concentration in some countries.

As an acute poison benzene produces narcotic effects comparable to those of toluene. It is a more potent narcotic than the alkanes or naphthenes of similar boiling points. But the effect of chronic exposure to this compound is by far the most serious disease caused by any of the common hydrocarbon solvents. Its action on the bone marrow may result in detectable alterations and in some instances aplastic anemia. The reported LD_{50} orally in young adult rats is 3.8 ml/kg.

It is unique among hydrocarbons as a myelotoxicant. More than 140 fatal cases of benzene poisoning had been recorded prior to 1959. Vigliani and Saita listed 36 deaths from chronic benzene poisoning in two provinces in Italy between 1960 and 1963. Eleven of these were diagnosed as leukemia, which may develop several years after cessation of exposure to benzene.

Most deaths from benzene have resulted from exposures of the order of 200 ppm or more. In a few instances concentrations of 1000 or even 2000 ppm have been recorded in workplaces where deaths occurred. Some of these are: Legge, 210 to 1050 ppm; Greenburg, 70 to 1800 ppm with over half above 200; Bowditch, 100 to 200+ measured; one leukemia case described by Hunter[4] and Mallory, six years after exposure at over 200 ppm; Greenburg, 25 to 1000 ppm in four rooms; Heimer, 140 to 200 ppm after improvements; Savilahti, 318, 433 and 470 ppm; Kozlova, 47 to 310 ppm; Vigliani, 190 to 600 ppm after four years death from leukemia; Tuzwiak, 31 to 156 ppm; Aksoy, 150 to 650 ppm and 210 to 650 ppm, 26 patients with acute leukemia or preleukemia; Ikeda, 100 to 800 ppm, 7 deaths, all females, none from leukemia.

Winslow[18], however, reported blood changes in workers where concentrations of benzene vapor below 100 ppm were found. Heimann and Ford[9] found one death and three cases with blood changes where air analysis for benzene showed a concentration of 105 ppm. Wilson[20] reported three fatal cases in a plant where the average concentration of benzene vapor was [illegible] ppm. In a fifth room associated with benzene poisoning, Greenburg found 11 to 57 ppm. So far as can be determined the lowest measured concentration of benzene vapor associated with a fatal case of benzene intoxication (due to aplastic anemia) was the 60 ppm reported by Hardy and Elkins in 1948, in a plant where repeated air analyses were made, and a number of other workers showed some blood abnormalities.

Blaney[22] found little evidence of benzene intoxication in a group of 90 workers regularly exposed to benzene for about 13 years. Concentrations were generally low, but urinary phenol measurements indicated some exposures of the order of 25 ppm. A followup several years later showed no evidence of persisting blood dyscrasias. No cases of leukemia are known to have occurred in this group of workers. Pagnotto *et al.* found workers in rubber spreading operations involving naphtha with a relatively high benzene content exposed to benzene in concentrations which were for the most part between 6 and 25 ppm. A number of blood studies showed a few abnormalities but only two were serious to warrant special consideration. In one case the possibility of leukemia was raised but on being removed from his job and given iron therapy the worker recovered. Because of several job changes his benzene exposure could not be reliably estimated.

The other worker was in a group studied intensively over a period of several years by Pagnotto. He had a red count below four million, a hemoglobin below twelve grams and suffered from nose bleeds. His benzene exposure, as estimated from several urinary phenol determinations, was to about 40 ppm. After his exposure to benzene was terminated, his blood picture gradually returned to normal. The 38 workers in this plant were followed up for 15 years after the use of naphtha containing benzene was discontinued. None showed any signs of permanent blood abnormalities. There were three deaths, none being from leukemia. It was concluded that 25 ppm of benzene vapor is safe for most workers, but that since the margin of safety is small, a TLV of 10 ppm was recommended. Elkins, in a summary of the findings in the rubber spreading industry, came to a similar conclusion.

These conclusions were consistent with those of Fuchs[27] in 1969, who found variations in the blood pictures of three workers but did not consider that the changes were proved to result from their benzene exposures of 19, 28 and 43 ppm respectively. He also stated that he could find no data in the literature on proved benzene poisoning in concentrations below 16 ppm, nor could he find any Soviet report which cited reasons for decreasing the Russian MAC to 5 ppm.

Two investigators have studied the effects on rats of exposures at relatively low levels of benzene vapor extended periods. Deichmann *et al.*[28] found that after 5 to 8 weeks of 5 hour/day, 5 days/week exposure at 44 and 47 ppm, rats developed a moderate degree of leukopenia but that none resulted from 15 to 31 ppm. Nau *et al.*[29] found a decrease in the white blood cell counts of rats following 756 hours of exposure at 50 ppm of benzene on a schedule of 8 hours/day, 5 days/week. Reduced amounts of DNA in the white cells, a depression in myelocytic activity, and an increase in the relative numbers of red cell precursors in the bone marrow were also observed.

There have been numerous reviews of the literature of benzene intoxication. Noteworthy are those of the National Academy of Sciences in 1976 and the NIOSH criteria document on benzene published in 1974. As a result of this extremely thorough review, NIOSH recommended a workplace time weighted average standard of 10 ppm, with a ceiling of 25 ppm.

In 1976, however, NIOSH issued a revised recommendation for an occupational exposure standard for benzene. The key to this recommendation is the statement in the introduction that "*Because it is not at present possible to establish a safe exposure level for a carcinogen, the NIOSH recommendation is to restrict exposure to very low levels which can still be reliably measured in the workplace.*" A number of references are given, primarily to support the characterization of benzene as a carcinogen (leukemogen). Thus most relate to leukemia cases associated with heavy benzene exposures, either measured or inferred from association with numerous cases of aplastic anemia or other blood dyscrasias. Others are epidemiologic studies on cancer in which no evidence of the degree, or even fact, of benzene exposure is cited. Thus in at least two of these papers,[33,34] the word "benzene" does not appear. In these and other papers the incidence of various types of cancer, including leukemia was found to be higher than in the general population among certain groups of rubber workers. Monson and Nakano[35] found 55 cases of leukemia vs 43 expected, among rubber workers. It was noted that benzene has been used extensively in the rubber industry but is no longer employed although it is a contaminant of extensively used naphtha solvents. The degree of exposure to benzene in the rubber industry during the first half of the 1940-1950 decade may well have been excessive. Wilson[34] has noted deaths and blood abnormalities among workers in the rubber industry during the war years who were exposed, on the average, to concentrations of benzene vapor of 100 ppm. Neither Monson-Nakano or other authors of similar papers quoted in the NIOSH update mention whether or not aplastic anemia or other blood dyscrasias, apart from leukemia, occurred in the groups of workers that were studied.

Nevertheless OSHA, in 1977, issued an Emergency Temporary Standard (ETS)[36] establishing a TWA limit of 1 ppm for benzene vapor. (Enforcement of this standard was voided by the courts.) Much of the evidence substantiating this action was the same as that quoted in the NIOSH update. However, one additional paper was cited by Infante *et al*[37] in which nine leukemia deaths were reported from two rubber film casting plants where benzene vapor concentrations allegedly ranged from 0 to 15 ppm. This report was critically examined in OSHA hearings on a permanent standard, with essentially the same provisions as the ETS, which were held during the summer of 1977. The data on benzene exposure in the two plants in question, especially during the first part of the ten year employment period (1940 to 1950) covered by the study, were found to be incomplete, unreliable and contradictory. Even in 1976 a NIOSH report of one of the plants involved, or its successor, showed concentrations in excess of 15 ppm at several locations.[38] A study by Harris *et al*[39] in 1973 and 1974 revealed similar findings, although the overall average of all sample results was slightly above 1 ppm. During the period 1940 to 1945 or so, when many of the involved workers were employed, the permissible concentration for benzene exposure (ASA standard) was 100 ppm. In common with the papers cited by the NIOSH update, no information on other blood abnormalities was given in the Infante report.

Epidemiologic studies of workers exposed to measured low concentrations of benzene vapor have yielded negative or inconclusive results. Thorpe[40] after studying the occurrence of leukemia in a population of 38,000 workers in a variety of European petroleum and petrochemical operations, some of whom were exposed at levels of benzene that occasionally reached 20 ppm, over a period of ten years, found that deaths from leukemia "were not abnormal" for the countries involved (18 vs. 23.23 expected).

Retrospective studies of employees of a large chemical company, exposed for many years to benzene, mostly at low levels, revealed no excess mortality.[41,42] A cohort of 594 workmen were divided into four exposure groups: very low exposures, less than 2 ppm as time weighted average (TWA); low exposures, 2-9 ppm; moderate exposures, 9-24 ppm; and high exposures, above 25 ppm. In many areas there was exposure to other chemicals as well as to benzene. The duration of exposure was also divided into four groups, with 186 workers having in excess of 20 years.

Of 102 deaths, two were due to anemia, two to leukemia, and one had leukemia as a complication. Of these five cases, only one, an autopsy-confirmed pernicious anemia, involved a previous exposure to benzene of significance, 5520 ppm months. The other anemia death, diagnosed as being of the aplastic type, was of a worker with 453 ppm months of benzene exposure. Two of the leukemia cases involved exposures of 545 and 305 ppm months, respectively, while the third was of a worker with only 18 ppm months benzene exposure.

To put these exposure data in perspective, three of the deceased workers had had exposures to benzene equivalent to 40 years' employment in concentrations slightly above or below 1 ppm; the exposure of the fourth, if spread over 30 years, would have been at a concentration of 0.05 ppm.

The predicted deaths from anemia and leukemia were 0.2 and 1 respectively. The fact that, apart from the pernicious anemia death, there appeared to have been no dose response relationship, apparently led to the conclusion of the authors that *"no mortality findings directly attributable to benzene exposure were observed."*

The NIOSH update mentions the consistent observations of chromosomal aberrations associated with benzene exposure, but further comments that the implications of these findings with respect to benzene leukemia are still not clear. The possibility of a chromosomal instability acting as a stimulus for a latent leukemogenic virus has been speculated upon.[43] This question was discussed at some length at the International Workshop on the Toxicology of Benzene, held in Paris in November 1976. Tough[44] had previously reported that marked aberrations were found only in plants where concentrations of benzene vapor were believed to be between 25 and 250 ppm, and that no significant changes were observed at 12 ppm. Forni,[45] however, stated that there had been a few positive, as well as negative, reports at levels between 5 and 25 ppm. The consensus of opinion was that the significance of the finding of increased chromosome aberrations for the occurrence of benzene leukemia was still not clear. Maugeri and Pollini[46] reported that among Italian shoe workers *"almost all the cases of haemopathy due to benzol which lead to death show features of terminal leukemia . . . and (the leukemias) were always preceded by aplastic conditions."*

Opinions of the workshop participants relative to the appropriate TLV for benzene were varied. The final recommendation was to retain 10 ppm as a permissible TWA which must not be exceeded, but it was also specified that benzene should not be employed when substitute materials were available.

DeGowin's report[47] of a case of leukemia following an apparent benzene-induced aplastic anemia contains a discussion which implies that there is evidence that aplastic anemia *per se* may lead to leukemia, and that delayed cases of this disease are not confined to aplastic anemia due to benzene.

It is the opinion of the Committee that the characterization of benzene as a leukemogen, by NIOSH, is in essense valid, although benzene may be what Truhaut has described as a "secondary carcinogen."[48] An A2 notation should be applied to benzene in the TLV listings.

On the other hand, the Committee does not agree with the NIOSH recommendation of 1 ppm as an occupational exposure standard insofar as the TLV can be defined as such a standard. There is little evidence that exposure to benzene at concentrations below 25 ppm causes blood dyscrasias of any kind. Setting the TLV at 10 ppm, as a time-weighted average, provides an added margin of safety.

If the standard is to be set at the lowest practicable detectable limit, it is the opinion of some members of the Committee that a value lower than 1 ppm should be selected. In the absence of interfering substances benzene vapor can be measured with reasonable accuracy in concentrations at least as low as 0.1 ppm; in the presence of certain interferences, it may be difficult to achieve the prescribed accuracy and reliability even at concentrations somewhat above 1 ppm.

Because the effects the TLV is designed to prevent are chronic in nature, a ceiling designation is not appropriate and a STEL of 25 ppm is recommended.

Other recommendations: ANSI (1969) 10 ppm. Czechoslovakia (1969) 16 ppm. USSR (1972) 1.6 ppm. DDR (1973) 16 ppm. Sweden (1975) 10 ppm. BRD (1974) 0 ppm (treats as carcinogen).

References:

1. Merck Index, 9th ed., p. 138, Merck & Co., Inc., Rahway, NJ (1976)
2. **Gerarde, H.W.:** *Toxicology & Biochemistry of Aromatic Hydrocarbons*. Elsevier Publishing Co., NY (1960)
3. **Elkins, H.B.:** *Chemistry of Industrial Toxicology*, p. 103, Wiley & Sons, NY (1959)
4. **Vigliani, E.C. Saita, G.:** *New Eng. J. Med.* 271 872 (1964)
5. **Legge, T.M.:** *J. Ind. Hyg.* 1 539 (1920)
6. **Greenburg, L.:** *U.S. Public Health Reports* 41 1357 (1926)
7. **Bowditch, M., Elkins, H.:** *J. Ind. Hyg. & Tox.* 21 321 (1939)
8. **Hunter, F.T.:** *Ibid.*, p. 331
9. **Mallory, T.B.** *et al.* *Ibid.*, p. 355
10. **Greenburg, L.** *et al.* *Ibid.*, p. 395
11. **Helmer, K.J.:** *Acta Med. Scand.* 118 354 (1944)
12. **Savilahti, M.:** *Arch. Gewerbepath. u. Gewerbehyg.* 15 147 (1956)
13. **Koslova, T.A., Volkova, A.P.:** *Gig. San.* 25 29 (1960). Cited by NIOSH in ref. 31
14. **Juzwiak, I.:** *Med. Przemyslowa* 20 67 (1969). Ibid.
15. **Aksoy, M.** *et al.* *Brit. J. Ind. Med.* 29 56 (1972)
16. **Aksoy, M.** *et al.* *Blood* 44 837 (1974)
17. **Ikeda, M.:** Poisoning Due to Benzene and its Substitutes in Japan. *International Workshop on the Toxicology of Benzene*, Paris (1976)
18. **Winslow, C.E.A.:** *J. Ind. Hyg.* 9 69 (1927)
19. **Heimann, H., Ford, C.B.:** *NY Ind. Hyg. Bull.*, p. 224 (November 1940)
20. **Wilson, R.H.:** *J. Lab. Clin. Med.* 27 1517 (1942)
21. **Hardy, H.L., Elkins, H.B.:** *J. Ind. Hyg. & Tox.* 30 196 (1948)
22. **Blaney, L.:** *Ind. Med. & Surg.* 19 227 (1950)
23. **Walkley, J.E.** *et al.* *Am. Ind. Hyg. Assoc. J.* 22 362 (1961)
24. **Pagnotto, L.D.** *et al.* *Ibid.*, p. 417
25. **Pagnotto, L.D.** *et al.* Benzene Exposure in the Rubber Coating Industry, a Followup. Presented at the *American Industrial Hygiene Conference*, New Orleans (May 1977)
26. **Elkins, H.B.:** Significance of Benzene Exposure Among Workers in Rubber Spreading Operations. Presented at the *International Workshop on the Toxicology of Benzene*, Paris (1976)
27. **Fuchs, A.:** in *Documentation of the MAC in Czechoslovakia*, Prague (1969)
28. **Deichmann, W.B.** *et al.* *Tox. Appl. Pharm.* 5 201 (1963)
29. **Nau, C.A.** *et al.* *Arch. Env. Health* 12 382 (1966)
30. **National Academy of Sciences:** *Health Effects of Benzene*, a review (1976)
31. **NIOSH:** *Criteria for a Recommended Standard for Occupational Exposure to Benzene* (1974)
32. **NIOSH:** *Revised Recommendation for an Occupational Exposure Standard for Benzene* (August 1976)
33. **McMichael, A.J.** *et al.* *J. Occup. Med.* 16 458 (1974)
34. **Andjelkovic, D.** *et al.* *Ibid.* 18 387 (1976)
35. **Monson, R.R., Nakano, K.K.:** *Am. J. Epidem.* 103 284 (1976)
36. **OSHA:** Emergency Temporary Standard for Occupational Exposure to Benzene. *Federal Register* 42 22516 (May 3, 1977)
37. **Infante, P.F.** *et al.* *Leukemia Among Workers Exposed to Benzene*. A manuscript (1977)
38. **Young, R.** *et al.* *Walk Through Survey of Goodyear Tire & Rubber Co.*, St. Mary's, OH. A manuscript (1977)
39. **Harris, R.L. Jr.:** Testimony before OSHA hearings on the proposed standards for occupational exposure to benzene, Washington, DC (August 1977)
40. **Thorpe, J.J.:** *J. Occup. Med.* 16 375 (1974)
41. **Ott, M.G.** *et al.* *Mortality Among Individuals Occupationally Exposed to Benzene*. A manuscript (1975)
42. **Fishbeck, W.A.:** Testimony before OSHA hearings on the proposed standards for occupational exposure to benzene, Washington, DC (August 1977)
43. **Todaro, G.J., Huebner, R.J.:** *Proc. Nat. Acad. Sci.* 69 1009 (1972). Cited by NIOSH in ref. 31
44. **Tough, I.M.** *et al.* *Eur. J. Cancer* 6 49 (1970)
45. **Forni, A.:** Report in the *Proceedings of International Workshop on the Toxicology of Benzene*, Paris (1976)
46. **Maugeri, S., Pollini, G.:** Benzene Haemopaty. Cellular Damage and Chromosome Changes, Personal Researches. *Ibid.*
47. **DeGowin, R.L.:** *J.A.M.A.* 185 748 (1963)
48. **Truhaut, R.:** *Proceedings of the XI International Cancer Congress*, Florence, Italy (1974)

Potential Exposure: Workers in organic synthesis of pharmaceuticals, dyestuffs, rubber chemicals. Used as a solvent and chemical intermediate.

Permissible Exposure Limits in Air: No standards set.

Permissible Concentration in Water: No criteria set. Biological effects reviewed (A-36).

Routes of Entry: Inhalation, ingestion, skin absorption.

Harmful Effects and Symptoms: Toxic when ingested or inhaled.

Personal Protective Methods: Wear long rubber gloves, overalls and apron (A-38).

Respirator Selection: Use self-contained breathing apparatus.

Disposal Method Suggested: (1) Mix with calcium hypochlorite and flush to sewer with water or (2) incinerate.

References

(1) Sax., N.I., Ed., *Dangerous Properties of Industrial Materials Report. 1,* No. 3, 40-42, New York, Van Nostrand Reinhold Co. (1981).

(2) See Reference (A-60).

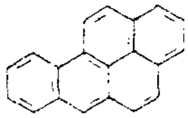
(3) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 3,* No. 4, 40-42, New York, Van Nostrand Reinhold Co. (1983).

BENZO[a]PYRENE

See "Polynuclear Aromatic Hydrocarbons" also.

- Carcinogen (EPA-CAG) (IARC) (1)
- Hazardous Waste Constituent (EPA)

Description: $C_{20}H_{12}$ with the structure



forms yellowish crystals melting at 179°C.

Code Numbers: CAS 50-32-8

DOT Designation: –

Synonyms: 3,4-Benzpyrene.

Potential Exposure: Benzo(a)pyrene [B(a)P] is a polycyclic aromatic hydrocarbon (PAH) that has no commercial-scale production.

B(a)P is produced in the United States by one chemical company and distributed by several specialty chemical companies in quantities from 100 mg to 5 g for research purposes.

Although not manufactured in great quantity, B(a)P is a by-product of combustion. It is estimated that 1.8 million pounds per year are released from stationary sources, with 96% coming from: (1) coal refuse piles, outcrops, and abandoned coal mines; (2) residential external combustion of bituminous coal; (3) coke manufacture; and (4) residential external combustion of anthracite coal.

Human exposure to B(a)P can occur from its presence as a by-product of chemical production. The number of persons exposed is not known. Persons working at airports in tarring operations, refuse incinerator operations, power plants, and coke manufacturers may be exposed to higher B(a)P levels than the general population. Scientists involved in cancer research or in sampling toxic materials may also be occupationally exposed. The general population may be exposed to B(a)P from air pollution, cigarette smoke, and food sources. B(a)P has been detected in cigarette smoke at levels ranging from 0.2 to 12.2 μg per 100 cigarettes. B(a)P has been detected at low levels in foods ranging from 0.1 to 50 ppb.

Permissible Exposure Limits in Air: 0.2 mg/m^3 8-hr TWA (coal tar pitch volatiles) (OSHA). ACGIH (1983/84) designates Benzo(a)pyrene as an industrial substance suspect of carcinogenic potential for man with no TWA value set.

Permissible Concentration in Water: Water quality criteria document for PAH published in final 11/2/80. Total PAH addressed. A concentration of PAH 2.8 ng/ℓ is estimated to limit a cancer risk to one in a million (EPA).

Harmful Effects and Symptoms: B(a)P has produced tumours in all of the nine species for which data are reported following different administrations including oral skin and intratracheal routes. It has both a local and a systemic carcinogenic effect. In sub-human primates, there is convincing evidence of the ability of B(a)P to produce local sarcomas following repeated subcutaneous injections and lung carcinomas following intratracheal instillation. It is also an initiator of skin carcinogenesis in mice, and it is carcinogenic in single-dose experiments and following prenatal exposure.

In skin carcinogenesis studies in mice, B(a)P was consistently found to produce more tumours in a shorter period of time than did other polycyclic aromatic hydrocarbons, with the possible exception of DB(a,h)A. In a dose-response study involving subcutaneous injection in mice, the minimal dose at which carcinogenicity was detected was higher for B(a)P than for DB(a,h)A and for MC. However, the latent periods were shorter for B(a)P than for DB(a,h)A. In studies using intratracheal administration, B(a)P appeared to be less effective than 7H-dibenzo(c,g)carbazole in the hamster (1).

No epidemiological studies on the significance of B(a)P exposure to man are available, and studies are insufficient to prove that B(a)P is carcinogenic for man. However, coal-tar and other materials which are known to be carcinogenic to man may contain B(a)P The substance has also been detected in other environmental situations.

References

(1) IARC Monographs on the *Evaluation of Carcinogenic Risk of Chemicals to Man*, vol. 3 IARC, Lyon, France, pp 91-136 (1973).

(2) See Reference (A-62). Also see reference (A-64).

(3) United Nations Environment Programme, *International Register of Potentially Toxic Chemicals*, Geneva, Switzerland (1979).

(4) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. I, pp VII/121-22, Geneva, Switzerland. International Register of Potentially Toxic Chemicals (1984).

...of 2 isomers, brown crystals, nearly insol in ...in most organic solvents. mp(α): 106°, mp(β): ...1.745 @ 20°/20°.

...S:

...1,2,3,4,7,7-
...OROBICYCLO(2.2.1)-
...-5,6-BIXOXY-
...SULFITE
...HEXACHLORO-
...2.1)HEPTEN-
...METHYLENESUL-
...OHEXAHYDRO-
2,4,3-BENZODIOXATHIEPIN-3-OXIDE
6,7,8,9,10,10-HEXACHLORO-1,5,5a,6,9,9a-HEXAHYDRO-6,9-METHANO-2,4,3-BENZODIOXATHIEPIN-3-OXIDE
1,4,5,6,7,7-HEXACHLORO-5-NORBORNENE-2,3-DIMETHANOL CYCLIC SULFITE
NCI-C00566

...ITY DATA: 3	CODEN:
...DLo:45 mg/kg/(6-14D ...ER:...	RPTOAN 42,150,78
...DLo:330 mg/kg/78W-	NTIS** PB223-159
...DLo:2 mg/kg:ETA	NTIS** PB223-159
...D50:18 mg/kg	ARSIM* 20,9,66
...D50:74 mg/kg	WRPCA2 9,119,70
...D50:22 mg/kg	BECTA6 15,708,76
...LD50:40 mg/kg	30ZDA9 -,267,71
...LD50:75 mg/kg	CTPZAB 8(4),30,64
...LD50:7 mg/kg	BECTA6 15,708,76
...D50:2 mg/kg	85DPAN -,-,71/76
...D50:167 mg/kg	BECTA6 14,513,75
...LD50:118 mg/kg	JETOAS 7,159,74
...D50:34 mg/kg	TXAPA9 22,556,72
...D50:35 mg/kg	TXAPA9 21,315,72

...Toxicity Rating: TLm96: under 1 ppm ...CHM* 3,-,74. *TLV*: Air: 0.1 mg/m3 (skin) ...VS* 4,165,80. *Toxicology Review:* DTTIAF ...(20),485,73; RREVAH 56,107,75; 27ZTAP 3,142,69. ...Carcinogenesis Bioassay Completed; Results Neg- ...(NCITR* NCI-CG-TR-62 77).

...An exper TER, NEO, ETA. VERY, VERY HIGH ...VERY HIGH via dermal routes. A CNS stimulant ...ing convulsions. A highly toxic organochlorine ...ide which does not accumulate significantly in ...tissue. Absorption is normally slow but is in- ...ed by alcohols, oil, emulsifiers.

...*Hazard:* Dangerous, see chlorides and S com-...

...ZO(j)FLUORANTHENE

...RN: 205823 NIOSH #: DF 6300000
...$C_{20}H_{12}$; mw: 252.32

...FLUORANTHENE
...FLUORANTHENE
DIBENZO(A,J,K)FLUORENE

...ITY DATA: 3	CODEN:
...TDLo:312 mg/kg/26W-...A	CANCAR 12,1194,59

...genic Determination: Animal positive IARC** ...92,73.

...cology *Review:* 85DHAX Pc,4,72. "NIOSH Manual ...Analytical Methods" VOL 1 183.

...: An exper ETA. An exper CARC.

Disaster Hazard: When heated to decomp it emits acrid smoke and irr fumes.

BENZO(k)FLUORANTHENE

CAS RN: 207089 NIOSH #: DF 6350000
mf: $C_{20}H_{12}$; mw: 252.32

SYN: 11,12-BENZO(K)FLUORANTHENE

TOXICITY DATA: 3	CODEN:
skn-mus TDLo:2820 mg/kg/47W-I:ETA	CANCAR 12,1194,59
scu-mus TDLo:72 mg/kg/9W-I:ETA	AICCA6 19,490,63

"NIOSH Manual of Analytical Methods" VOL 1 183,184.
THR: An exper ETA.
Disaster Hazard: When heated to decomp it emits acrid smoke and irr fumes.

BENZO(b)FLUORENE

CAS RN: 30777196 NIOSH #: DF 6383000
mf: $C_{17}H_{12}$; mw: 216.29

TOXICITY DATA:	CODEN:
mma-sat 25 umol/L/2H	CNREA8 39,4152,79

THR: MUT data.
Disaster Hazard: When heated to decomp it emits acrid smoke and irr fumes.

BENZOFURAN

CAS RN: 271896 NIOSH #: DF 6423800
mf: C_8H_6O; mw: 118.14

SYNS:
BENZO(B)FURAN
2,3-BENZOFURAN
BENZOFURFURAN
NCI-C56166
1-OXINDENE

Currently Tested by NTP for Carcinogenesis by Standard Bioassay Protocol as of December 1980. Reported in EPA TSCA Inventory, 1980.
THR: No data.
Disaster Hazard: When heated to decomp it emits acrid and irr smoke and fumes.

2-BENZOFURANCARBOXYLIC ACID

CAS RN: 496413 NIOSH #: DF 6490000
mf: $C_9H_6O_3$; mw: 162.15

SYN: COUMARILIC ACID

TOXICITY DATA: 3	CODEN:
ivn-mus LD50:320 mg/kg	CSLNX* NX#02495

Reported in EPA TSCA Inventory, 1980.
THR: HIGH ivn.
Disaster Hazard: When heated to decomp it emits acrid smoke and irr fumes.

2-BENZO-FURANCETONITRILE

CAS RN: 6149699 NIOSH #: DF 6550000

MICAL NAME
BERYLLIUM

Beryllium ,0

MULA
BE

NYMS
ERYLLIUM DUST
GLUCINIUM
GLUCINUM
ERYLLIUM-9
UN 1567
502910

MISSIBLE EXPOSURE LIMIT
UG/M3 OSHA/8 HR TWA - 5 UG/M3 OSHA CEILING
UG/M3 OSHA 30 MINUTE PEAK
UG/M3 ACGIH TWA
5 UG/M3 NIOSH RECOMMENDED 130 MINUTE CEILING
IMAL CARCINOGEN (IARC)
SUSPECT HUMAN CARCINOGEN (IARC, NTP, ACGIH)
MUTAGENIC DATA (RTECS)
ERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 2 - REACTIVITY 0 -
PERSISTENCE 3

OXICOLOGY: BERYLLIUM AND ITS COMPOUNDS ARE SEVERE PULMONARY IRRITANTS, PRIMARY SKIN IRRITANTS, AND SKIN SENSITIZERS. THE PRINCIPAL SYMPTOM OF ACUTE EXPOSURE IS DYSPNEA.

CHRONIC INHALATION CAUSES 'BERYLLIOSIS', OR CHRONIC PULMONARY GRANULOMATOSIS. THE DISEASE BEGINS WITH DYSPNEA AND COUGH AND PROGRESSES TO ANOREXIA, FATIGUE, AND WEAKNESS.

SKIN CONTACT WILL RESULT IN DERMATITIS LEADING TO MODERATE AND SEVERE URNS. EYE CONTACT PRODUCES CONJUNCTIVITIS.

SOLUBLE COMPOUNDS ARE BOTH ACUTELY AND CHRONICALLY TOXIC: INSOLUBLE COMPOUNDS ARE ONLY CHRONICALLY HAZARDOUS.

THERE IS LIMITED EVIDENCE FOR CARCINOGENICITY IN HUMANS AND SUFFICIENT EVIDENCE IN EXPERIMENTAL ANIMALS. EPIDEMIOLOGICAL STUDIES PROVIDE EVIDENCE THAT OCCUPATIONAL EXPOSURE TO BERYLLIUM MAY LEAD TO PULMONARY CANCER. BERYLLIUM METAL PRODUCED LUNG TUMORS IN RATS EXPOSED VIA INHALATION OR INTRATRACHEALLY, AND OSTEOSARCOMAS IN RABBITS FOLLOWING INTRAVENOUS AND/OR INTRAMEDULLARY ADMINISTRATION.

THE OSHA STANDARD WAS ADOPTED TO PREVENT TOXIC EFFECTS OTHER THAN CANCER.

HL-HMN TCLO:300 MG/M3
IVN-RAT LD50:496 UG/KG

EDIATELY DANGEROUS TO LIFE OR HEALTH CONCENTRATION
NONE SPECIFIED

SICAL DESCRIPTION
HARD, BRITTLE, GRAY WHITE METAL

MICAL AND PHYSICAL PROPERTIES
MOLECULAR WEIGHT: 9.012
BOILING POINT AT 1 ATM, F: 5378 F AT 5 MM HG
SOLUBILITY IN WATER, G/100 G WATER AT 20C: INSOLUBLE
FLASH POINT, CLOSED CUP, F (OR OPEN CUP IF OC): FLAMMABLE
VAPOR PRESSURE @ 20 C, MMHG: 1 MM AT 2768F
MELTING POINT, F: 2332 F
UPPER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: NA
LOWER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: NA
SPECIFIC GRAVITY: 1.85

[illegible] TETRA[illegible]
[illegible]
[illegible]
RONG ALKALIES
HLORINATED HYDROCARBONS
STRONG OXIDIZERS
TAL IN POWDERED FORM IS EXPLOSIVE
SPHOROUS

2/

ONAL PROTECTIVE EQUIPMENT
NIOSH/OSHA DATA: RECOMMEND
REVENT REPEATED OR PROLONGED SKIN CONTACT
WEAR IMPERVIOUS CLOTHING
WEAR GLOVES
WEAR FACESHIELD (8 INCH MINIMUM)

ACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL
LAUNDERED OR DISCARDED
E CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF
CONTAMINANT S HAZARDOUS PROPERTIES

GGLES
PREVENT REASONABLE PROBABILITY OF EYE CONTACT

HING CHEMICALS FROM THE SKIN
IMMEDIATELY WHEN SKIN BECOMES CONTAMINATED
TINE CHANGING OF WORK CLOTHING
F THERE IS ANY POSSIBILITY THAT CLOTHING MAY BE CONTAMINATED

THING REMOVAL FOLLOWING ACCIDENTAL CONTAMINATION
HOWER AFTER EACH SHIFT PRIOR TO LEAVING PREMISES

FIC EMERGENCY PROVISIONS
-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES' EYES MAY
BE EXPOSED TO SUBSTANCE
UICK DRENCHING FACILITIES WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES
MAY BE EXPOSED TO SUBSTANCE

SPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

G M3
- HIGH-EFFICIENCY PARTICULATE RESPIRATOR

G/M3
- HIGH-EFFICIENCY PARTICULATE RESPIRATOR
WITH A FULL FACE-PIECE

0 G/M3
- POWERED AIR-PURIFYING RESPIRATOR
- HIGH-EFFICIENCY PARTICULATE RESPIRATOR
- TYPE C SUPPLIED AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
WITH A FULL FACE PIECE, HELMET, OR HOOD
OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
MODE
- SELF-CONTAINED BREATHING APPARATUS

IREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
WITH A FULL FACE-PIECE
OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

[illegible]
INHALATION
SKIN OR EYE CONTACT

[illegible]
EYE IRRITATION
CONJUNCTIVITIS
EYE EDEMA
SKIN IRRITATION
DERMATITIS
SENSITIZATION DERMATITIS
SKIN ULCERATION
ECZEMA
ITCH
ERYTHEMA
VESICULATION
SKIN BURNS
MUCOUS MEMBRANE IRRITATION
RESPIRATORY IRRITATION
RESPIRATORY EDEMA
PHARYNGITIS
LARYNGITIS
TRACHEOBRONCHITIS
PNEUMONIA
[illegible]
BRONCHOSPASM
RESPIRATORY GRANULOMATOSIS
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
SUBSTERNAL PAIN
[illegible]
DIARRHEA
WEIGHT LOSS
[illegible]
[illegible]
[illegible]
FINGER CLUBBING
ANOREXIA
RESPIRATORY: [illegible]
[illegible]

FIRST AID PROCEDURES FOLLOWING EXPOSURE
IF THIS CHEMICAL GETS INTO THE EYES, IMMEDIATELY WASH THE EYES WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE LOWER AND UPPER LIDS. GET MEDICAL ATTENTION IMMEDIATELY. CONTACT LENSES SHOULD NOT BE WORN WHEN WORKING WITH THIS CHEMICAL.

IF THIS CHEMICAL GETS ON SKIN, IMMEDIATELY FLUSH CONTAMINATED SKIN WITH WATER. IF THIS CHEMICAL PENETRATES CLOTHING, IMMEDIATELY REMOVE THE CLOTHING AND FLUSH THE SKIN WITH WATER. GET MEDICAL ATTENTION PROMPTLY.

IF A PERSON BREATHES IN LARGE AMOUNTS OF THIS CHEMICAL, MOVE THE EXPOSED PERSON TO FRESH AIR AT ONCE. IF BREATHING HAS STOPPED PERFORM ARTIFICIAL RESPIRATION. KEEP THE AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION AS SOON AS POSSIBLE.

BERYLLIUM EXPOSURE:

ACHEAL TUBE IS [illegible] [illegible] [illegible]
[illegible] VENTILATORY ASSISTANCE MAY BE NECESSARY.
NTIDOTE - CALCIUM ACETATE HAS BEEN SUGGESTED.
URTHER TREATMENT - RELIEVE BRONCHIAL SPASM. GIVE EPINEPH-
INE, 0.2 MG (0.2 ML OF 1:1000 SOLUTION) SUBCUTANEOUSLY,
OR AMINOPHYLLINE, 0.25 GRAMS INTRAVENOUSLY EVERY SIX HOURS.
REAT BRONCHIAL PNEUMONIA WITH ORGANISM-SPECIFIC CHEMOTHER-
GIVE DIGITALIZE FOR RIGHT HEART FAILURE. GIVE PREDNI-
ONE OR EQUIVALENT CORTICOSTEROID, 25-50 MG/DAY ORALLY, TO
ECREASE HYPERSENSITIVITY REACTION.
MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL.
REISBACH, HANDBOOK OF POISONING, 11TH ED.)

HEN THIS CHEMICAL HAS BEEN SWALLOWED, DO NOT INDUCE VOMITING.
EMOVE BY GASTRIC LAVAGE AND CATHARSIS.

GANS
ESPIRATORY SYSTEM
YES
KIN
LIVER
PLEEN
UNGS
CENTRAL NERVOUS SYSTEM

IUS OF REGULATORY ENFORCEMENT
OSHA STANDARD 29CFR1910.1200 HAZARD COMMUNICATION
REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS
F CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS HAVING
WORKPLACES IN THE MANUFACTURING DIVISION, STANDARD INDUSTRIAL CLASS-
IFICATION CODES 20 THROUGH 39, TO PROVIDE INFORMATION TO THEIR EMPLOYEES
CONCERNING HAZARDOUS CHEMICALS BY MEANS OF HAZARD COMMUNICATION PROGRAMS
INCLUDING LABELS, MATERIAL SAFETY DATA SHEETS, TRAINING, AND ACCESS TO
WRITTEN RECORDS.
BFR53280 11/25/83

FOLLOWING OSHA STANDARD APPLICABLE TO SUBSTANCES LISTED 29CFR1910.
[illegible]

OSHA STANDARD 29CFR1910.1000 AIR CONTAMINANTS
TABLE Z-1

SHA STANDARD 29CFR1910.94 VENTILATION

SHA STANDARD 29CFR1910.134 RESPIRATORY PROTECTION

OSHA STANDARD 29CFR1910.20 ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL
RECORDS

OSHA STANDARD 29CFR1910.132 PERSONAL PROTECTIVE EQUIPMENT

OSHA STANDARD 29CFR1910.141 SANITATION

OSHA STANDARD 29CFR1910.151 MEDICAL SERVICES AND FIRST AID

OSHA STANDARD 29CFR1910.133 EYE AND FACE PROTECTION

40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES
CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES
AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO HEALTH
OR THE ENVIRONMENT ALLEGED TO HAVE BEEN CAUSED BY A SUBSTANCE OR

51

```
SUBSTANCE LISTED TOXIC SUBSTANCES CONTROL ACT INVENTORY

 UBSTANCE ESTABLISHED AS CONFIRMED OR SUSPECTED CARCINOGEN (POTENTIAL
CARCINOGEN) BY THE INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC)

 UBSTANCE LISTED AS  KNOWN TO BE CARCINOGENIC' OR 'MAY REASONABLY BE AN-
  IPATED TO BE CARCINOGENIC  IN NATIONAL TOXICOLOGY PROGRAM (NTP) THIRD
A. JAL REPORT ON CARCINOGENS

 0CFR261.33(E)  DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-
SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF
  COMMERCIAL CHEMICAL PRODUCT OR MANUFACTURING CHEMICAL INTER-
 EDIATE IDENTIFIED AS ACUTE HAZARDOUS WASTE
45FR33084 05/19/80

 UBSTANCE LISTED AS TOXIC POLLUTANT UNDER CLEAN WATER ACT (CWA) SECTION
 07(A)

49CFR172.101  TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION,
 ROPER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER RE-
QUIREMENTS
  DESIGNATED IN HAZARDOUS MATERIALS TABLE AS HAZARDOUS MATER-
 AL (UNDER N.O.S CATEGORY) FOR THE PURPOSE OF TRANSPORTATION.
 1FR15996 04/15/76
45FR34588 05/22/80 (AMENDMENT)
 5FR46420 07/10/80 (AMENDMENT)
 5FR[illegible] 09/19/80 (AMENDMENT)
45FR74640 11/10/80 (AMENDMENT)
46FR17739 03/13/81 (AMENDMENT)
 6FR.9235 03/30/81 (AMENDMENT)

49CFR172.102  TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION,
 . PER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER RE-
 UIREMENTS
  DESIGNATED IN OPTIONAL HAZARDOUS MATERIALS TABLE WITH ALTER-
 ATIVES TO CORRESPONDING REQUIREMENTS IN 49CFR172.101 FOR IN-
 ERNATIONAL SHIPMENTS AS AUTHORIZED BY 49CFR171.12
41FR15996 04/15/76
46FR[illegible] [illegible] 81 (AMENDMENT)
 6FR[illegible] [illegible] 81 (AMENDMENT)

40CFR61  NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLU-
 ANTS
 UBPART C - NATIONAL EMISSION STANDARD FOR BERYLLIUM
  APPLICABLE TO EXTRACTION PLANTS, CERAMIC PLANTS, FOUNDRIES,
INCINERATORS, AND PROPELLANT PLANTS WHICH PROCESS BERYLLIUM ORE,
 ERYLLIUM, BERYLLIUM OXIDE, BERYLLIUM ALLOYS, OR BERYLLIUM-CON-
TAINING WASTE, AND MACHINE SHOPS WHICH PROCESS BERYLLIUM, BERYL-
LIUM OXIDES, OR ANY ALLOY WHEN SUCH ALLOY CONTAINS MORE THAN 5
 ERCENT BERYLLIUM BY WEIGHT.
.8FR8826  04/06/73
43FR8800  03/03/79 (AMENDMENT)

 UBPART D - NATIONAL EMISSION STANDARD FOR BERYLLIUM ROCKET
MOTOR FIRING
  APPLICABLE TO ROCKET MOTOR TEST SITES
 8FR8826  04/06/73
4  78800  03/03/79 (AMENDMENT)

 ECHNICAL ASSISTANCE DATA COMPLETED/PUBLISHED CLEAN WATER ACT
 CWA) SECTION 311

REGULATION IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)
```

```
RITERIA DOCUMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT (CWA)
SECTION 304(A)

ANALYTICAL METHODS DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN
AIR ACT (CAA)

   CE/EXPOSURE ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT
(CAA)

 ONTROL TECHNOLOGY DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN
WATER ACT (CWA)

 EST METHOD DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT
(CWA)

 NALYTICAL METHODS DEVELOPMENT IN DEVELOPMENT/PROGRESS RESOURCE
 ONSERVATION AND RECOVERY ACT (RCRA)

 ONTROL TECHNOLOGY DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN
 IR ACT (CAA)

MONITORING LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS CLEAN AIR
 CT (CAA)

REGULATION PROMULGATED RESOURCE CONSERVATION AND RECOVERY ACT
 RCRA) 40CFR260

SOURCE/EXPOSURE ASSESSMENT COMPLETED/PUBLISHED CLEAN AIR
ACT (CAA)

TOXIC SUBSTANCE CONTROL ACT (TSCA) SECTION 8(E) INITIAL
EVALUATION OF SUBSTANTIAL RISK SUBMITTED TO EPA, 19[illegible]

 UBSTANCE LISTED HAZARDOUS
STATE OF CALIFORNIA ADMINISTRATIVE CODE
 ITLE 22. SOCIAL SECURITY
 IVISION 4. ENVIRONMENTAL HEALTH
CHAPTER 30. MINIMUM STANDARDS FOR MANAGEMENT OF HAZARDOUS AND
EXTREMELY HAZARDOUS WASTES

SUBSTANCE SUBJECT TO REQUIREMENTS OF GENERAL INDUSTRY SAFETY ORDER
(GISO) 5194 OF TITLE 8 OF CALIFORNIA ADMINISTRATIVE CODE AND DIVISION 5,
 HAPTER 2.5 OF CALIFORNIA LABOR CODE

SUBSTANCES LISTED APPENDIX A - CONSENT DECREE LIST OF
INDUSTRIES AND TOXIC POLLUTANTS.  SETTLEMENT AGREEMENT BETWEEN
 .S. EPA AND NATIONAL RESOURCES DEFENSE COUNCIL, ET AL
U.S. DISTRICT COURT DISTRICT OF COLUMBIA, JUNE 7, 1976.
SITE 8ERC2120, DDC 1976.  MODIFIED MARCH 9, 1979, SITE
 2ERC1833, DDC 1979 AND AGAIN ON OCTOBER 26, 1982.

40CFR122.21  TESTING REQUIREMENTS FOR NATIONAL POLLUTANT
 ISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT APPLICATIONS
 PPENDIX D - TABLE III - OTHER TOXIC POLLUTANTS:
(TOTAL) METAL, (TOTAL) CYANIDE, AND (TOTAL) PHENOLS
48FR14153 04/01/83

C   N WATER ACT (CWA) SECTION 304(A)
WATER QUALITY CRITERIA FOR BERYLLIUM:
     11 UG/L FOR THE PROTECTION OF AQUATIC LIFE IN SOFT
             FRESH WATER
   1100 UG/L FOR THE PROTECTION OF AQUATIC LIFE IN HARD
             FRESH WATER
```

TEXTURED SOLID

UBSTANCE LISTED COMMONWEALTH OF VIRGINIA STATE BOARD OF HEALTH
ZARDOUS WASTE MANAGEMENT REGULATIONS UNDER AUTHORITY OF THE CODE OF
RGINIA, AS AMENDED, CHAPTER 6, TITLE 32.1, ARTICLE 3, SOLID WASTE
ANAGEMENT

S SUBSTANCE TESTED FOR BIOCHEMICAL/CELLULAR/TISSUE EFFECTS
THE NATIONAL HEART, LUNG, AND BLOOD INSTITUTE (NHLBI)

HIS SUBSTANCE TESTED FOR PULMONARY TOXICITY
THE NATIONAL HEART, LUNG, AND BLOOD INSTITUTE (NHLBI)

HIS SUBSTANCE TESTED FOR IMMUNOLOGIC TOXICITY
THE NATIONAL HEART, LUNG, AND BLOOD INSITITUTE (NHLBI)

ICAL SURVEILLANCE REQUIRED
ENERAL MEDICAL HISTORY
OCFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES
USE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES
ANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES
O KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR
0 YEARS
8FR38187 08/22/83
48FR39225 08/30/83 (EFFECTIVE DATE CORRECTION)
ESPIRATORY HISTORY
RE-PLACEMENT AND ANNUAL EXAMS
WEIGHT
ERIODIC EXAM FOLLOWING EXPOSURE
LOOD CHEMISTRY
PLETE BLOOD COUNT
4 BY 17 CHEST P.A. X-RAY
ISION TEST
RINALYSIS
ELECTROCARDIOGRAM
ULMONARY FUNCTIONS
TENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS

PHYSICIAN EXAMINATION
INDUSTRIAL EXPOSURE HISTORY

RTIFICATIONS
HEALTH STATUS CLASSIFICATION

SHA RESPIRATOR CERTIFICATION 29CFR1910.13

EPARTMENT OF TRANSPORTATION IF OPERATES HEAVY EQUIPMENT

EMPLOYEE HAZARDOUS MATERIALS EDUCATION RECEIPT

MPLOYEE MEDICAL RECORDS RECEIPT

TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE
EQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL
TANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT
ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
CONTACT: JACK P. MCCARTHY, OFFICE OF TOXIC SUBSTANCES,
EPA (800)424-1404. 48FR38178 8/22/83

MEDICAL WARNING REQUIRED FOR MEDICAL EXAM REFUSAL SIGNED

```
CIAL DIAGNOSTIC TESTS
PUTUM GRAM STAIN AND CULTURE
 PULMONARY EDEMA OCCURS, ANALYSIS OF ARTERIAL BLOOD GAS
 HOLOGICAL BLOOD SLIDE

KS AND SPILL PROCEDURES
 REPORTABLE QUANTITY OF ONE POUND APPLIES TO THIS SUBSTANCE ESTABLISHED
Y SECTIONS 101(14) AND 102(B) OR ADJUSTED UNDER SECTION 102(A) OF THE
OMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT
F 1980 (CERCLA). SECTIONS 103(A) AND 103(B) REQUIRE THAT PERSONS IN
HARGE OF A VESSEL OR FACILITY FROM WHICH A HAZARDOUS SUBSTANCE HAS BEEN
ELEASED IN A QUANTITY EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY
OR THAT SUBSTANCE IMMEDIATELY NOTIFY THE NATIONAL RESPONSE CENTER
300) 424-8802; IN THE WASHINGTON, D.C. METROPOLITAN AREA (202) 426-2675
50FR13456 04/04/85


***********************************************************************

EPARTMENT OF TRANSPORTATION HAZARD CLASS
 49CFR172.101 HAZARDOUS MATERIALS TABLE

LAMMABLE SOLID, N.O.S.
LAMMABLE SOLID
UN 1325

EPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS
 49CFR172.101 (SUBJECT TO ADDITIONAL LABELING REQUIREMENTS OF
  49CFR172.402)

LAMMABLE SOLID

***********************************************************************

INTERGOVERNMENTAL MARITIME ORGANIZATION HAZARD CLASS
 49CFR172.102 OPTIONAL HAZARDOUS MATERIALS TABLE

METAL POWDER
CLASS 6.1-POISONOUS (TOXIC) SUBSTANCE

NTERGOVERNMENTAL MARITIME ORGANIZATION LABELING SPECIFICATIONS FOR
 DOMESTIC AND EXPORT SHIPMENTS
 49CFR172.102

POISON
FLAMMABLE SOLID

***********************************************************************

OLLOWING INFORMATION FROM BUREAU OF EXPLOSIVES 'EMERGENCY HANDLING OF
 HAZARDOUS MATERIALS'.


IF MATERIAL ON FIRE OR INVOLVED IN FIRE:
  EXTINGUISH FIRE USING AGENT SUITABLE FOR TYPE OF SURROUNDING FIRE
  (MATERIAL ITSELF DOES NOT BURN OR BURNS WITH DIFFICULTY)
 * USE WATER IN FLOODING QUANTITIES AS FOG
 * USE ALCOHOL FOAM OR CO2 OR DRY CHEMICAL EXTINGUISHERS

IF MATERIAL IS NOT ON FIRE AND IS NOT INVOLVED IN FIRE:
```

RSONNEL PROTECTION:

AVOID BREATHING DUST VAPORS FUMES FROM MATERIAL
* KEEP UPWIND
* AVOID BODILY CONTACT WITH MATERIAL
* WEAR FULL PROTECTIVE CLOTHING (FIREMANS GEAR INADEQUATE)
* DO NOT HANDLE BROKEN PACKAGES WITHOUT PROTECTIVE EQUIPMENT
* WASH AWAY ANY MATERIALS WHICH MAY HAVE CONTACTED THE BODY WITH COPIOUS AMOUNTS OF WATER OR SOAP AND WATER
* WEAR SELF-CONTAINED BREATHING APPARATUS WHEN FIGHTING FIRES INVOLVING THIS MATERIAL

NO REPORTING OF RELEASES OF MASSIVE FORMS OF THIS METAL EQUIRED UNDER CERCLA SUPERFUND NOTIFICATION 40CFR302 IF DIAMETER OF PIECES RELEASED IS EQUAL TO OR EXCEEDS 100 MICROMETERS (0.004 INCHES)

****

OLLWING INFORMATION FROM DEPARTMENT OF TRANSPORTATION/U.S. COAST GUARD CHEMICAL RESPONSE INFORMATION SYSTEM'. REGARDING WATER SPILLS:

* RESTRICT ACCESS OF GENERAL PUBLIC WHEN APPRECIABLE DANGER ARISES FROM SPILL
* RESTRICT IGNITION SOURCES WHEN SUBSTANCE INVOLVED
* USE MECHANICAL DREDGES OR LIFTS TO REMOVE IMMOBILIZED MASSES OF POLLUTION AND PRECIPITATES
* HIGHLY VOLATILE. AVOID INHALATION. VAPORS OR DUST ARE IRRITATING OR TOXIC
* HIGHLY CORROSIVE. AVOID DIRECT CONTACT. CONTACT WITH SKIN OR EYES CAN CAUSE IRRITATION OR BURNS
* SUBSTANCE HAS UNUSUAL FIRE OR TOXICITY HAZARDS
* SUBSTANCE SINKS IN WATER

THIS MATERIAL LISTED AS HAZARDOUS SUBSTANCE, AS DEFINED IN SECTION 01(14) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSTATION, AND LIABILITY ACT (CERCLA) OF 1980, PURSUANT TO ONE OR MORE OF THE FOLLOWING:

* FEDERAL WATER POLLUTION CONTROL ACT (FWPCA) SECTION 311(B)(2)(A)
* SOLID WASTE DISPOSAL ACT SECTION 3001
* CLEAN WATER ACT (CWA) SECTION 307(A)
* CLEAN AIR ACT (CAA) SECTION 112
* TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 7
* COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA) SECTION 102

PA HAZARDOUS WASTE NUMBER P015
ERYLLIUM DUST

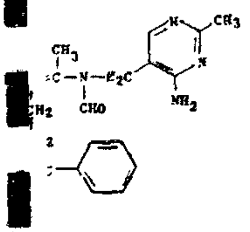
0CFR260 HAZARDOUS WASTE MANAGEMENT SYSTEM: GENERAL

PROVIDES DEFINITIONS OF TERMS, GENERAL STANDARDS, AND OVERVIEW NFORMATION APPLICABLE TO 40CFR PARTS 260-265

R261 IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

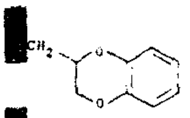
IDENTIFIES THOSE SOLID WASTES WHICH ARE SUBJECT TO REGULATION AS AZARDOUS WASTES UNDER 40CFR PARTS 262-265, 270, 271, AND 124 AND WHICH RE SUBJECT TO THE NOTIFICATION REQUIREMENTS OF SECTION 3010 OF THE RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) AND IDENTIFIES ONLY SOME OF THE MATERIALS WHICH ARE HAZARDOUS [illegible]

```
0CFR262  STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE

 ESTABLISHES STANDARDS FOR GENERATORS OF HAZARDOUS WASTE


40CFR263  STANDARDS APPLICABLE TO TRANSPORTERS OF HAZARDOUS WASTE

 ESTABLISHES STANDARDS WHICH APPLY TO PERSONS TRANSPORTING HAZARDOUS
ASTE WITHIN THE UNITED STATES IF THE TRANSPORTATION REQUIRES A MANIFEST
NDER 40CFR262


0CFR264  STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE
REATMENT, STORAGE, AND DISPOSAL FACILITIES

 ESTABLISHES MINIMUM NATIONAL STANDARDS WHICH DEFINE THE ACCEPTABLE
ANAGEMENT OF HAZARDOUS WASTE


0CFR265  INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS
ASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

 ESTABLISHES MINIMUM NATIONAL STANDARDS WHICH DEFINE THE ACCEPTABLE
ANAGEMENT OF HAZARDOUS WASTE DURING THE PERIOD OF INTERIM STATUS


0CFR267  INTERIM STANDARDS FOR OWNERS AND OPERATORS OF NEW HAZARDOUS
ASTE LAND DISPOSAL FACILITIES

 ESTABLISHES MINIMUM NATIONAL STANDARDS THAT DEFINE THE ACCEPTABLE
ANAGEMENT OF HAZARDOUS WASTE FOR NEW LAND DISPOSAL FACILITIES


0CFR270  EPA ADMINISTERED PERMIT PROGRAMS: THE HAZARDOUS WASTE PERMIT
ROGRAM

 ESTABLISHES PROVISIONS FOR THE HAZARDOUS WASTE PERMIT PROGRAM UNDER
UBTITLE C OF THE SOLID WASTE DISPOSAL ACT, AS AMENDED BY THE RESOURCE
ONSERVATION AND RECOVERY ACT


0CFR271  REQUIREMENT FOR AUTHORIZATION OF STATE HAZARDOUS WASTE
PROGRAMS

 SPECIFIES THE PROCEDURES EPA WILL FOLLOW IN APPROVING, REVISING, AND
ITHDRAWING APPROVAL OF STATE PROGRAMS AND THE REQUIREMENTS STATE
OGRAMS MUST MEET TO BE APPROVED BY THE ADMINISTRATION UNDER SECTION
006(B) OF RCRA


 NUMBER
7440-41-7

ISTRY TOXIC CHEMICALS NUMBER
DS1750000

    'INS

PECIAL INFORMATION
 JB. FOUND AT LIPARI LANDFILL, PITMAN,N.J.--
E WHAT INFORMATION YOU REQUIRE
ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND, /HELP/, OR /NONE/,
```



ce

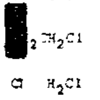
1-ylmethyl)piperazine.
oxin-2-yl)methyl]pipera-
N,O,; mol wt 382.44. C
6.11%. Prepn: Swain, U.S.



methanol. mp 162-167°.

ses

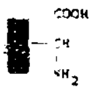
tylamine. N,N-Bis(2-
nzylbis(β-chloroethyl)-
C 56.91%. H 6.51%. Cl
ump, Nikawitz, U.S. pat.
Goldman, Nickerson, U.S.
sh).



s.c. in mice: 50 mg/kg.
bitol. Crystals. mp 148-

le cancer research.

sine. $C_{13}H_{20}Cl_2N_2O_2$;
Cl 26.15%. N 10.33%.
ed. Chem. 7, 468 (1964)



ely hygroscopic mass.

2H₂O, crystals from

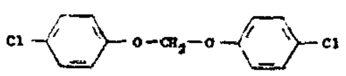
s exptl antineoplastic.

α,α'-Dichlorodimeth-
sym-dichlorodimethyl
C 14.73%. H 2.47%.
$(CH_2Cl)_2$. Prepd by
su le: Lewin. J. Prakt.
of diazomethane with
Obshch. Khim. 27, 780

ride or from alcohol plus
nol thanol, ether. Easily
OH and KOH.

ne. 1,1'-[Methylene-
hlorophenoxy)methane;
O₂; mol wt 269.12. C
1.8 . Prepd from p-chlo-
. U.S. pat. 2,503,207

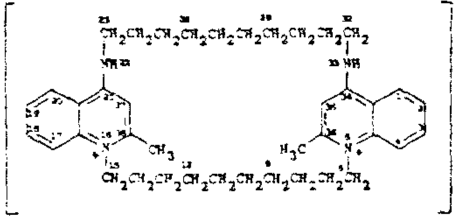
(1950 to Dow); from sodium phenolate and dichloromethane: Miron, Lowry, *J. Am. Chem. Soc.* 73, 1872 (1951).



Crystals from petr ether. mp 69.7-70.2°. bp_4 189-194°. Solubilities at 25° in g/100 ml: acetone 189; benzene 40; carbon tetrachloride 28; methanol 0.5; ether 87. Practically insol in water, petr oils. LD_{50} orally in rats: 5.8 g/kg; lethal concn for rats in air: 18,000 ppm.

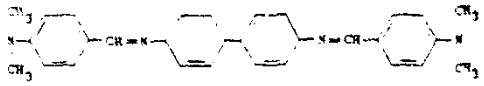
USE: Miticide. *Toxicity:* No record of human poisoning. Animal expts show low toxicity, but large doses have caused liver injury. Effects may be similar to, but less severe than, DDT, *q.v.* Spencer *et al., Arch. Ind. Hyg. Occup. Med.* 1, 341 (1950).

1267. **Bisdequalinium Chloride.** *6,7,8,9,10,11,12,13,14,15,22,23,24,25,26,27,28,29,30,31,32,33-Docosahydro-3c,38-dimethyl-5,34:16,21-diethenodibenzo[b,r][1,5,16,20]tetraazacyclotriacontine-5,16-diium dichloride;* $N^1,N^{1'}$-decamethylene-$N^4,N^{4'}$-decamethylenebis(4-aminoquinaldinium chloride); 1,1'-decamethylene-4,4'-(1,10-decamethylenediimino)bis[quinaldinium chloride]; Salvizol. $C_{48}H_{68}Cl_2N_4$; mol wt 665.84. C 72.16%. H 8.78%. Cl 10.65%. N 8.41%. Prepn: Stark, Brit. pat. 895,090 (1960).



MED USE: Antiseptic, disinfectant.
THERAP CAT: Antiseptic, disinfectant.

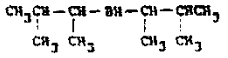
1268. **Bis(*p*-dimethylaminobenzylidene)benzidine.** *N,N'-Bis[[4-(dimethylamino)phenyl]methylene][1,1'-biphenyl]-4,4'-diamine;* 4,4'-di(4-dimethylaminobenzylideneamino)biphenyl; bis(4-dimethylaminobenzylidene)-*p,p'*-diaminodiphenyl; *N,N'*-bis(*p*-dimethylaminobenzal)benzidine. $C_{30}H_{30}N_4$; mol wt 446.57. C 80.68%. H 6.77%. N 12.55%. Prepn from hydrazobenzene and *p*-dimethylaminobenzaldehyde: Sachs, Whittaker, *Ber.* 35, 1435 (1902).



Yellow crystals from nitrobenzene; mp 318°. Reacts with solutions of the alkali tungstates to give a cinnabar-red precipitate.

USE: Determination of tungsten. Hovorka, *Coll. Czech. Chem. Commun.* 10, 518 (1938); *C.A.* 33, 1624 (1939).

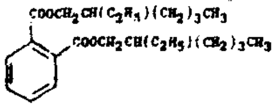
1269. **Bis(1,2-dimethylpropyl)borane.** Disiamylborane; di-*sec*-isoamylborane; bis(3-methyl-2-butyl)borane. $C_{10}H_{23}B$; mol wt 154.10. C 77.94%. H 15.04%. B 7.01%. Prepn: Brown, Zweifel, *J. Am. Chem. Soc.* 83, 1241 (1961).



Crystals. mp 35-40°. Unstable to air.

USE: Selective reagent for steric control of hydroboration of olefins.

1270. **Bis(2-ethylhexyl) Phthalate.** *1,2-Benzenedicarboxylic acid bis(2-ethylhexyl) ester;* di(2-ethylhexyl) phthalate; dioctyl phthalate; Octoil. $C_{24}H_{38}O_4$; mol wt 390.54. C 73.80%. H 9.81%. O 16.39%. Prepn: Garner, Watson, U.S. pat. 2,508,911 (1950 to Shell); Brit. pat. 747,260 (1956 to Chemische Werke Hüls).



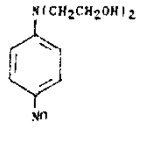
USE: In vacuum pumps.

1271. **Bis(2-ethylhexyl) Sebacate.** *Decanedioic acid bis(2-ethylhexyl) ester;* di(2-ethylhexyl) sebacate; Octoil S. Plexol 201. $C_{26}H_{50}O_4$; mol wt 426.66. C 73.19%. H 11.81%. O 15.00%. $CH_3(CH_2)_3CH(C_2H_5)CH_2OOC(CH_2)_8COOCH_2CH(C_2H_5)(CH_2)_3CH_3$. Prepn: Bruno, U.S. pat. 2,628,249 (1953 to Pittsburgh Coke & Chemical); Brit. pat. 747,260 (1956 to Chemische Werke Hüls).

Liquid. d_{15}^{15} 0.9119, n_D^{15} 1.4496.

USE: In vacuum pumps.

1272. ***N,N*-Bis(2-hydroxyethyl)-*p*-nitrosoaniline.** *2,2'-[(4-Nitrosophenyl)imino]bisethanol.* $C_{10}H_{14}N_2O_3$; mol wt 210.23. C 57.13%. H 6.71%. N 13.33%. O 22.83%. Prepn: D'Amico *et al., J. Am. Chem. Soc.* 81, 5957 (1959); Sen, Price, *J. Org. Chem.* 24, 125 (1959).



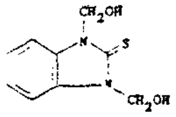
Crystals from aq ethanol. mp 137-138°.

Hydrochloride. $C_{10}H_{14}N_2O_3.HCl$, crystals. mp 123-125°.

Dimethanesulfonate. $C_{12}H_{18}N_2O_7S_2$. *N,N-bis[(2-methanesulfonoxy)ethyl]-p-nitrosoaniline,* NAMS ADL-45, NSC-79423. Commercial development: Arthur D. Little, Inc.

THERAP CAT: Exptl. antineoplastic.

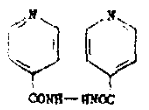
1273. **1,3-Bis(hydroxymethyl)-2-benzimidazolinethione.** 2-Mercaptobenzimidazole-1,3-dimethylol; Thyreocordon. $C_9H_{10}N_2O_2S$; mol wt 210.26. C 51.41%. H 4.79%. N 13.33%. O 15.22%. S 15.25%. Prepn: Monti, Venturi, *Gazz. Chim. Ital.* 76, 365 (1946).



Very bitter. mp 160-162°. Soluble dil in alkalies.

THERAP CAT. Sedative, thyroid inhibitor.

1274. **N,N'-Bis[isonicotinic acid] Hydrazide.** *4-Pyridinecarboxylic acid 2-(4-pyridinylcarbonyl)hydrazide;* di(4-pyridoyl)hydrazine; bis[4-pyridoyl]hydrazine. $C_{12}H_{10}N_4O_2$; mol wt 242.23. C 59.50%. H 4.16%. N 23.13%. O 13.21%. Formed by boiling isonicotinic acid hydrazide with amyl nitrite in alc: Graf, *J. Prakt. Chem.* 138, 289 (1933).



Long, thin needles from water, mp 254-255°. Sparingly sol in water, petr ether, benzene. Sol in alcohol, acetic acid.

1275. **Bismark Brown R.** *4,4'-[(4-Methyl-1,3-phenylene)bis(azo)]bis[6-methyl-1,3-benzenediamine] dihydrochloride; C.I. Basic Brown 4;* 5,5'-[(4-methyl-*m*-phenylene)bis(azo)]bis[toluene-2,4-diamine] dihydrochloride; C.I. 21010; Bismark Brown 53; Vesuvine. $C_{21}H_{26}Cl_2N_8$; mol wt 461.41. C 54.67%. H 5.68%. Cl 15.37%. N 24.29%. Prepd by reac-

tion of
(2nd e

₂

Dark
soln; s
tically
which
gives v
Free
mp 13
acetone
USE:
our Ina

1276
(1,3-be
4,4'-(m
drochlo
mol wt
Prepd b
F. J. W
trand C
1956) w

h

Black
ethanol.
carbon
concd m
USE:
(2nd ed.

1277.
butaned
dihexyl
$C_{16}H_{29}N$
5.92%. C
sulfosucc
with the
ate alco
sodium
Brit. pat

Availab
Must be
in hot wa
447 g/l.
the wettin
HPO₄; 3
pine oil,
2B ethan

```
CADMIUM
TYPE WHAT INFORMATION YOU REQUIRE:
 (ALL), SPECIFIC INFORMATION (BY 4-LETTER COMMAND), (HELP), OR (NONE).
  NM

SYNONYMS
  C.I. 77180
  CADMIUM DUST
  OHS03750
TYPE WHAT INFORMATION YOU REQUIRE:
 (ALL), SPECIFIC INFORMATION (BY 4-LETTER COMMAND), (HELP), OR (NONE).
PERM

PERMISSIBLE EXPOSURE LIMIT
  0.2 MG/M3 OSHA TWA (DUST)
  0.6 MG/M3 OSHA CEILING (DUST)
  0.1 MG/M3 OSHA TWA (FUME)
  0.3 MG/M3 OSHA CEILING (FUME)
  0.05 MG/M3 ACGIH TWA (DUST)
  0.04 MG/M3 NIOSH RECOMMENDED TWA
  0.2 MG/M3 NIOSH RECOMMENDED 15 MINUTE CEILING
  SUSPECT HUMAN CARCINOGEN (NIH)
  ANIMAL CARCINOGEN (IARC)
  MUTAGENIC DATA (RTEC)
  REPORTABLE QUANTITIES - 1 LB CWA 307(A)
  CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 2 - REACTIVITY 2 -
    PERSISTENCE 3

  TOXICOLOGY:  ACUTE POISONING FROM INGESTION CAUSES GASTROINTESTINAL
  UPSET, SALIVATION, SHOCK, LIVER AND KIDNEY DAMAGE.  FUME INHALATION
  CAUSES PULMONARY DISTURBANCES, WEAKNESS, AND LEG PAIN, PROGRESSING TO
  FEVER AND LUNG CONGESTION.
    CHRONIC INHALATION PRODUCES ANOSMIA, DYSPNEA, WEIGHT LOSS, AND YELLOW
  DISCOLORATION OF THE TEETH.  IRREVERSIBLE LUNG INJURY HAS RESULTED,
  AS HAS KIDNEY DAMAGE.  HYPERTENSION HAS RECENTLY BEEN REPORTED.
```

```
[illegible]
GENIC IN RATS, CAUSING LOCAL SARCOMAS FOLLOWING SUBCUTANEOUS INJECTION.
CADMIUM POWDER AND CADMIUM SULFIDE PRODUCE LOCAL SARCOMAS IN RATS
FOLLOWING INTRAMUSCULAR ADMINISTRATION.  CADMIUM CHLORIDE AND SULFATE
PRODUCE TESTICULAR TUMORS IN MICE AND RATS FOLLOWING SUBCUTANEOUS
ADMINISTRATION.  EVIDENCE FOR CARCINOGENICITY IN HUMANS IS LIMITED.
STUDIES SUGGEST OCCUPATIONAL EXPOSURE TO SOME FORM OF CADMIUM, POSSIBLY
THE OXIDE, INCREASES THE RISK OF PROSTATE, RESPIRATORY, AND GENITOURIN-
ARY CANCERS IN HUMANS.
  THE THRESHOLD LIMIT VALUE WAS SET TO PREVENT SYSTEMIC EFFECTS FROM
CHRONIC POISONING.
IHL-MAN TCLO: 88 UG/M3/8.6 YR        ORL-RBT LDLO: 70 MG/KG
IHL-MAN LCLO: 39 MG/M3/20 MIN
UNK-MAN LDLO: 15 MG/KG
ORL-RAT LD50:225 MG/KG
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
IDLH

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONCENTRATION
  40 MG/M3
  OSHA/NIOSH
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
DESC

PHYSICAL DESCRIPTION
  SILVER-WHITE, BLUE-TINGED, LUSTROUS METAL OR GRAYISH WHITE POWDER.
  MALLEABLE
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
PROP

  EMICAL AND PHYSICAL PROPERTIES
  MOLECULAR WEIGHT: 112.4
  BOILING POINT AT 1 ATM, F: 1409 F
  SOLUBILITY IN WATER, G/100 G WATER AT 20C: INSOLUBLE
  FLASH POINT, CLOSED CUP, F (OR OPEN CUP IF OC): FLAMMABLE
  VAPOR PRESSURE @ 20 C, MMHG: 0.00 MM
  MELTING POINT, F: 610 F
  UPPER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: DUST CLOUD
  LOWER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: COMBUSTIBLE
  AUTOIGNITION TEMPERATURE: 482 F
  SPECIFIC GRAVITY: 8.642
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
INCO

INCOMPATIBILITIES
  STRONG OXIDIZERS
  SULFUR
  SELENIUM
  TELLURIUM
  SPONTANEOUSLY FLAMMABLE IN AIR
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
CLOT

 PERSONAL PROTECTIVE EQUIPMENT
  FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES
   FOR CHEMICAL HAZARDS':

   PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL
     LAUNDERED OR DISCARDED
   IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF
```

```
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
SP

SPECIFIC EMERGENCY PROVISIONS
  FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES
    FOR CHEMICAL HAZARDS':

  AN EYE-WASH FOUNTAIN SHOULD BE PROVIDED WITHIN THE IMMEDIATE WORK AREA
    WHERE THERE IS ANY POSSIBILITY THAT EMPLOYEES' EYES MAY BE EXPOSED TO
    CADMIUM CHLORIDE DUST
  NO EATING OR SMOKING IN AREAS WHERE CADMIUM FUMES MAY BE GENERATED, OR
    WHERE CADMIUM DUST IS HANDLED, PROCESSED, OR STORED
  WASH HANDS WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING OR
    SMOKING
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
RESP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

1 MG/M3
    - DUST MASK
        (EXCEPT SINGLE-USE RESPIRATORS)


5 MG/M3
    - DUST MASK
        (EXCEPT SINGLE-USE RESPIRATORS)
        AND QUARTER-MASK RESPIRATORS
    - HIGH-EFFICIENCY PARTICULATE RESPIRATOR
    - SUPPLIED-AIR RESPIRATOR
    - SELF-CONTAINED BREATHING APPARATUS


10 MG/M3
    - HIGH-EFFICIENCY PARTICULATE RESPIRATOR
        WITH A FULL FACE-PIECE, HELMENT, OR HOOD
    - SELF-CONTAINED BREATHING APPARATUS
        WITH A FULL FACE-PIECE


40 MG/M3
    - POWERED AIR-PURIFYING RESPIRATOR
        WITH A HIGH-EFFICIENCY PARTICULATE FILTER
    - TYPE  C  SUPPLIED-AIR RESPIRATOR
        OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
         MODE


ESCAPE
    - DUST MASK
        (EXCEPT SINGLE-USE RESPIRATORS)
    - SELF-CONTAINED BREATHING APPARATUS


FIREFIGHTING
    - SELF-CONTAINED BREATHING APPARATUS
        WITH A FULL FACE-PIECE
        OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE



TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
```

```
ROUTE OF ENTRY INTO BODY:
  INHALATION
  INGESTION
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
SYMP

 SYMPTOMS
  EYE IRRITATION
  SKIN IRRITATION
  MUCOUS MEMBRANE IRRITATION
  CENTRAL NERVOUS SYSTEM DEPRESSION
  RESPIRATORY DISTRESS
  WEAKNESS
  ANOSMIA
  HEADACHE
  MUSCULAR PAIN
  ABDOMINAL CRAMPS
  NAUSEA
  DIARRHEA
  DYSPNEA
  VOMITING
  PROTEINURIA
  KIDNEY DAMAGE
  LIVER DAMAGE
  RESPIRATORY EDEMA
  SHOCK
  SALIVATION
  FEVER
  WEIGHT LOSS
  RESPIRATORY IRRITATION
  HYPERTENSION
  PE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
ORGA

ORGANS
  EYES
  SKIN
  RESPIRATORY SYSTEM
  CENTRAL NERVOUS SYSTEM
  CARDIOVASCULAR SYSTEM
  KIDNEYS
  LIVER
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
NONE
ENTER NAME, KEYWORD, SYMPTOM, STLA, NAMELIST, HELP, OR QUIT
NAME
ENTER CHEMICAL NAME
```

Spray workers exposed at 0.5% Dursban emulsion in field trials for malaria control on premises showed a measurable decrease in plasma and red cell cholinesterase levels.[illegible] In this study, 5 of 7 sprayers showed more than 50 per cent reduction in cholinesterase within two weeks after the spraying program began. In another study,[6] human volunteers were exposed to thermal aerosols containing Dursban insecticide for one period. Exposures of 3 to 8 minutes at concentrations of about 0.8 $\mu m/m^3$ in air produced no significant alteration of cholinesterase levels. This concentration resulted from the recommended application rate in thermal fogging.

Available studies indicate that Dursban is rapidly metabolized in the animal body.[8]

There was evidence of teratologic or reproductive effects in male and female rats fed 1.0 mg/kg per day during a three-generation reporduction and fertility study.[11]

A TLV of 0.2 and a STEL of 0.6 mg/m^3 are recommended to prevent any measurable decrease in plasma cholinesterase activities and provides a very wide margin of safety in preventing cholinergic symptoms or organic injury.

References:

1. **Martin, H.:** *Pesticides Manual,* 2nd ed., British Crop Protection Council (1971).
2. **Spencer, E.Y.:** *Guide to the Chemicals Used in Crop Protection,* Canada Dept. of Agriculture (1968).
3. *Merck Index,* 9th ed., p. 281, Merck & Co., Inc., Rahway, NJ (1976).
4. **Gray, H.E.:** *Down to Earth 21*:26 (1965). A Dow Chemical Co. Publication.
5. **Gaines, T.B.:** *Tox. Appl. Pharm. 14*:515 (1969).
6. **Ludwig, P.O., Kilian, D.J., Dishburger, H.J. Edwards, H.N.:** *Mosquito News 30*:346 (1970).
7. **FAO/WHO Pesticide Residue Report,** No. FAD/RES/72.6a (November 1972).
8. **The Dow Chemical Company:** Personal communication to TLV Committee, Midland, MI (1973).
9. **Griffin, T.B.** *et al: Soc. Tox. Abstract No. 32,* Atlanta, GA (March 1976).
10. **Eliason, D.A., Cranmer, M.F., vonWindeguth, D.C., Kilpatrick, J.W., Sugs, J.E., Schoof, H.F.:** *Mosquito News 29*:591 (1969).
11. **The Dow Chemical Company:** Communication to the TLV Committee of unpublished data (1972).

CHROMIUM

Cr

Metal and Inorganic Compounds as Cr

TLV, 0.5 mg/m^3 — Metal

0.5 mg/m^3 — Cr II Compounds

0.5 mg/m^3 — Cr III Compounds

0.05 mg/m^3 — Water Soluble Cr VI Compounds

0.05 mg/m^3, Appendix A1a — Recognized Carcinogen — Certain Water Insoluble Cr VI Compounds

Chromium is a metallic element, atomic number 24, atomic weight 51.996, in Group VIB of the periodic table. It is a steel-gray, lustrous metal, with a specific gravity of 7.20. The melting point is 1900° C and boils at 2642° C. The metal reacts with dilute hydrochloric acid and sulfuric acid, but not with nitric acid.

Chromium metal was first isolated in 1798. The chief uses of chromium and chromium compounds are in stainless and alloy steels, refractory products, tanning agents for leather, pigments, electroplating, catalyst and in corrosion resistant products. Chromium is obtained from chromite ores ($FeO \cdot Cr_2O_3$). Relatively large deposits of chromite ore were found near Baltimore in the United States but no mining has taken place there since 1961.

Chromium can have a valence of 2, 3 or 6, and a wide range of chromium alloys and inorganic chromium compounds are encountered in the workplace. These chromium compounds vary greatly in their toxic and carcinogenic effects. For this reason it is necessary to divide chromium and its inorganic compounds into a number of groupings — each with its specific TLV based on available toxicological and epidemiological evidence. These groupings are:

1. **Chromium metals and alloys**
   This grouping includes chromium metal, stainless steels and other chromium-containing alloys.
2. **Divalent chromium compounds (Cr^{2+}) (Chromous compounds)**
   This grouping includes chromous chloride ($CrCl_2$) and chromous sulfate ($CrSO_4$).
3. **Trivalent chromium compounds (Cr^{3+}) (Chromic compounds)**
   This grouping includes chromic oxide (Cr_2O_3), chromic sulfate ($Cr_2[SO_4]_3$), chromic chloride ($CrCl_3$), chromic potassium sulfate ($KCr[SO_4]_2$) and chromite ore ($FeO \cdot Cr_2O_3$).
4. **Hexavalent chromium compounds (Cr^{6+})**
   This grouping includes chromium trioxide (CrO_3) — the anhydride of chromic acid — chromates (e.g., Na_2CrO_4), dichromates (e.g., $Na_2Cr_2O_7$) and polychromates. Certain hexavalent chromium compounds have been demonstrated to be carcinogenic on the basis of epidemiological investigations on workers and experimental studies in animals. In general, these compounds tend to be of low solubility in water and thus may be subdivided into two subgroups:
   - (a) **Water soluble hexavalent chromium compounds**
     These include chromic acid and its anhydride, and the monochromates and dichromates of sodium, potassium, ammonium, lithium, cesium and rubidium.
   - (b) **Water insoluble hexavalent chromium compounds**
     These include zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate and sintered chromium trioxide.

Hexavalent Chromium

The first cases of occupational health effects from hexavalent chromium were reported in 1827[2] by Cumin, who observed cases of skin ulceration and dermatitis in dye workers handling potassium dichromate. Mackenzie[3] in

1884 reported that perforation of the nasal septum occurred in workers exposed to potassium bichromate. Da Costa *et al*(4) in 1916 described chrome ulcers in tanners and dryers. Parkhurst(5) in 1925 reported chrome dermatitis in blueprint workers exposed to potassium dichromate. Bloomfield and Blum(6) reported on their study of electroplaters exposed to acidic mist of hexavalent chromium compounds. They noted that 20 of 23 workers examined showed evidence of perforated or ulcerated nasal septa and skin ulcers (*chrome holes*). The Factory Inspectorate in Great Britain(7) reported in 1930 on the results of medical examinations of 223 persons engaged in chromium plating, 42.6% had dermatitis or skin ulcers and 52% had perforated or ulcerated nasal septa.

The occupational health literature affords abundant evidence that hexavalent chromium compounds may cause irritant and allergic contact dermatitis, skin ulcers, and nasal irritation varying from rhinitis to perforation of the nasal septum. Dermatitis from exposure to soluble hexavalent chromium has been reported in lithographers(8,9) diesel repair shop workers(10) and leather workers.(11) Soluble chromates in cement have been stated to be the cause of cement dermatitis in some workers.(12)

Attempts have been made to correlate the airborne levels of hexavalent chromium with irritation of the nasal mucosa. In the study by Bloomfield and Blum,(6) electroplaters were exposed to estimated exposures ranging from 0.06 to 2.8 mg/m³ (as Cr^{6+}). Levels of Cr^{6+} in the form of chromium trioxide, were capable of giving rise to nasal irritation at concentrations as low as 0.06 mg/m³. It is difficult to rule out the importance of personal hygiene in the production of nasal symptoms from direct transfer of chromium (Cr^{6+}) to the nasal mucosa. Nasal irritation is produced from exposure to soluble chromate and bichromate salts as well as to chromic acid mist.(12,13) The study by the U.S. Public Health Service(14) noted that the mean concentration of water-soluble chromium in plants where nasal irritation was encountered was 0.068 mg/m³ as Cr^{6+}.

Epidemiological studies showing an increased incidence of lung cancer among workers involved in the manufacture of chrome pigments have been reported from Germany,(15) Norway(16) and United States.(17) Machle and Gregorius(3) first reported increased incidence of lung cancer in the United States chromate industry. Baetjer(18) carried out a case control study and confirmed the increased risk of lung cancer among the U.S. chromate workers. Mancuso and Hueper(19) attempted to estimate the airborne exposures to chromium in those who developed lung cancer. They found that these workers were exposed to 0.01 to 0.15 mg/m³ of water soluble chromium and 0.1 to 0.58 mg/m³ of water insoluble chromium. The insoluble fraction was denoted as Cr^{3+} and the soluble as Cr^{6+} but it is impossible to assign Cr^{6+} or Cr^{3+} exclusively to either fraction.

The chromate workers in the preceding studies were exposed to various Cr^{3+} and Cr^{6+} compounds as well as to other substances. In general, the evidence does not suggest that chromite ore, a water insoluble Cr^{3+} substance, is a carcinogen. While the evidence is incomplete it does appear that certain Cr^{6+} compounds, mainly water insoluble, were involved in increased risk of lung cancer. The experimental data from animals supports the view that water insoluble Cr^{6+} compounds, e.g., chromic and zinc chromates, are carcinogenic, whereas the soluble forms are not.(20) Royle,(21) however, has reported an increase in lung and other cancers in chrome platers in England.

Hexavalent chromium compounds have been said to also cause kidney damage in workers(22,23) where absorption through damaged skin has occurred.

The TLVs for hexavalent chromium compounds are recommended as follows:

(a) Water soluble hexavalent chromium compounds (see examples noted above). A TLV of 0.05 mg/m³ as water soluble Cr^{6+} is considered adequate to protect against irritation of the respiratory tract and possible kidney and liver damage. NIOSH in the criteria document on chromic acid(24) recommended that occupational exposures be controlled to prevent exposures above 0.05 mg/m³ TWA. In a later criteria document on hexavalent chromium(25) NIOSH recommended a permissible exposure limit of 0.025 mg/m³.

(b) Certain water insoluble hexavalent chromium compounds (see examples noted above). A TLV of 0.05 mg/m³ as water insoluble Cr^{6+} and insertion in appendix A1a is recommended. There is, unfortunately, little previous environmental data from those exposures associated with increased respiratory cancer risk. With the data available, however, this TLV provides an adequate margin of safety. NIOSH recommended a permissible exposure limit of 0.001 mg/m³ for certain insoluble hexavalent chromium compounds.(25)

(c) Mixed exposure to soluble and insoluble hexavalent chromium compounds. A TLV of 0.05 mg/m³ as Cr^{6+} is recommended.

(d) Chromite ore processing
Chromate pigment manufacture
It may be advisable to list these process TLVs both as 0.05 mg/m³ as Cr and include them in appendix A1a. This TLV will serve to draw attention to those processes where increased risk of cancer has been associated with chromium compounds.

Chromium Metal

Divalent chromium compounds

(see examples listed earlier)

Trivalent chromium compounds

(see examples listed earlier)

Early studies indicated that trivalent chromium and divalent chromium compounds have a low order of toxicity.(26) Dermatitis has been reported in workers handling trivalent chromium compounds.(27,28)

Chest X-rays carried out in workers exposed to chromite dust have been reported to show "exaggerated pulmonary markings"(29) and Princi *et al*(30) have reported pulmonary disease in workers exposed to ferrochrome alloys with chromium levels in air of 0.27 mg/m³ reported. Other dusts and fumes were present, however, in this plant. Exposure to chromium metal does not give rise to pulmonary fibrosis or pneumoconiosis.

Because of the low toxicity of the metal and its divalent and trivalent compounds, a TLV of 0.5 mg/m^3 as Cr is recommended. This TLV should be adequate to prevent pulmonary disease or other toxic effect.

Other recommendations: Chromic acid and chromates, as *Cr*, Sweden (1978) 0.02 mg/m^3, Czechoslovakia (1969) 0.05 mg/m^3; USSR (1976) 0.005 mg/m^3. Lower valence chromium, Sweden 0.5 mg/m^3 for metal and compounds, as Cr; USSR, chromic oxide 1 mg/m^3, chrome alum 0.02 mg/m^3 and chromium trichloride 0.01 mg/m^3, all as *Cr*.

References:

1. *Chromium*, Committee on Biological Effects of Atmospheric Pollutants, National Academy of Sciences, Washington, DC (1974).
2. **Cumin, W.:** *Edinburg Med. Sug. J. 28*:295-312 (1827).
3. **Mackenzie, J.N.:** *JAMA 3*:601-603 (1884).
4. **DaCosta, J.C. Jones, J.P.X., Rosenberger, R.C.:** *Ann. Surg 63* 155-166 (1916).
5. **Parkhurst, H.J.:** *Arch. Dermatol Syphilol 12* 253-256 (1925)
6. **Bloomfield, J.J., Blum, W.:** *Pub Health Rep. 43*:2330-2347 (1928).
7. **Medical Inspectorate of Factories:** *J Ind. Hyg. 12*:314-315 (1930).
8. **McCord, C.P. Higginbottom, H.C., McGuire, J.C.:** *JAMA 94* 1043-1044 (1930)
9. **Levin, H.M. Brunner, M.J. and Rattner, H.:** *JAMA 169* 566-569 (1959)
10. **Winston, J.R., Walsh, E.M.:** *JAMA 147* 1133-1134 (1951)
11. **Morris, G.E.:** *Arch Ind. Health 11* 368-371 (1955)
12. **Englebrigtsen, J.K.:** *Acta Derm Venereol 32* 462 468 (1952)
13. **Machle, W., Gregorius, F.:** *Pub Health Rep 63* 1114-1127 (1948)
14. **Federal Security Agency:** *Health of Workers in Chromate Producing Industry — A Study*, US Pub. Health Serv., Div. of Occupational Health (1953).
15. **Gross, E., Kosch, F.:** *Arch. Gewerbepath. Gewerbehyg.* 12:164-170, Germany (1943).
16. **Langard, S. and Norseth, T.:** *Brit. J. Ind. Med. 32* 62-65 (1975)
17. **Equitable Environmental Health, Inc.:** *An Epidemiological Study of Workers in Lead Chromate Plants*, final report to The Dry Color Manufacturers Assoc, Arlington, VA (June 25, 1976).
18. **Baetjer, A.M.:** *Arch. Ind. Hyg. & Occup. Med.* 2:505-516 (1950).
19. **Mancuso, R.F., Hueper, W.C.:** *Ind. Med. Sug. 20*:358-363 (1951).
20. **Laskin, S., Kuschner, M., Drew, R.T.:** Studies in Pulmonary Carcinogenesis *Inhalation Carcinogenesis*, M.G. Hanna, P. Nettesheim & J.R. Gilbert, Eds., pp. 321-351, US Atomic Energy Commission, Oak Ridge, TN (1969)
21. **Royle, H.:** *Env Res. 10*:39-53 (1975).
22. **Major, R.H.:** *Johns Hopkins Hosp. Bull 33*:56-61 (1922)
23. **Hunter, W.C., Roberts, J.M.:** *Am. J. Pathol.* 9:133-147 (1933)
24. **NIOSH:** *Criteria for a Recommended Standard — Occupational Exposure to Chromic Acid* (1973)
25. **NIOSH:** *Criteria for a Recommended Standard — Occupational Exposure to Chromium (VI)* (1975).
26. **Akatsuka, K., Fairhall, L.T.:** *J. Ind. Hyg. 16* 1 (1934)
27. **Morris, G.E.:** *Arch Derm. 78* 612 (1958)
28. **Fregert, S., Rorsman, H.:** *Arch Derm 90*:4 (1964), abstracted in *J Occ. Med.* 7:49 (1965).
29. **Government of India:** *Report No. 1*, p. 24, Ministry of Labour (1953)
30. **Princi, F. Miller, L.H. Davis, A. Cholak, J.:** *J Occup Med* 4 301 (1962)

CHROMYL CHLORIDE

Chromium dioxychloride

CrO_2Cl_2

TLV. 0.025 ppm (≈ 0.15 mg/m^3)

A dark red, fuming liquid, chromyl chloride has a molecular weight of 154.92 and a specific gravity of 1.91 at 25° C. The freezing and boiling points are −96.5° C and 116° C, respectively. It is miscible with carbon tetrachloride and carbon disulfide, with water it reacts vigorously to form CrO_3, HCl, $CrCl_3$ and Cl_2

Chromyl chloride is used in organic oxidations and chlorinations, as a solvent for CrO_3 and in making chromium complexes and dyes.

NIOSH has classified this compound as an inferred carcinogen, with an occupational exposure standard, calculated as Cr, of 1 µg/m^3.(1) The subcutaneous LD_{50} in mice has been reported to be 5.45 mg/kg.(2)

The physical and chemical properties of chromyl chloride suggest that it would belong in the group of soluble dichromates, CrO_3, etc., which are considered (by NIOSH) to be non-carcinogenic, rather than the sparingly soluble chromates that appear to have been responsible for most chromate worker cancers

The propsed TLV of 0.025 ppm corresponds to 0.05 mg/m^3 of Cr, the same as the limit for other forms of hexavalent chromium, and twice the NIOSH recommendation for non-carcinogenic chromium. It would be lower than the TLV's for most oxidizing and acidic gases.

References:

1. **NIOSH:** *Criteria for a Recommended Standard — Occupational Exposure to Chromium(VI)* HEW Pub. No. (NIOSH) 76-129 (1975)
2. **NIOSH:** *Toxic Substances List*, p. 145, HEW Pub. No. (NIOSH) 74-134 (1974).

```
      CHEMICAL NAME
CHRYSENE
CHRYSENE IS A SYNONYM OF 1.2-BENZPHENANTHRENE
TYPE WHAT INFORMATION YOU REQUIRE
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND, /HELP/, OR /NONE/.
ALL
{_
CHEMICAL NAME
  1.2-BENZPHENANTHRENE

FORMULA
  C18H12

SYNONYMS
  1.2-BENZOPHENANTHRENE
  BENZ(A)PHENANTHRENE
  1.2.5.6-DIBENZONAPHTHALENE
  CHRYSENE
  BENZO(A)PHENANTHRENE
  OHS26430

PERMISSIBLE EXPOSURE LIMIT
  NONE ESTABLISHED (SEE COAL TAR PITCH VOLATILES)
  ANIMAL CARCINOGEN (IARC)
  SUSPECT HUMAN CARCINOGEN (ACGIH)
  MUTAGENIC DATA (RTEC)
  CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 3 -
    PERSISTENCE 3

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONCENTRATION
  NONE SPECIFIED

PHYSICAL DESCRIPTION
  CRYSTALS

CHEMICAL AND PHYSICAL PROPERTIES
  MOLECULAR WEIGHT: 228.30
  BOILING POINT AT 1 ATM, F: 838 F
  SOLUBILITY IN WATER, G/100 G WATER AT 20C: INSOLUBLE
  FLASH POINT, CLOSED CUP, F (OR OPEN CUP IF OC): INCOMBUSTIBLE
  VAPOR PRESSURE @ 20 C, MMHG: 0 MM HG
  MELTING POINT, F: 469 F
  UPPER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: INCOMBUSTIBLE
  LOWER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: INCOMBUSTIBLE
  SPECIFIC GRAVITY: 1.274

INCOMPATIBILITIES
  UNKNOWN

PERSONAL PROTECTIVE EQUIPMENT
  NO NIOSH/OSHA DATA: RECOMMEND
  PREVENT SKIN CONTACT. WHERE SKIN CONTACT MAY OCCUR
    WEAR IMPERVIOUS CLOTHING
    WEAR GLOVES
    WEAR FACESHIELD (8 INCH MINIMUM)

  PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL
    LAUNDERED OR DISCARDED
  IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF
    CONTAMINANT'S HAZARDOUS PROPERTIES

GOGGLES
  NO STANDARD REQUIREMENT, BUT ADVISE EYE PROTECTION TO
```

CHRYSENE or
1,2-BENZPHENANTHRENE

1/8

NO STANDARD REQUIREMENT, BUT ADVISE WASHING
PROMPTLY WHEN SKIN BECOMES CONTAMINATED

2/8

ROUTINE CHANGING OF WORK CLOTHING
NO STANDARD REQUIREMENT. BUT ADVISE CHANGING
IF IT IS REASONABLY PROBABLE THAT CLOTHING IS CONTAMINATED

CLOTHING REMOVAL FOLLOWING ACCIDENTAL CONTAMINATION
NO STANDARD REQUIREMENT. BUT ADVISE REMOVING

DRY SWEEPING AREA OR DRY MOPPING PROHIBITED - CARCINOGEN

SPECIFIC EMERGENCY PROVISIONS
NO NIOSH/OSHA DATA, ADVISE:
EYE-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES' EYES MAY BE EXPOSED TO SUBSTANCE
QUICK DRENCHING FACILITIES WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES MAY BE EXPOSED TO SUBSTANCE
EATING AND SMOKING SHOULD NOT BE PERMITTED IN IMMEDIATE WORK AREA

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

NO SPEC ADVISE
- CHEMICAL CARTRIDGE RESPIRATOR
  WITH AN ORGANIC VAPOR CARTRIDGE

HIGH LEVELS
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE, HELMENT, OR HOOD

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE
  OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

ROUTE OF ENTRY INTO BODY
SKIN OR EYE CONTACT
SKIN ABSORPTION
INHALATION

SYMPTOMS
SKIN IRRITATION
DERMATITIS
RESPIRATORY IRRITATION
DYSPNEA
MUCOUS MEMBRANE IRRITATION

FIRST AID PROCEDURES FOLLOWING EXPOSURE -
IF THIS CHEMICAL GETS INTO THE EYES, IMMEDIATELY WASH THE EYES WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE LOWER AND UPPER LIDS. GET MEDICAL ATTENTION IMMEDIATELY. CONTACT LENSES SHOULD [illegible] WITH THIS CHEMICAL.

IF THIS CHEMICAL GETS ON THE SKIN, IMMEDIATELY WASH CONTAMINATED SKIN WITH SOAP OR MILD DETERGENT & WATER. IF THIS CHEMICAL SOAKS CLOTHING, IMMEDIATELY REMOVE CLOTHING & WASH SKIN WITH SOAP OR MILD DETERGENT & WATER. GET MEDICAL ATTENTION PROMPTLY.

EXPOSED PERSON TO FRESH AIR AT ONCE. IF BREATHING HAS STOPPED PERFORM ARTIFICIAL RESPIRATION. KEEP THE AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION AS SOON AS POSSIBLE.

3/d

WHEN THIS CHEMICAL HAS BEEN SWALLOWED AND PERSON IS CONSCIOUS, IMMEDIATELY GIVE PERSON LARGE QUANTITIES OF WATER. AFTER WATER HAS BEEN SWALLOWED, TRY TO GET THE PERSON TO VOMIT BY HAVING HIM TOUCH THE BACK OF HIS THROAT WITH HIS FINGER. DO NOT MAKE AN UNCONSCIOUS PERSON VOMIT. GET MEDICAL ATTENTION IMMEDIATELY.

ORGANS
SKIN
RESPIRATORY SYSTEM

STATUS OF REGULATORY ENFORCEMENT

OSHA STANDARD 29CFR1910.1200 HAZARD COMMUNICATION

REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS HAVING WORKPLACES IN THE MANUFACTURING DIVISION, STANDARD INDUSTRIAL CLASSIFICATION CODES 20 THROUGH 39, TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF HAZARD COMMUNICATION PROGRAMS INCLUDING LABELS, MATERIAL SAFETY DATA SHEETS, TRAINING, AND ACCESS TO WRITTEN RECORDS
48FR53280 11/25/83

FOLLOWING OSHA STANDARDS APPLICABLE TO SUBSTANCES LISTED 29CFR1910, OTHERWISE ADVISE:

OSHA STANDARD 29CFR1910.20	ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL RECORDS
OSHA STANDARD 29CFR1910.132	PERSONAL PROTECTIVE EQUIPMENT
OSHA STANDARD 29CFR1910.141	SANITATION
OSHA STANDARD 29CFR1910.151	MEDICAL SERVICES AND FIRST AID
OSHA STANDARD 29CFR1910.133	EYE AND FACE PROTECTION

40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT

REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT ALLEGED TO HAVE BEEN CAUSED BY A SUBSTANCE OR MIXTURE. EPA MAY INSPECT AND REQUIRE REPORTING OF SUCH RECORDS.
48FR38178 08/22/83

SUBSTANCE LISTED TOXIC SUBSTANCES CONTROL ACT INVENTORY

RISK DOCUMENTATION/ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED ENERGY RESEARCH AND DEVELOPMENT ACT (ERDA)

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)

REGULATION PROMULGATED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) 40CFR[illegible]

4/8

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED CLEAN AIR ACT (CAA)

40CFR261.33(F) DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF
COMMERCIAL CHEMICAL PRODUCT OR MANUFACTURING CHEMICAL INTERMEDIATE IDENTIFIED AS TOXIC WASTE UNLESS OTHERWISE DESIGNATED.
45FR33084 05/19/80

MONITORING/LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

SUBSTANCES LISTED APPENDIX A - CONSENT DECREE LIST OF INDUSTRIES AND TOXIC POLLUTANTS. SETTLEMENT AGREEMENT BETWEEN U.S. EPA AND NATIONAL RESOURCES DEFENSE COUNCIL, ET AL
U.S. DISTRICT COURT DISTRICT OF COLUMBIA, JUNE 7, 1976.
SITE 8ERC2120. DDC 1976. MODIFIED MARCH 9, 1979, SITE 12ERC1833, DDC 1979 AND AGAIN ON OCTOBER 26, 1982.

SUBSTANCE SUBJECT TO REQUIREMENTS OF GENERAL INDUSTRY SAFETY ORDER (GISO) 5194 OR TITLE 8 OF CALIFORNIA ADMINISTRATIVE CODE AND DIVISION 5, CHAPTER 2.5 OF CALIFORNIA LABOR CODE

40CFR122, APPENDIX D - NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT APPLICATION TESTING REQUIREMENTS
TABLE II - ORGANIC TOXIC POLLUTANTS IN EACH OF FOUR FRACTIONS IN ANALYSIS BY GAS CHROMATOGRAPHY/MASS SPECTROSCOPY (GS/MS)
48FR14153 04/01/83

OSHA STANDARD 29CFR1910.94 VENTILATION

OSHA STANDARD 29CFR1910.134 RESPIRATORY PROTECTION
49CFR172.101 TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION, PROPER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER REQUIREMENTS
DESIGNATED IN HAZARDOUS MATERIALS TABLE AS HAZARDOUS MATERIAL (UNDER N.O.S CATEGORY) FOR THE PURPOSE OF TRANSPORTATION.
41FR15996 04/15/76
45FR34588 05/22/80 (AMENDMENT)
45FR46420 07/10/80 (AMENDMENT)
45FR62080 09/18/80 (AMENDMENT)
45FR74649 11/10/80 (AMENDMENT)
46FR17738 03/19/81 (AMENDMENT)
46FR19235 03/30/81 (AMENDMENT)

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K022: DISTILLATION BOTTOM TARS FROM THE PRODUCTION OF PHENOL/ACETONE FROM CUMENE. (T)

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K001: BOTTOM SEDIMENT [illegible]

[illegible] PENTACHLOROPHENOL. (T)

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K024: DISTILLATION BOTTOMS FROM THE PRODUCTION OF PHTHALIC ANHYDRIDE FROM NAPHTHALENE. (T)

SUBSTANCE LISTED [illegible] VIRGINIA DEPARTMENT OF [illegible] LISTING OF HAZARDOUS SUBSTANCES

SUBSTANCE LISTED [illegible]

THIS SUBSTANCE TESTED FOR CARCINOGENESIS BY THE NATIONAL
INSTITUTE OF ARTHRITIS, DIABETES, AND DIGESTIVE AND KIDNEY
DISEASES (NIADDK)

5/8

MEDICAL SURVEILLANCE REQUIRED
NO NIOSH/OSHA DATA; ADVISE:
EKG RECOMMENDED IF EMPLOYEE TO WEAR FULL-FACE RESPIRATOR
GENERAL MEDICAL HISTORY
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES
CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES
MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES
TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR
30 YEARS
48FR38187 08/22/83
48FR39225 09/30/83 (EFFECTIVE DATE CORRECTION)
PHYSICIAN EXAMINATION
INDUSTRIAL EXPOSURE HISTORY
PRE-PLACEMENT AND ANNUAL EXAMS
MEDICAL WARNING FOR REFUSAL OF MEDICAL EXAMINATION
ATTENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS

CERTIFICATIONS
NO FEDERAL AGENCY REQUIREMENT, BUT DUE TO HAZARDOUS NATURE OF
SUBSTANCE, ADVISE FOLLOWING:

HEALTH STATUS CLASSIFICATION

OSHA RESPIRATOR CERTIFICATION 29CFR1910.134
DEPARTMENT OF TRANSPORTATION IF OPERATES HEAVY EQUIPMENT

EMPLOYEE HAZARDOUS MATERIALS EDUCATION RECEIPT

EMPLOYEE MEDICAL RECORDS RECEIPT

TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE
REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL
SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT
ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
CONTACT: JACK P. MCCARTHY, OFFICE OF TOXIC SUBSTANCES,
EPA (800)424-1404. 48FR38178 8/22/83

MEDICAL WARNING REQUIRED FOR MEDICAL EXAM REFUSAL SIGNED
BY EMPLOYEE

SPECIAL DIAGNOSTIC TESTS
NONE IN COMMON USE
LEAKS AND SPILL PROCEDURES
A REPORTABLE QUANTITY OF ONE POUND APPLIED TO THIS SUBSTANCE ESTABLISHED
BY SECTIONS 101(14) AND 102(B) OR ADJUSTED UNDER SECTION 102(A) OF THE
COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT
OF 1980 (CERCLA). SECTIONS 103(A) AND 103(B) REQUIRE THAT PERSONS IN
CHARGE OF A VESSEL OR FACILITY FROM WHICH A HAZARDOUS SUBSTANCE HAS BEEN
RELEASED IN A QUANTITY EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY

```
***************************************************************************   6/8

DEPARTMENT OF TRANSPORTATION HAZARD CLASS
  49CFR172.101 HAZARDOUS MATERIALS TABLE

HAZARDOUS SUBSTANCE, LIQUID OR SOLID, N.O.S.
ORM-E
UN 9188

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS
  49CFR172.101 (SUBJECT TO ADDITIONAL LABELING REQUIREMENTS OF
  49CFR172.402)

NONE


***************************************************************************

INTERGOVERNMENTAL MARITIME ORGANIZATION HAZARD CLASS
  49CFR172.102 OPTIONAL HAZARDOUS MATERIALS TABLE

NOT LISTED

***************************************************************************

FOLLOWING INFORMATION FROM BUREAU OF EXPLOSIVES 'EMERGENCY HANDLING OF
  HAZARDOUS MATERIALS':

  HAZARDOUS SUBSTANCE, LIQUID OR SOLID, N.O.S.
ORM-E
IF MATERIAL ON FIRE OR INVOLVED IN FIRE:
 * EXTINGUISH USING SUITABLE MATERIAL TO SURROUND FIRE
IF MATERIAL IS NOT ON FIRE AND IS NOT INVOLVED IN FIRE:
 * KEEP MATERIAL OUT OF WATER SOURCES AND SEWERS
 * BUILD DIKES TO CONTAIN FLOW AS NECESSARY
PERSONAL DANGER SITUATION PROTECTION:
 * KEEP UPWIND
 * WEAR BOOTS, PROTECTIVE GLOVES AND GAS TIGHT GOGGLES
 * AVOID BREATHING VAPORS OR DUST
 * WASH AWAY ANY MATERIAL WHICH MAY HAVE CONTACTED THE
   BODY WITH COPIOUS AMOUNTS OF WATER OR SOAP AND WATER
LAND SPILL
 * DIG PIT, POND TO HOLD MATERIAL
 * COVER SOLIDS WITH A PLASTIC SHEET TO PREVENT DISSOLVING
   IN RAIN OR FIREFIGHTING WATER
WATER SPILL
 * IF DISSOLVED, APPLY ACTIVATED CARBON AT 10 TIMES SPILLED
   AMOUNT AT 10 PPM OR GREATER CONCENTRATION
 * REMOVE TRAPPED MATERIAL WITH SUCTION HOSES
 * USE MECHANICAL DREDGES OR LIFTS TO REMOVE IMMOBILIZED MASSES
   OF POLLUTION AND PRECIPITATES

WASTE
  THIS MATERIAL LISTED AS HAZARDOUS SUBSTANCE, AS DEFINED IN SECTION
  101(14) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND
  LIABILITY ACT (CERCLA) OF 1980, PURSUANT TO ONE OR MORE OF THE
  FOLLOWING:

   * FEDERAL WATER POLLUTION CONTROL ACT (FWPCA) SECTION 311(B)(2)(A)
   * SOLID WASTE DISPOSAL ACT SECTION 3001
   * CLEAN WATER ACT (CWA) SECTION 307(A)
   * CLEAN AIR ACT (CAA) SECTION 112
   * TOXIC SUBSTANCES CONTROL ACT
```

A COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA) SECTION 102

7/8

EPA HAZARDOUS WASTE NUMBER U050
CHRYSENE

40CFR260 HAZARDOUS WASTE MANAGEMENT SYSTEM: GENERAL

PROVIDES DEFINITIONS OF TERMS, GENERAL STANDARDS, AND OVERVIEW INFORMATION APPLICABLE TO 40CFR PARTS 260-265

40CFR261 IDENTIFICATION AND LISTING OF HAZARDOUS WASTE
IDENTIFIES THOSE SOLID WASTES WHICH ARE SUBJECT TO REGULATION AS HAZARDOUS WASTES UNDER 40CFR PARTS 262-265, 270, 271, AND 124 AND WHICH ARE SUBJECT TO THE NOTIFICATION REQUIREMENTS OF SECTION 3010 OF THE RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) AND IDENTIFIES ONLY SOME OF THE MATERIALS WHICH ARE HAZARDOUS WASTES UNDER SECTIONS 3007 AND 7003 OF RCRA

40CFR262 STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE

ESTABLISHES STANDARDS FOR GENERATORS OF HAZARDOUS WASTE

40CFR263 STANDARDS APPLICABLE TO TRANSPORTERS OF HAZARDOUS WASTE

ESTABLISHES STANDARDS WHICH APPLY TO PERSONS TRANSPORTING HAZARDOUS WASTE WITHIN THE UNITED STATES IF THE TRANSPORTATION REQUIRES A MANIFEST UNDER 40CFR262

40CFR264 STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES
ESTABLISHES MINIMUM NATIONAL STANDARDS WHICH DEFINE THE ACCEPTABLE MANAGEMENT OF HAZARDOUS WASTE

40CFR265 INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

ESTABLISHES MINIMUM NATIONAL STANDARDS WHICH DEFINE THE ACCEPTABLE MANAGEMENT OF HAZARDOUS WASTE DURING THE PERIOD OF INTERIM STATUS

40CFR267 INTERIM STANDARDS FOR OWNERS AND OPERATORS OF NEW HAZARDOUS WASTE LAND DISPOSAL FACILITIES

ESTABLISHES MINIMUM NATIONAL STANDARDS THAT DEFINE THE ACCEPTABLE MANAGEMENT OF HAZARDOUS WASTE FOR NEW LAND DISPOSAL FACILITIES

40CFR270 EPA ADMINISTERED PERMIT PROGRAMS: THE HAZARDOUS WASTE PERMIT PROGRAM

ESTABLISHES PROVISIONS FOR THE HAZARDOUS WASTE PERMIT PROGRAM UNDER SUBTITLE C OF THE SOLID WASTE DISPOSAL ACT, AS AMENDED BY THE RESOURCE CONSERVATION AND RECOVERY ACT

40CFR271 REQUIREMENTS FOR AUTHORIZATION OF STATE HAZARDOUS WASTE

```
  SPECIFIES THE PROCEDURES EPA WILL FOLLOW IN APPROVING, REVISING, AND
WITHDRAWING APPROVAL OF STATE PROGRAMS AND THE REQUIREMENTS STATE
PROGRAMS MUST MEET TO BE APPROVED BY THE ADMINISTRATION UNDER SECTION
3006(B) OF RCRA


CAS NUMBER
  218-01-9

REGISTRY TOXIC CHEMICALS NUMBER
  GC0700000

BULLETINS

SPECIAL INFORMATION
TYPE WHAT INFORMATION YOU REQUIRE
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
NONE
CHRYSENE - NO MORE HITS IN DATABASE.

ENTER NAME, KEYWORD, SYMPTOM, STLA, NAMELIST, HELP, OR QUIT.
```

8/8

EMICAL NAME
OPPER

Copper

RMULA
CU

NONYMS
ALLBRI NATURAL COPPER
.I. 77400
.I. PIGMENT METAL 2
1721 GOLD
OPPER DUST
OPPER FUME
CDA 101
CDA 102
OPPER-AIRBORNE
COPPER-BRONZE
COPPER-MILLED
OPPER SLAG-AIRBORNE
OPPER SLAG-MILLED
GOLD BRONZE
AEAP COPPER
ANE: COPPER
CDA 122
OHSC5430

MISSIBLE EXPOSURE LIMIT
0.1 MG/M3 OSHA TWA (FUME) - 1 MG/M3 OSHA TWA (DUST AND MIST)
.2 MG/M3 ACGIH TWA (FUME) - 1 MG/M3 ACGIH TWA (DUST AND MIST)
ERATOGENIC DATA (RTECS)
C LA HAZARD RATINGS - TOXICITY 2 - IGNITABILITY 0 - REACTIVITY 0 -
PERSISTENCE 3

TOXICOLOGY: COPPER DUSTS AND MISTS ARE EYE AND MUCOUS MEMBRANE IRRITANTS, PRIMARY SKIN IRRITANTS, AND SKIN SENSITIZERS.

ACUTE EXPOSURE MAY CAUSE METALLIC TASTE AND NASAL ULCERATION AND PERFORATION. PROLONGED SKIN CONTACT PRODUCES SENSITIZATION DERMATITIS.

COPPER FUME IS AN EYE AND MUCOUS MEMBRANE IRRITANT.

EXPOSURE RESULTS IN IRRITATION AND METAL-FUME FEVER, METALLIC TASTE, ND DISCOLORATION OF THE SKIN AND HAIR.

INGESTION OF COPPER COMPOUNDS CAUSES VOMITING AND COLLAPSE. ACUTE POISONING IS CHARACTERIZED BY HEMOLYSIS, JAUNDICE, ANURIA, HYPOTENSION ND CONVULSIONS.

CHRONIC SKIN CONTACT WITH COPPER SOLUTIONS WILL CAUSE ERYTHEMA AND OTHER SKIN REACTIONS IN SOME INDIVIDUALS.

THE THRESHOLD LIMIT VALUES WERE ESTABLISHED TO PREVENT IRRITATION.
RL-HMN TDLO:120 UG/KG

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONCENTRATION
ONE SPECIFIED

HYSICAL DESCRIPTION
EDDISH, LUSTROUS, DUCTILE, MALLEABLE METAL.
BECOMES DULL WHEN EXPOSED TO AIR.

EMICAL AND PHYSICAL PROPERTIES
CULAR WEIGHT: 63.5
BOILING POINT AT 1 ATM, F: 4653 F
SOLUBILITY IN WATER, G/100 G WATER AT 20C: INSOLUBLE
FLASH POINT, CLOSED CUP, F (OR OPEN CUP IF OC): NONFLAMMABLE
VAPOR PRESSURE @ 20 C, MMHG: 1 MM
MELTING POINT, F: 1982 F

ECIFIC GRAVITY: 8.92

COMPATIBILITIES
TRONG ALKALIES
IR
CHLORATES
AROMATES
L IN POWDERED FORM IS EXPLOSIVE

RSONAL PROTECTIVE EQUIPMENT
OLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':

EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE ROTECTIVE CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH COPPER SALTS OR LIQUIDS CONTAINING COPPER SALTS. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND A)(6).

EMPLOYERS SHALL ENSURE THAT CLOTHING WHICH MAY HAVE BECOME CONTAMINATED ITH COPPER SALTS BE PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT AN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM HE PERSON PERFORMING THE OPERATION OF THE HAZARDOUS PROPERTIES OF THE COPPER SALT.
GGLES
OLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':

EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE DUST- AND SPLASH-ROOF GOGGLES WHICH COMPLY WITH 29CFR1910.133(A)(2)-(A)(6) WHERE P ERED COPPER OR DUSTS, MISTS, OR LIQUIDS CONTAINING COPPER SALTS MAY CONTACT THE EYES.

HING CHEMICALS FROM THE SKIN
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':

EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED ITH COPPER SALTS SHOULD PROMPTLY WASH OR SHOWER WITH SOAP OR MILD ETERGENT AND WATER TO REMOVE ANY COPPER SALTS FROM THE SKIN.

EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE POWDERED COPPER, COPPER ALTS, OR LIQUIDS CONTAINING COPPER SALTS WASH THEIR HANDS THOROUGHLY ITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

TINE CHANGING OF WORK CLOTHING
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':

EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING MAY HAVE BECOME CONTAMINATED WITH POWDERED COPPER, COPPER SALTS, OR LIQUIDS CONTAINING COPPER SALTS CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

OTHING REMOVAL FOLLOWING ACCIDENTAL CONTAMINATION
OWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':

EMPLOYERS SHALL ENSURE THAT NON-IMPERVIOUS CLOTHING WHICH BECOMES CONTAMINATED WITH COPPER SALTS BE REMOVED PROMPTLY AND NOT REWORN UNTIL THE COPPER SALTS ARE REMOVED FROM THE CLOTHING.

LLOWING INFORMATION FROM NIOSH/OSHA "OCCUPATIONAL HEALTH GUIDELINES
FOR CHEMICAL HAZARDS":

36

MPLOYERS SHALL ENSURE THAT EMPLOYEES DO NOT EAT OR SMOKE IN AREAS WHERE
WDERED COPPER, COPPER SALTS, OR LIQUIDS CONTAINING COPPER SALTS ARE
ANDLED, PROCESSED, OR STORED.

RATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

PPER DUST & MIST:

MG/M3
- HIGH-EFFICIENCY PARTICULATE RESPIRATOR
  WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE, HELMENT, OR HOOD
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE

MG/M3
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE
  OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE
  OPERATED IN CONTINUOUS-FLOW MODE

PPER FUME:

M3
- FUME OR HIGH-EFFICIENCY PARTICULATE RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

G/M3
- HIGH-EFFICIENCY PARTICULATE RESPIRATOR
  WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE, HELMENT, OR HOOD
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE

MG/M3
- POWERED AIR-PURIFYING RESPIRATOR
  WITH A HIGH-EFFICIENCY FILTER
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
  OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW MODE

0 MG/M3
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE
  OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE
  OPERATED IN CONTINUOUS-FLOW MODE

OUTE OF ENTRY INTO BODY

INGESTION
IN OR EYE CONTACT

[illegible]
VER
HIRST
VOMITING
DIZZINESS
CONVULSIONS
KIDNEY DAMAGE
METALLIC TASTE
IVER DAMAGE
SHOCK
DERMATITIS
NASAL ULCERATION
NASAL PERFORATION
EYE IRRITATION
MUCOUS MEMBRANE IRRITATION
MUSCULAR ACHE
NAUSEA
OUGHING
EAKNESS
ICTERUS
PHARYNGITIS
OMITING
DIARRHEA
TENESMUS
EMOLYSIS
EMATURIA
PROTEINURIA
NURIA
AUNDICE
HYPOTENSION
COLLAPSE
EPRODUCTIVE EFFECTS IN EXPERIMENTAL ANIMALS

RST AID PROCEDURES FOLLOWING EXPOSURE

F THIS CHEMICAL GETS INTO THE EYES. IMMEDIATELY WASH THE EYES ITH LARGE AMOUNTS OF WATER. OCCASIONALLY LIFTING THE LOWER AND UPPER LIDS. GET MEDICAL ATTENTION IMMEDIATELY. CONTACT LENSES SHOULD NOT BE WORN WHEN WORKING WITH THIS CHEMICAL.

IF THIS CHEMICAL GETS ON THE SKIN. IMMEDIATELY WASH CONTAMINATED SKIN WITH SOAP OR MILD DETERGENT & WATER. IF THIS CHEMICAL OAKS CLOTHING. IMMEDIATELY REMOVE CLOTHING & WASH SKIN WITH SOAP OR MILD DETERGENT & WATER. GET MEDICAL ATTENTION PROMPTLY.

F A PERSON BREATHES IN LARGE AMOUNTS OF THIS CHEMICAL. MOVE THE XPOSED PERSON TO FRESH AIR AT ONCE. IF BREATHING HAS STOPPED PERFORM ARTIFICIAL RESPIRATION. KEEP THE AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION AS SOON AS POSSIBLE.

INGESTED SALTS OF ALUMINUM. COPPER. NICKEL. TIN. AND ZINC:

EMERGENCY TREATMENT - DILUTE WITH WATER OR MILK. REMOVE BY GASTRIC LAVAGE UNLESS PATIENT IS VOMITING.

ANTIDOTE - FOR COPPER AND ZINC SALTS. GIVE CALCIUM DISODIUM EDETATE ORALLY AND INTRAVENOUSLY. PENICILLAMINE IS EFFECTIVE FOR COPPER POISONING.

URTHER TREATMENT - TREAT HYPOTENSION. RELIEVE IRRITATION BY GIVING MILK OR CORNSTARCH BY DISSOLVING 10 GRAMS CORNSTARCH OR FLOUR IN 1 LITER OF WATER. REPLACE FLUIDS WITH 5% DEXTROSE IN SALINE. KEEP PATIENT WARM AND QUIET. RELIEVE PAIN WITH MEPERIDINE OR MORPHINE.

(MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL)

STRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO ASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH EAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT TH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM OUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM TH. OPEN MOUTH. USE GAG IF NECESSARY. EXTEND HEAD BY TING THE CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK E THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION MET BEFORE THE MARK ON TUBE REACHES LEVELS OF TEETH, NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL UBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE RK, IT MAY HAVE ENTERED TRACHEA.

AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH ONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND ITHDRAWAL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT EGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. VOID GIVING LARGE QUANTITIES OF WATER.

MASSAGE OF EPIGASTRIUM WHILE STOMACH TUBE IS BEING SPIRATED MAY AID IN POISON REMOVAL.

IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE.

ISBACH, HANDBOOK OF POISONING, 11TH ED.)

AIN - MORPHINE SULFATE, 5-15 MG SUBCUTANEOUSLY, ORALLY, OR LOWLY INTRAVENOUSLY. MORPHINE CAN CAUSE NAUSEA AND VOMITING, ENTRAL NERVOUS SYSTEM DEPRESSION, AND SLOWING OF RESPIRATION. SE CAUTIOUSLY OR NOT AT ALL IN CENTRAL NERVOUS SYSTEM DEPRESSION, RESPIRATORY DIFFICULTY, HYPEREXCITABILITY, AND HEPATIC ISEASE.

- MEPERIDINE HYDROCHLORIDE (DEMEROL, DOLANTIN), 50-150 MG RALLY OR INTRAMUSCULARLY.

MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL)
DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

UTE RENAL FAILURE - TREAT SHOCK. FOR HEMOLYTIC REACTIONS, IVE SODIUM BICARONATE, 5 G EVERY 1-2 HOURS AS NECESSARY TO AINTAIN AN ALKALINE URINE.

MEDICATION MUST BE GIVEN BE QUALIFIED MEDICAL PERSONNEL)
DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

IVER DAMAGE - REMOVE FROM EXPOSURE TO ALL CHEMICALS AND RUGS. MAINTAIN COMPLETE BED REST. AVOID ANESTHESIA OR SURGICAL PROCEDURES. AVOID DEHYDRATION OR OVERHYDRATION. IF VOMITING SEVERE AND ORAL FLUIDS NOT RETAINED, REPLACE VOMITUS WITH AN EQUAL QUANTITY OF 100% DEXTROSE IN NORMAL SALINE. IN RENAL FUNCTION ADEQUATE, GIVE 1 LITER OF 5% DEXTROSE OR INVERT SUGAR IN NORMAL SALINE PLUS 1-3 LITERS OF 10% DEXTROSE OR INVERT SUGAR IN DISTILLED WATER INTRAVENOUSLY EVERY TWENTY-FOUR HOURS.
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

CIRCULATORY FAILURE/SHOCK - PLACE PATIENT IN SUPINE POSITION WITH FEET ELEVATED. ESTABLISH AND MAINTAIN AN ADEQUATE AIRWAY. MAINTAIN BODY WARMTH BY APPLICATION OF BLANKENTS, BUT DO NOT APPLY EXTERNAL HEAT. RELIEVE PAIN WITH MORPHINE SULFATE 10

64

OLLABLE PAIN. DO NOT GIVE MORPHINE TO CHILDREN UNDER 5 YEAR-
AGE OR TO UNCONSCIOUS OR STUPOROUS PATIENTS. PATIENTS WITH
DEPRESSED RESPIRATION SHOULD NOT BE GIVEN MORPHINE UNLESS PER-
SONNEL AND EQUIPMENT TO MAINTAIN RESPIRATION ARE IMMEDIATELY
AILABLE. RESTORE AND MAINTAIN ADEQUATE BLOOD VOLUME. GET
URTHER MEDICAL TREATMENT IMMEDIATELY.
(MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL)
ISBACH. HANDBOOK OF POISONING, 11TH ED.)

NS
RESPIRATORY SYSTEM
NASAL SEPTUM
KIN
YES
GASTROINTESTINAL
IDNEYS
IVER
CARDIOVASCULAR SYSTEM

US OF REGULATORY ENFORCEMENT
OSHA STANDARD 29CFR1910.1200 HAZARD COMMUNICATION
REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS
CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS HAVING
WORKPLACES IN THE MANUFACTURING DIVISION, STANDARD INDUSTRIAL CLASS-
IFICATION CODES 20 THROUGH 39, TO PROVIDE INFORMATION TO THEIR EMPLOYEES
ONCERNING HAZARDOUS CHEMICALS BY MEANS OF HAZARD COMMUNICATION PROGRAMS
NCLUDING LABELS, MATERIAL SAFETY DATA SHEETS, TRAINING, AND ACCESS TO
WRITTEN RECORDS
9FR53280 11/25/83

OWING OSHA STANDARDS APPLICABLE TO SUBSTANCES LISTED 29CFR1910.
O..ERWISE ADVISE:

SHA STANDARD 29CFR1910.1000 AIR CONTAMINANTS
TABLE Z-1

SHA STANDARD 29CFR1910.94 VENTILATION

OSHA STANDARD 29CFR1910.134 RESPIRATORY PROTECTION

SHA STANDARD 29CFR1910.20 ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL
RECORDS

SHA STANDARD 29CFR1910.132 PERSONAL PROTECTIVE EQUIPMENT

OSHA STANDARD 29CFR1910.141 SANITATION

40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES
AUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES
AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO HEALTH
OR THE ENVIRONMENT ALLEGED TO HAVE BEEN CAUSED BY A SUBSTANCE OR
URE. EPA MAY INSPECT AND REQUIRE REPORTING OF SUCH RECORDS.
48FR38178 08/22/83

SHA STANDARD 29CFR1910.151 MEDICAL SERVICES AND FIRST AID

SUBSTANCE LISTED TOXIC SUBSTANCES CONTROL ACT INVENTORY

ECHNICAL ASSISTANCE DATA COMPLETED/PUBLISHED CLEAN WATER ACT (CWA) SECTION 311

TROL TECHNOLOGY DEVELOPMENT IN DEVELOPMENT/PROGRESS RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

ONTROL TECHNOLOGY DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN ATER ACT (CWA)

OURCE/EXPOSURE ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT CAA)

RISK DOCUMENTATION/ASSESSMENT COMPLETED/PUBLISHED FEDERAL NSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

MONITORING/LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT (CWA)

ONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED CLEAN AIR ACT (CAA)

ONITORING/LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

NALYTICAL METHODS DEVELOPMENT COMPLETED/PUBLISHED CLEAN AIR ACT (CAA)

ISK DOCUMENTATION/ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN ATER ACT (CWA)

NALYTICAL METHODS DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN ATER ACT (CWA)

ANALYTICAL METHODS DEVELOPMENT IN DEVELOPMENT/PROGRESS RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

CONTROL TECHNOLOGY DEVELOPMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)

CONTROL TECHNOLOGY DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

RISK DOCUMENTATION/ASSESSMENT COMPLETED/PUBLISHED SAFE DRINKING WATER ACT (SDWA)

RISK DOCUMENTATION/ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

ANALYTICAL METHODS DEVELOPMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)

RISK DOCUMENTATION/ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED FEDERAL I CTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

MONITORING/LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

CRITERIA DOCUMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT (CWA)

BSTANCES LISTED APPENDIX A - CONSENT DECREE LIST OF
DUSTRIES AND TOXIC POLLUTANTS. SETTLEMENT AGREEMENT BETWEEN
U.S. EPA AND NATIONAL RESOURCES DEFENSE COUNCIL, ET AL
.S. DISTRICT COURT DISTRICT OF COLUMBIA, JUNE 7, 1976.
ITE 8ERC2120, DDC 1976. MODIFIED MARCH 9, 1979, SITE
2ERC1833, DDC 1979 AND AGAIN ON OCTOBER 26, 1982.

STANCE LISTED RESOURCE CONSERVATION AND RECOVERY AND (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K064: ACID PLANT BLOWDOWN
SLURRY/SLUDGE RESULTING FROM THE THICKENING OF BLOWDOWN SLURRY
ROM PRIMARY COPPER PRODUCTION. (T)

SUBSTANCE SUBJECT TO REQUIREMENTS OF GENERAL INDUSTRY SAFETY ORDER
GISO) 5194 OR TITLE 8 OF CALIFORNIA ADMINSTRATIVE CODE AND DIVISION 5,
HAPTER 2.5 OF CALIFORNIA LABOR CODE

SUBSTANCE LISTED HAZARDOUS
TATE OF CALIFORNIA ADMINISTRATIVE CODE
ITLE 22. SOCIAL SECURITY
DIVISION 4. ENVIRONMENTAL HEALTH
HAPTER 30. MINIMUM STANDARDS FOR MANAGEMENT OF HAZARDOUS AND
XTREMELY HAZARDOUS WASTES

0CFR122.21 TESTING REQUIREMENTS FOR NATIONAL POLLUTANT
ISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT APPLICATIONS
APPENDIX D - TABLE III - OTHER TOXIC POLLUTANTS:
(TOTAL) METAL, (TOTAL) CYANIDE, AND (TOTAL) PHENOLS
8FR14153 04/01/83

49CFR172.101 TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION,
ROPER SHIPPING NAME, CLASS, LABEL, PACKAGING AND OTHER RE-
UIREMENTS
DESIGNATED IN HAZARDOUS MATERIALS TABLE AS HAZARDOUS MATER-
IAL (UNDER N.O.S CATEGORY) FOR THE PURPOSE OF TRANSPORTATION.
1FR15996 04/15/76
45FR34533 05/22/80 (AMENDMENT)
45FR46420 07/10/80 (AMENDMENT)
5FR62060 09/18/80 (AMENDMENT)
5FR74649 11/10/80 (AMENDMENT)
46FR17739 03/19/81 (AMENDMENT)
6FR19235 03/30/81 (AMENDMENT)

49CFR172.102 TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION,
PROPER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER RE-
UIREMENTS
DESIGNATED IN OPTIONAL HAZARDOUS MATERIALS TABLE (UNDER N.O.S.
CATEGORY) WITH ALTERNATIVES TO CORRESPONDING REQUIREMENTS IN
9CFR172.101 FOR INTERNATIONAL SHIPMENTS.
1FR15996 04/15/81
46FR29393 06/01/81 (AMENDMENT)
6FR32250 06/22/81 (AMENDMENT)

LEAN WATER ACT (CWA) SECTION 304(A)
WATER QUALITY CRITERIA FOR COPPER:
1.0 MG/L FOR DOMESTIC WATER SUPPLIES (WELFARE).
FOR FRESHWATER AND MARINE AQUATIC LIFE, 0.1 TIMES A
HOUR LC50 AS DETERMINED THROUGH NONAERATED BIOASSAY
USING SENSITIVE AQUATIC RESIDENT SPECIES.

40CFR143.3 NATIONAL SECONDARY DRINKING WATER REGULATIONS
MAXIMUM CONTAMINANT LEVEL FOR COPPER: 1 MG/L
44FR42198 07/19/79

CAL SURVEILLANCE REQUIRED
ENERAL MEDICAL HISTORY
HYSICIAN EXAMINATION
DUSTRIAL EXPOSURE HISTORY
HRONIC RESPIRATORY DISEASE
RESPIRATORY HISTORY
N EXAM
LMONARY FUNCTIONS
4 BY 17 CHEST P.A. X-RAY
INALYSIS
ISION TEST
TTENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS

IFICATIONS
ALTH STATUS CLASSIFICATION

CLEAR REG. 0041

SHA RESPIRATOR CERTIFICATION 29CFR1910.134

PARTMENT OF TRANSPORTATION IF OPERATES HEAVY EQUIPMENT

EMPLOYEE HAZARDOUS MATERIALS EDUCATION RECEIPT

PLOYEE MEDICAL RECORDS RECEIPT

OXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE
QUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL
STANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT
VERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS.
ONTACT: JACK P. MCCARTHY, OFFICE OF TOXIC SUBSTANCES,
PA 800-424-1404. 48FR38178 8/22/83

DICAL WARNING REQUIRED FOR MEDICAL EXAM REFUSAL SIGNED
EMPLOYEE

CIAL DIAGNOSTIC TESTS
RINALYSIS
IFFERENTIAL WHITE BLOOD CELL COUNT

AKS AND SPILL PROCEDURES
REPORTABLE QUANTITY OF ONE POUND APPLIES TO THIS SUBSTANCE ESTABLISHED
SECTIONS 101(14) AND 102(B) OR ADJUSTED UNDER SECTION 102(A) OF THE
OMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT
OF 1980 (CERCLA). SECTIONS 103(A) AND 103(B) REQUIRE THAT PERSONS IN
HARGE OF A VESSEL OR FACILITY FROM WHICH A HAZARDOUS SUBSTANCE HAS BEEN
ELEASED IN A QUANTITY EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY
FOR THAT SUBSTANCE IMMEDIATELY NOTIFY THE NATIONAL RESPONSE CENTER
800) 424-8802; IN THE WASHINGTON, D.C. METROPOLITAN AREA (202) 426-2675
0FR13456 04/04/85

:**

DEPARTMENT OF TRANSPORTATION HAZARD CLASS
49CFR172.101 HAZARDOUS MATERIALS TABLE

HAZARDOUS SUBSTANCE, LIQUID OR SOLID, N.O.S.
ORM-E

```
 EPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS
  49CFR172.101 (SUBJECT TO ADDITIONAL LABELING REQUIREMENTS OF
  49CFR172.402)

 ONE

    *************************************************************

INTERGOVERNMENTAL MARITIME ORGANIZATION HAZARD CLASS
  49CFR172.102 OPTIONAL HAZARDOUS MATERIALS TABLE

NONE

*************************************************************

 OLLOWING INFORMATION FROM BUREAU OF EXPLOSIVES 'EMERGENCY HANDLING OF
  HAZARDOUS MATERIALS':

  HAZARDOUS SUBSTANCE, LIQUID OR SOLID, N.O.S.
 RM-E
IF MATERIAL ON FIRE OR INVOLVED IN FIRE:
 * EXTINGUISH USING SUITABLE MATERIAL TO SURROUND FIRE
 F MATERIAL IS NOT ON FIRE AND IS NOT INVOLVED IN FIRE:
 * KEEP MATERIAL OUT OF WATER SOURCES AND SEWERS
 * BUILD DIKES TO CONTAIN FLOW AS NECESSARY
 ERSONAL DANGER SITUATION PROTECTION:
 * KEEP UPWIND
 * WEAR BOOTS, PROTECTIVE GLOVES AND GAS TIGHT GOGGLES
 * AVOID BREATHING VAPORS OR DUST
 * WASH AWAY ANY MATERIAL WHICH MAY HAVE CONTACTED THE
   BODY WITH COPIOUS AMOUNTS OF WATER OR SOAP AND WATER
 AND SPILL
 * DIG PIT, POND TO HOLD MATERIAL
 * COVER SOLIDS WITH A PLASTIC SHEET TO PREVENT DISSOLVING
   IN RAIN OR FIREFIGHTING WATER
 ATER SPILL
 * IF DISSOLVED, APPLY ACTIVATED CARBON AT 10 TIMES SPILLED
   AMOUNT AT 10 PPM OR GREATER CONCENTRATION
 * REMOVE TRAPPED MATERIAL WITH SUCTION HOSES
 * USE MECHANICAL DREDGES OR LIFTS TO REMOVE IMMOBILIZED MASSES
   OF POLLUTION AND PRECIPITATES

 TE
THIS MATERIAL LISTED AS HAZARDOUS SUBSTANCE, AS DEFINED IN SECTION
101(14) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND
 IABILITY ACT (CERCLA) OF 1980, PURSUANT TO ONE OR MORE OF THE
 OLLOWING:

  * FEDERAL WATER POLLUTION CONTROL ACT (FWPCA) SECTION 311(B)(2)(A)
  * SOLID WASTE DISPOSAL ACT SECTION 3001
  * CLEAN WATER ACT (CWA) SECTION 307(A)
  * CLEAN AIR ACT (CAA) SECTION 112
  * TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 7
  * COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY
    ACT (CERCLA) SECTION 102



 S NUMBER
 140-50-8

 ISTRY TOXIC CHEMICALS NUMBER
```

CCT CREOSOTE, COAL TAR

[illegible] Creosote oil Dead oil	Liquid Yellow to black Tarry odor May float or sink in water

Stop discharge if possible
Call fire department
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire	Combustible Extinguish with dry chemical, foam or carbon dioxide Water may be ineffective on fire
Exposure	Call for medical aid LIQUID Irritating to skin and eyes Harmful if swallowed [illegible]
Water Pollution	Effect of low concentrations on aquatic life is unknown Fouling to shoreline May be dangerous if it enters water intakes [illegible]

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG-446-4)

Issue warning—water contaminant
Mechanical containment
Should be removed
Chemical and physical treatment

2. LABELS

No label required by Code of Federal Regulations

3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:** Creosote oil
Dead oil

3.2 **Coast Guard Compatibility Classification:** Cresols

3.3 **Chemical Formula:** Mixture

3.4 **IMCO/United Nations Numerical Designation:** 9/2012

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid

4.2 **Color:** Yellow to brownish black

4.3 **Odor:** Creosote or tarry, aromatic

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Air supplied canister mask; rubber gloves; chemical safety goggles and/or face shield; overalls or a neoprene apron; barrier creams.

5.2 **Symptoms Following Exposure:** Vapors cause moderate irritation of nose and throat. Liquid causes severe burns of eyes and reddening and itching of skin. Prolonged contact with skin can cause burns. Ingestion causes salivation, vomiting, respiratory difficulties, thready pulse, vertigo, headache, loss of pupillary reflexes, hypothermia, cyanosis, mild convulsions.

5.3 **Treatment for Exposure:** INHALATION: remove victim to fresh air; if he is not breathing, give artificial respiration, preferably mouth-to-mouth; if breathing is difficult, give oxygen; call a physician. EYES: flush immediately with plenty of water for at least 15 min. and call a physician. SKIN: wipe with vegetable oil or margarine, then wash with soap and water. INGESTION: have victim drink water or milk; do NOT induce vomiting.

5.4 **Toxicity by Inhalation (Threshold Limit Value):** Data not available

5.5 **Short-Term Inhalation Limits:** Data not available

5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} 0.5 to 5 g/kg

5.7 **Late Toxicity:** Repeated exposures may cause cancer of skin

5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.

5.9 **Liquid or Solid Irritant Characteristics:** Fairly severe skin irritant. May cause pain and second-degree burns after a few minutes' contact.

5.10 **Odor Threshold:** Data not available

6. FIRE HAZARDS

6.1 **Flash Point:** > 160°F C.C.

6.2 **Flammable Limits in Air:** Not pertinent

6.3 **Fire Extinguishing Agents:** Dry chemical, carbon dioxide or foam

6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective

6.5 **Special Hazards of Combustion Products:** Data not available

6.6 **Behavior in Fire:** Heavy irritating black smoke is formed

6.7 **Ignition Temperature:** 637°F

6.8 **Electrical Hazard:** Not pertinent

6.9 **Burning Rate:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction

7.2 **Reactivity with Common Materials:** No reaction

7.3 **Stability During Transport:** Stable

7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent

7.5 **Polymerization:** Not pertinent

7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** Data not available

8.2 **Waterfowl Toxicity:** Data not available

8.3 **Biological Oxygen Demand (BOD):** Data not available

8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Witco Chemical Corporation
Pioneer Division
277 Park Avenue
New York, N.Y. 10017

2. Koppers Company, Inc.
Organic Materials Division
Koppers Building
Pittsburgh, Pa. 15219

3. Allied Chemical Corporation
Semet-Solvay Division
Ironton Tar Plant
1710 South Third Street
Ironton, Ohio 45638

10. SHIPPING INFORMATION

10.1 **Grades of Purity:** Whole creosote or various fractions depending on boiling point. All have similar properties.

10.2 **Storage Temperature:** Ambient

10.3 **Inert Atmosphere:** No requirement

10.4 **Venting:** Open (flame arrester)

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG-446-3)

A-T-U-X-Y

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Combustible liquid

12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	1
Health	
Vapor Irritant	2
Liquid or Solid Irritant	3
Poisons	2
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	1
Aesthetic Effect	4
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

12.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	2
Reactivity (Yellow)	0

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm.:** Liquid

13.2 **Molecular Weight:** Mixture

13.3 **Boiling Point at 1 atm.:** > 356°F = > 180°C = > 453°K

13.4 **Freezing Point:** Not pertinent

13.5 **Critical Temperature:** Not pertinent

13.6 **Critical Pressure:** Not pertinent

13.7 **Specific Gravity:** 1.05-1.09 at 15°C (liquid)

13.8 **Liquid Surface Tension:** (est.) 15 dynes/cm = 0.015 N/m at 20°C

13.9 **Liquid-Water Interfacial Tension:** (est.) 20 dynes/cm = 0.020 N/m at 20°C

13.10 **Vapor (Gas) Specific Gravity:** Not pertinent

13.11 **Ratio of Specific Heats of Vapor (Gas):** Not pertinent

13.12 **Latent Heat of Vaporization:** Not pertinent

13.13 **Heat of Combustion:** (est.) –12,400 Btu/lb = –6,900 cal/g = –290 X 10^5 J/kg

13.14 **Heat of Decomposition:** Not pertinent

13.15 **Heat of Solution:** Not pertinent

13.16 **Heat of Polymerization:** Not pertinent

[illegible]

NOTES

CRS

CRESOLS

Common Synonyms Cresylic acids Hydroxytoluenes Methylphenols Oxytoluenes	Watery liquid, or solid crystals	Colorless or yellow	Sweet tarry odor
	Sinks in water		

Avoid contact with liquid. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stop discharge if possible.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES MAY BE PRODUCED IN FIRE.
Wear goggles and self-contained breathing apparatus.
Extinguish with water, dry chemical, foam or carbon dioxide.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.
LIQUID
Will burn skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

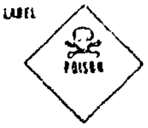
Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook, CG-446-4)
Issue warning—water contaminant, poison
Restrict access
Should be removed
Chemical and physical treatment

2. LABEL



3. CHEMICAL DESIGNATIONS

3.1 **Synonyms:**
Cresylic acids
Hydroxytoluenes
Methylphenols
Oxytoluenes
Tar acids
3.2 **Coast Guard Compatibility Classification:** Cresol
3.3 **Chemical Formula:** $CH_3C_6H_4OH$
3.4 **IMCO/United Nations Numerical Designation:** [illegible]/2022

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid or solid
4.2 **Color:** Colorless to dark yellow
4.3 **Odor:** Sweet, tarry

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic vapor canister unit (U.S.B.M. Type B) approved by U.S. Bureau of Mines; rubber gloves; chemical safety goggles; face shield; coveralls and/or rubber apron; rubber shoes or boots.
5.2 **Symptoms Following Exposure:** Vapors cause irritation of eyes, nose, and throat. Contact with skin or eyes causes severe burns. Chemical is readily absorbed through skin.
5.3 **Treatment for Exposure:** Call a physician. INHALATION: remove to fresh air. INGESTION: have victim drink water or milk; do NOT induce vomiting. SKIN OR EYES: flush immediately with plenty of water for at least 15 min.; remove contaminated clothing immediately and wash before reuse; discard contaminated shoes.
5.4 **Toxicity by Inhalation (Threshold Limit Value):** 5 ppm
5.5 **Short-Term Inhalation Limits:** Data not available
5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} [illegible] to 5 g/kg (rabbit)
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Fairly severe skin irritant; may cause pain and second-degree burns after a few minutes' contact.
5.10 **Odor Threshold:** 5 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** [illegible]°F O.C.; [illegible]°F C.C.
6.2 **Flammable Limits in Air:** LEL [illegible] (ortho); [illegible] (meta or para)
6.3 **Fire Extinguishing Agents:** Water, dry chemical, carbon dioxide, and foam
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Flammable toxic vapors given off in a fire
6.6 **Behavior in Fire:** Sealed closed containers can build up pressure if exposed to heat (fire).
6.7 **Ignition Temperature:** 1110°F (ortho-cresol); 1038°F (meta- or para-cresol)
6.8 **Electrical Hazard:** Data not available
6.9 **Burning Rate:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity with Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
[illegible] mg/l/96 hr/[illegible]/TLm/fresh water
[illegible]
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):**
ortho-cresol [illegible], 5 days
meta-cresol [illegible], 5 days
para-cresol [illegible], 5 days
8.4 **Food Chain Concentration Potential:** None

9. SELECTED MANUFACTURERS

1. Allied Chemical Corp.
Plastics Division
Morristown, N.J. 07960
2. Continental Oil Co.
Petrochemicals Department
Park 80 Plaza East
Saddle Brook, N.J. 07662
3. Koppers Co., Inc.
Organic Materials Division
Pittsburgh, Pa. [illegible]

10. SHIPPING INFORMATION

10.1 **Grades of Purity:**
U.S.P.: mixed isomers
Phenol-cresol mixtures
Orthocresol [illegible], containing phenol
Metacresol [illegible], containing other cresols and xylenols
Paracresol [illegible], containing meta-cresol
Meta-paracresol, containing ortho-cresol and xylenols

11. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook, CG-446-3)
A-P-O-T-U-X-Y

12. HAZARD CLASSIFICATIONS

12.1 **Code of Federal Regulations:** Poisonous liquid or solid, Class B
12.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	1
Health	
Vapor Irritant	2
Liquid or Solid Irritant	3
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	4
Reactivity	
Other Chemicals	2
Water	0
Self Reaction	0

12.3 **NFPA Hazard Classification:**

Category	Classification	
	ortho	meta and para
Health Hazard (Blue)	3	3
Flammability (Red)	2	1
Reactivity (Yellow)	0	0

13. PHYSICAL AND CHEMICAL PROPERTIES

13.1 **Physical State at 15°C and 1 atm:** Liquid
13.2 **Molecular Weight:** [illegible]
13.3 **Boiling Point at 1 atm:**
[illegible]
13.4 **Freezing Point:** Not pertinent
13.5 **Critical Temperature:** Not pertinent
13.6 **Critical Pressure:** Not pertinent
13.7 **Specific Gravity:** [illegible] at 20°C (liquid)
13.8 **Liquid Surface Tension:**
37 dynes/cm = 0.037 N/m at 20°C
13.9 **Liquid-Water Interfacial Tension:**
Data not available
13.10 **Vapor (Gas) Specific Gravity:**
Not pertinent
13.11 **Ratio of Specific Heats of Vapor (Gas):**
[illegible]
13.12 **Latent Heat of Vaporization:**
[illegible] Btu/lb = [illegible] cal/g = [illegible] J/kg
13.13 **Heat of Combustion:**
[illegible] Btu/lb
= [illegible] cal/g
= [illegible] J/kg
13.14 **Heat of Decomposition:** Not pertinent
13.15 **Heat of Solution:** Not pertinent
13.16 **Heat of Polymerization:** Not pertinent

[illegible]

10. SHIPPING INFORMATION (Cont'd)

Resin grade cresols containing phenols and xylenols
Cresylic acids containing xylenols, cresols and phenols
10.2 **Storage Temperature:** Ambient
10.3 **Inert Atmosphere:** No requirement
10.4 **Venting:** Open

REVISED 1978

```
[illegible]
NAME
ENTER CHEMICAL NAME
```

124

```
HYDROGEN CYANIDE
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
SYNM

SYNONYMS
   HYDROCYANIC ACID
   PRUSSIC ACID
   HYDROGEN CYANIDE, ANHYDROUS, STABILIZED
   UN 1614
   UN 1613
   HYDROCYANIC ACID, LIQUEFIED
   UN 1051
   NA 1051
   AERO LIQUID HCN
   CYCLON
   CYCLONE B
   HCN
   ZACLONDISCOIDS
   FORMONITRILE
   CARBON HYDRIDE NITRIDE
   FORMIC ANAMMONIDE
   EVERCYNE
   EVERCYN
   OHS11160
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
EXPO

PERMISSIBLE EXPOSURE LIMIT
   10 PPM OSHA TWA (SKIN NOTATION)
   10 PPM ACGIH CEILING
   5 MG/M3 NIOSH RECOMMENDED 10 MINUTE CEILING
   ODOR THRESHOLD 1 MG/M3
   REPORTABLE QUANTITIES - 10 LB CWA 311(B)(4) - 1 LB RCRA 3001 -
   10 LB PROPOSED RQ
   CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 3 - REACTIVITY 2 -
   PERSISTENCE 0
   CROP TOLERANCES (40 CFR 180.130) PPM - ALLSPICE 250, ALMONDS 25,
   ANISE 250, BARLEY 75, BEANS 25, OATS 75, PEANUTS 25, PEAS 25, RICE 75,
   RYE 75, SAGE 250, SAVORY 250, THYME 250, TUMERIC 250, WALNUTS 25,
   WHEAT 75, WHITE PEPPER 250, CORN 75, CLOVES 250, CITRUS FRUITS 50

   TOXICOLOGY:  HYDROGEN CYANIDE IS A CHEMICAL ASPHYXIANT.  THE MAJOR
   SYMPTOMS OF POISONING ARE RAPID HYPOTENSION, CONVULSIONS AND COMA.
     ACUTE INHALATION OR HYDROGEN CYANIDE GAS OR SKIN CONTACT WITH LIQUID
```

```
LOWER CONCENTRATIONS, SYMPTOMS ARE HEADACHE, WEAKNESS, [illegible]
 CONFUSION, AND [illegible]. NAUSEA AND VOMITING. RESPIRATION [illegible]
AT FIRST, THEN LATER BECOMES SLOW WITH GASPING.
  CHRONIC INHALATION RESULTS IN DIZZINESS, WEAKNESS, LUNG CONGESTION,
HOARSENESS, CONJUNCTIVITIS, LOSS OF APPETITE, WEIGHT LOSS, AND MENTAL
DETERIORATION.  CHRONIC POISONING IS RARE.
  AT HIGH CONCENTRATIONS, THE ODOR OF CYANIDE DOES NOT PROVIDE ADEQUATE
WARNING.  AT LOW LEVELS, A FEW INDIVIDUALS MAY DETECT THE ODOR.
  THE THRESHOLD LIMIT VALUE WAS SET TO PREVENT UPPER RESPIRATORY TRACT
IRRITATION, SUCH AS EPISTAXIS AND NASAL ULCERATION.
ORL-HMN LDLO: 570 UG/KG
IHL-HMN LCLO: 120 MG/M3/1 HR
IHL-HMN LCLO: 200 MG/M3/10 MIN
SCU-HMN LDLO:   1 MG/KG
IVN-HMN LD50:   1 MG/M3
UNK-MAN LDLO:1471 UG/KG
ORL-RAT LDLO:  10 MG/KG
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
IDLH

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONCENTRATION
  50 PPM
  OSHA/NIOSH
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
DESC

PHYSICAL DESCRIPTION
  COLORLESS GAS OR WATER-WHITE LIQUID. FAINT ODOR OF BITTER ALMONDS.
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
PHYP

CHEMICAL AND PHYSICAL PROPERTIES
  MOLECULAR WEIGHT: 27
  BOILING POINT AT 1 ATM, F: 79 F
  SOLUBILITY IN WATER, G/100 G WATER AT 20C: SOLUBLE
  FLASH POINT, CLOSED CUP, F (OR OPEN CUP IF OC): 0 F
  VAPOR PRESSURE @ 20 C, MMHG: 620 MM
  MELTING POINT, F: 7 F
  UPPER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: 40.0%
  LOWER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: 5.6%
  AUTOIGNITION TEMPERATURE: 1000 F
  SPECIFIC GRAVITY: 0.699 AT 70 F
  VAPOR DENSITY (AIR=1): 0.95
  ODOR THRESHOLD: 1.0 PPM
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
INCO

INCOMPATIBILITIES
  CAUSTICS
  AMINES
  OXYGEN
  OXIDIZERS
  PEROXIDES
  ACETALDEHYDE
  PLASTICS
  ACIDS
  DUST/VAPORS MAY FORM EXPLOSIVE MIXTURE WITH AIR
  HEAT
  THERMAL DECOMPOSITION PRODUCTS ARE HAZARDOUS AND/OR TOXIC
  POLYMERIZES AT HIGH TEMPERATURES
```

```
   STEAM
   STRONG BASES
   SPONTANEOUSLY FLAMMABLE IN AIR
TYPE WHAT INFORMATION YOU REQUIRE:
 ALL , SPECIFIC INFORMATION (BY 4-LETTER COMMAND), (HELP), OR (NONE).
CLOT

PERSONAL PROTECTIVE EQUIPMENT
  FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES
   FOR CHEMICAL HAZARDS':

  PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH LIQUID
    WEAR IMPERVIOUS CLOTHING
    WEAR GLOVES
    WEAR FACESHIELD (8 INCH MINIMUM)

  PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL
    LAUNDERED OR DISCARDED
  IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF
    CONTAMINANT'S HAZARDOUS PROPERTIES

                                  --  --  --

  ACGIH 'GUIDELINES FOR SELECTION OF CHEMICAL PROTECTIVE
  CLOTHING' INDICATES THE FOLLOWING MATERIALS AND
  PROTECTIVE RATINGS BY INDEPENDENT VENDORS AGAINST
  HYDROCYANIC ACID:
    EXCELLENT/GOOD:
  NONE INDICATED

    GOOD/FAIR:
  BUTYL RUBBER
  NEOPRENE
  POLYVINYL CHLORIDE
  VITON
TYPE WHAT INFORMATION YOU REQUIRE:
(ALL), SPECIFIC INFORMATION (BY 4-LETTER COMMAND), (HELP), OR (NONE).
PPRO

SPECIFIC EMERGENCY PROVISIONS
  EYE-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES' EYES MAY
    BE EXPOSED TO SUBSTANCE
  QUICK DRENCHING FACILITIES WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES
    MAY BE EXPOSED TO SUBSTANCE
TYPE WHAT INFORMATION YOU REQUIRE:
 ALL , SPECIFIC INFORMATION (BY 4-LETTER COMMAND),  HELP , OR  NONE/.
RESP

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

50 PPM
   - SUPPLIED-AIR RESPIRATOR
   - SELF-CONTAINED BREATHING APPARATUS


50 PPM
   - SUPPLIED-AIR SUITS TO PREVENT SKIN CONTACT AND AUXILIARY SELF-
     CONTAINED BREATHING APPARATUS
   - SELF-CONTAINED BREATHING APPARATUS
     WITH A FULL FACE-PIECE
     OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
   - SUPPLIED-AIR SUITS TO PREVENT SKIN CONTACT AND AUXILIARY SELF-
     CONTAINED BREATHING APPARATUS
   - TYPE 'C' SUPPLIED-AIR RESPIRATOR
     WITH A FULL FACE-PIECE
```

```
      AND
   - AUXILIARY SELF-CONTAINED BREATHING APPARATUS
     OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE


ESCAPE
   - GAS MASK
     PROVIDING PROTECTION AGAINST SPECIFIC COMPOUND OF CONCERN
     (CHIN-STYLE OR FRONT- OR BACK-MOUNTED CANISTER)
   - SELF-CONTAINED BREATHING APPARATUS


FIREFIGHTING
   - SELF-CONTAINED BREATHING APPARATUS
     WITH A FULL FACE-PIECE
     OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE



TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
ROUT

ROUTE OF ENTRY INTO BODY
  INHALATION
  SKIN ABSORPTION
  INGESTION
  SKIN OR EYE CONTACT
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
SYMP

SYMPTOMS
  SKIN IRRITATION
  EYE IRRITATION
  MUCOUS MEMBRANE IRRITATION
  RESPIRATORY IRRITATION
  DERMATITIS
  WEAKNESS
  HEADACHE
  PHARYNGITIS
  ANOREXIA
  WEIGHT LOSS
  RESPIRATORY EDEMA
  OPISTHOTONUS
  NAUSEA
  VOMITING
  METHEMOGLOBINEMIA
  COLLAPSE
  CONFUSION
  VERTIGO
  RESPIRATORY DISTRESS
  CYANOSIS
  CONVULSIONS
  PARALYSIS
  ASPHYXIA
  GASPING
  UNCONSCIOUSNESS
  DIZZINESS
  HYPOTENSION
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
```

```
ORGANS
   BLOOD
   CENTRAL NERVOUS SYSTEM
   CARDIOVASCULAR SYSTEM
   GASTROINTESTINAL
   RESPIRATORY SYSTEM
   EYES
TYPE WHAT INFORMATION YOU REQUIRE:
 /ALL/. SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/. OR /NONE/.
NONE
ENTER NAME. KEYWORD. SYMPTOM. STLA. NAMELIST, HELP. OR QUIT
```

DIBENZ(a,h)ANTHRACENE

CAS RN: 53703 NIOSH #: HN 2625000
mf: $C_{22}H_{14}$; mw: 278.36

SYNS:
1,2,5,6-DIBENZANTHRACEEN (DUTCH)
1,2:5,6-DIBENZANTHRACENE
DIBENZO(A,H)ANTHRACENE

TOXICITY DATA: 3	CODEN:
mma-sat 10 ug/plate	PNASA6 72,5135,75
mrc-esc 25 ug/well	MUREAV 46,53,77
sln-dmg-par 5 mmol/L	EJGCA9 4,400,75
mmo-nsc 500 ppm	ANYAA9 71,1072,58
dns-hmn:fbr 1 mg/L	CNREA8 38,2091,78
dns-hmn:hla 100 nmol/L	CNREA8 38,2621,78
dnd-mus:lvr 6 umol/L	JNCIAM 62,947,79
dnd-mus-skn 1 gm/L	CNREA8 27,1678,67
mma-ham:lng 56400 nmol/L	MUREAV 46,27,77
otr-ham:emb 2500 ug/L	CNREA8 32,1391,72
dnd-ham:fbr 5 mg/L/24H	BCPCA6 20,1297,71
cyt-ham:fbr 1 mmol/L	PJACAW 53,46,77
sce-ham-ipr 900 mg/kg/24H	MUREAV 66,65,79
msc-ham:lng 1 mg/L	PNASA6 73,188,76
dnd-mam:lym 2 nmol/L	JMOBAK 5,521,62
scu-rat TD:2400 ug/kg/50D-I:NEO	85DLAB -,-,75
orl-mus *TDLo:360 mg/kg/43W-I:ETA*	*VRRAAT 20,276,38*
skn-mus TDLo:1200 mg/kg/50W-I:CAR	14JTAF -,275,64
scu-mus TDLo:78 ug/kg:NEO	JNCIAM 3,503,43
ivn-mus TDLo:10 mg/kg:ETA	JNCIAM 1,225,40
imp-mus TDLo:80 mg/kg:CAR	BJCAAI 11,212,57
scu-gpg TDLo:250 mg/kg/24D-I:ETA	AKBNAE 51,112,38
ivn-gpg TDLo:30 mg/kg:ETA	JNCIAM 13,705,52
ims-pgn TDLo:6 mg/kg:CAR	JNCIAM 32,905,64
im-frg TDLo:12 mg/kg:NEO	CNREA8 24,1969,64
imp-mus TD:14 mg/kg:NEO	AJPAA4 16,287,40
scu-mus TD:16 mg/kg:NEO	JNCIAM 44,641,70
scu-rat TD:450 ug/kg:ETA	BAFEAG 30,66,42
imp-mus TD:200 mg/kg:NEO	AJCAA7 36,201,39
skn-mus TD:6 ug/kg:NEO	CNREA8 20,1179,60
scu-mus TD:20 mg/kg:ETA	CNREA8 22,78,62
skn-mus TD:400 mg/kg/40W-I:NEO	CNREA8 22,78,62
imp-mus TD:100 mg/kg:CAR	BMBUAQ 14,147,58
scu-rat TD:135 mg/kg/9W-I:NEO	PSEBAA 68,330,48
scu-mus TD:400 mg/kg/10W-I:NEO	IJCNAW 2,500,67
ivn-mus LDLo:10 mg/kg	JNCIAM 1,225,40
dnd-sal:tes 5 ug/1H-C	BIJOAK 110,159,68
dnd-hmn:emb 360 nmol/L	CBINA8 22,257,78
otr-ham:kdy 25 ug/L	TOLED5 7,143,80
dnd-ham:emb 360 nmol/L	CBINA8 22,257,78
dnd-ham:kdy 5 mg/L	BCPCA6 20,1297,71

Carcinogenic Determination: Animal Positive IARC** 3,178,73. *Toxicology Review:* AEHLAU 23,6,71; MUREAV 39,257,77. Reported in EPA TSCA Inventory, 1980. EPA TSCA 8(a) Preliminary Assessment Information Proposed Rule FERREAC 45,13646,80.
THR: MUT data. An exper CARC, NEO, ETA. HIGH ivn.
Disaster Hazard: When heated to decomp it emits acrid smoke and irr fumes.

DIBENZ(a,j)ANTHRACENE

CAS RN: 224419 NIOSH #: HN 2800000
mf: $C_{22}H_{14}$; mw: 278.36

SYN: 1,2:7,8-DIBENZANTHRACENE

TOXICITY DATA: 3	CODEN:
mma-sat 1 ug/plate	MUREAV 51,311,78
skn-mus TDLo:252 mg/kg/81W-I:ETA	JNCIAM 44,641,70
scu-mus TDLo:4 mg/kg:ETA	JNCIAM 1,45,40
skn-mus TD:1250 mg/kg/52W-I:ETA	PRLBA4 117,318,35
scu-mus TD:16 mg/kg:ETA	JNCIAM 44,641,70
scu-mus TD:4 mg/kg:ETA	JNCIAM 1,45,40

Toxicology Review: 85DHAX Pc,4,72.
THR: MUT data. An exper ETA.
Disaster Hazard: When heated to decomp it emits acri smoke and irr fumes.

1,2,5,6-DIBENZANTHRACENE-CHOLEIC ACID

NIOSH #: FZ 22200
mf: $C_{96}H_{160}O_{16} \cdot C_{22}H_{14}$; mw: 1848.92

TOXICITY DATA: 3	CODEN:
scu-mus TDLo:800 mg/kg/9W-I:ETA	JNCIAM 2,99,41

THR: An exper ETA.
Disaster Hazard: When heated to decomp it emits acr smoke and irr fumes.

DIBENZ(a,h)ANTHRACENE-5,6-cis-DIHYDRODIOL

CAS RN: 3719399 NIOSH #: HN 4250
mf: $C_{22}H_{16}O_2$; mw: 312.38

SYN: DBA-5,6-CIS-DIHYDRODIOL

TOXICITY DATA:	CODEN:
otr-ham:emb 2500 ug/L	CNREA8 32,1391,72

THR: MUT data.
Disaster Hazard: When heated to decomp it emits acr smoke and irr fumes.

1,2,5,6-DIBENZANTHRACENE-9,10-ENDO-alpha,beta-SUCCINIC ACID

NIOSH #: KJ 46300
mf: $C_{26}H_{18}O_4$; mw: 394.44

SYN: 7,14-DIHYDRO-7,14-ETHANODIBENZ(A,H)ANTHRACENE-15,1 DICARBOXYLICACID

TOXICITY DATA. 3	CODEN.
mmo-esc 2040 mg/L/4H	GENTAE 39,141,54
scu-rat TDLo:665 mg/kg/50D-I:CARC	85DLAB -,-,75

THR: An exper CARC. MUT data.
Disaster Hazard: When heated to decomp it emits ac smoke and irr fumes.

DIBENZ(a,h)ANTHRACEN-5-OL

CAS RN: 4002760 *NIOSH #:* HN 578
mf: $C_{22}H_{14}O$; mw: 294.36

SYN: 5-HYDROXY-DIBENZ(A,H)ANTHRACENE

TOXICITY DATA:	CODEN:
otr-ham:emb 1 mg/L	CNREA8 32,1391,72
dnd-ham:kdy 5 mg/L	BCPCA6 20,1297,71

sacrifice of the highest dosed group were elevated although no histologic changes were evident.

Inhalation exposure of five rats to DBAE six hours daily, five days per week at 70 ppm for one week resulted in the death of one rat, a 57% average body weight loss for the group, a two-fold increase in liver and kidney-to-body-weight ratio, a 10-fold increase in total serum bilirubin, a slight increase in clotting time and an elevated hematocrit.(3) Inhalation exposure at 33 ppm for one week resulted in a 3% body weight loss, no significant changes in liver and kidney weights, slight increase in clotting time, but no changes in serum bilirubin or in hematocrit. Exposure for 27 weeks at 22 ppm DBAE resulted in no differences in the variables measured compared with controls.

DBAE, as well as DEA and other 2-aminoethanols inhibit acetylcholinesterase in vitro, the degree of inhibition being related to the number of carbon atoms attached to the nitrogen head of the molecule. Thus DBAE is a more potent inhibitor than DEA.

In view of the approximately 10-fold greater toxicity of DBAE than DEA, which has a TLV of 10 ppm based on irritation, and in view of the inhalation *no-health-effect* level of DBAE of 22 ppm, a TLV of 2 ppm for DBAE is recommended. This limit is believed to be sufficiently low to protect against systemic effects. Information is not available from which to judge whether 2 ppm will cause irritation. A STEL of 4 ppm is also recommended.

References:

1. **Hartung, R., Cornish, H.H.:** *Tox. Appl. Pharm.* 12:486 (1968).
2. **Smyth, H.F. Jr.** *et al: Arch. Ind. Hyg. & Occup. Med.* 10:6[illegible] (1954).
3. **Cornish, H.H., Dambrauskas, T., Beatty, L.D.:** *Am. Ind. Hyg. Assoc. J.* 30:46 (1969).

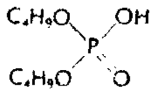
DIBUTYL PHOSPHATE

Di-n-butyl phosphate

$(n\text{-}C_4H_9O)_2(OH)PO$

TLV, 1 ppm (≈ 5 mg/m³)

STEL, 2 ppm (≈ 10 mg/m³)



Dibutyl phosphate is a pale amber liquid with a molecular weight of 210.21. It decomposes at temperatures above 100° C and has a vapor pressure of ≤ 1 mm Hg at 20° C. It is insoluble in water and is a moderately strong monobasic acid.(1)

It is encountered in industrial operations as an organic catalyst and an antifoaming agent.

Although no published reports have appeared on the effects of exposure to this chemical, some workers exposed to it have complained of repiratory tract irritation and headache at relatively low levels.(2)

A TLV of 1 ppm and a STEL of 2 ppm are recommended, but it is possible that this limit is not sufficiently low to prevent sensory effects.

References:

1. **Albright and Wilson (Mfg.) Limited:** Brochure, *Organo Phosphorus Compounds*, London, England (November 1960).
2. **Mastromatteo, E.:** Personal communication to TLV Committee (1964).

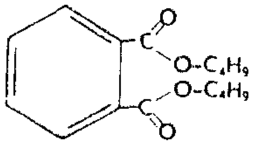
DIBUTYL PHTHALATE

n-Butyl phthalate; DBP

$C_6H_4(CO_2C_4H_9)_2$

TLV, 5 mg/m³

STEL, 10 mg/m³



Dibutyl phthalate is a colorless, odorless, very stable, oily liquid with a molecular weight of 278.34 and a specific gravity at 20° C of 1.0484. It has a distillation range between 227 and 235° C, a freezing point of −35° C and a vapor pressure of ≤ 0.1 mm Hg at 20° C. The closed cup flash point is 315° F, autoignition temperature is approximately 750° F and is combustible. It is miscible with common organic solvents, but insoluble in water.

It is used as in insect repellant for the impregnation of clothing.(1)

The acute oral LD_{50} in the rat is 8-16 g/kg. When rats were dosed twice weekly with dibutyl phthalate (1 mL/kg of body weight of a solution in oil) for a period of 6 weeks no adverse effects were reported. Another group of rats were maintained on this regimen for 1.5 years without any adverse effects on the parameters studied which included hematology, pathology of organ tissues, and organ weights.(2) Smith(3) reported the maximal concentration that did not inhibit growth of rats in a chronic one-year finding study was 0.25% of the diet. In vitro studies with pancreatic lipase indicated that dibutyl phthalate is metabolized similarly to fat in the diet, however, rats given dibutyl phthalate orally excreted the monobutyl ester as the principal metabolite in the urine with phthalic acid as the secondary metabolite.(4)

Soviet experimenters found(5) that a 2-hour exposure of mice to an aerosol of dibutyl phthalate resulted in irritation of the eyes and upper respiratory tract mucous membranes at exposure levels around 250 mg/m³. At the higher levels, labored breathing, ataxia, paresis, convulsions, and death from paralysis of the respiratory system. The LC_{50} (exposure time not stated) was given as 25,000 mg/m³, and the threshold for more sensitive responses as 4 mg/m³, including changes in the numbers of the formed elements of the blood. Similar findings from acute exposures of animals, either by inhalation or topically, were made by another Soviet investigator,(6) dibutyl, diethyl, dimethyl and dioctyl phthalates were considered nontoxic and nonirritant (levels not stated in abstract).

Cagianot(7) reported that a chemical operator who swallowed by accident 10 g (ca. 140 mg/kg) dibutyl phthalate became nauseated and dizzy, experienced photophobia, lacrimation and conjunctivitis, but made a prompt and uneventful recovery.

In a preliminary study of exposure of 150 to 250 workers to vapors in air mixtures of diethyl phthalate, dibutyl phthalate and di-2-ethyl hexyl phthalate, 19 personal air samples (collected in breathing zone of employees), 4 hours duration each, were taken over 8 different days at a number of locations in the vicinity of the operations. The results of the air analysis ranged from 1-6 ppm, (8-15 mg/m³). In a diagnostic multiphasic testing operation, no phthalates in blood were found before and after the phthalate exposure and no peripheral polyneuritis was observed in the population.(8)

From the standpoint of hazard by inhalation, dibutyl phthalate should present little problem because of low vapor pressure, inhalation of significant amounts would occur only by spray or mist exposures. Its wide use as an insect repellent for man during World War II resulted in no report of toxic symptoms.

A TLV of 5 and a STEL of 10 mg/m³ are recommended for dibutyl phthalate based on its low order to toxicity. There are no reports that this level will cause either irritation or systemic effects in workers.

References:

1. *Merck Index*, 9th ed., p. 202, Merck & Co., Inc., Rahway, NJ (1976).
2. **Bornmann, G.** *et al.* Behavior of the Organism as Influenced by Various Plasticizers. *Z. Lebens.-Unters. Forsch. 103*:413 (1956).
3. **Smith, C.C.:** *Arch. Ind. Hyg. & Occup. Med. 7*:310 (1953).
4. **Chambon, P.** *et al.* Etude du Metabisme des Phthalates de Dibutyle et de Diethyle Chez le Rat. *C.R. Acad. Sci. (D) (Paris) 273*:2165 (1971).
5. **Varonin, A.P.:** *Zh. Khim. Abstr. No. 91523* (1973).
6. **Timofievskaya, L.A.:** Abstract Trans. from *Toksikol. Gig. Prod. Neftekhim. Neftekhim. Proizvod.* 2nd Publ., p. 206 (1972).
7. **Cagianot, B.:** *Schweiz Med. Wochschr. 84*:1243 (1954).
8. **Raleigh, Robert, Dr.:** Personal communication to TLV Committee from Eastman Kodak Co., Rochester, NY.

DICHLOROACETYLENE

$ClC\equiv CCl$

CEILING LIMIT, 0.1 ppm (≈ 0.4 mg/m³)

Dichloroacetylene has a molecular weight of 94.93. It has a melting range between −66 and −64.2° C and explodes upon boiling. It is soluble in alcohol, ether and acetone.

Dichloroacetylene may be generated by thermal decomposition of trichloroethylene, as in the faulty operation of catalytic burners at below optimal operating temperatures (450° F). Similarly, in closed circuit anesthesia, using trichloroethylene, sufficient heat and moisture may be produced from the soda-lime absorption of carbon dioxide to develop fatal quantities of dichloroacetylene in conjunction with phosgene and carbon monoxide.(1) Or dichloroacetylene can be synthesized by passing trichloroethylene over any one of several alkaline materials at a temperature of 70° C.(2)

Very preliminary exposures of guinea pigs indicated a four-hour LC_{50} at approximately 20 ppm, death occurring two or three days later from pulmonary edema. A similar exposure of rats indicated an LC_{50} of 55 ppm dichloroacetylene in the presence of 330 ppm trichloroethylene.(3)

When mixed with 9 parts of ether, the 4-hour rat LC_{50} was 219 ppm, that for guinea pigs, 52 ppm.(6) With 7 parts trichloroethylene the 4-hour LC_{50} for rats was 55 ppm, while with 10 parts trichloroethylene the 4-hour LC_{50} for guinea pigs was 15 ppm.(6)

The signs and symptoms of dichloroacetylene response are characteristic: headache, loss of appetite, extreme nausea, vomiting, involvement of the trigeminal nerve and facial muscles and the "lighting up" of facial herpes.

Disabling nausea occurred among individuals exposed for prlonged periods at about 0.5 to 1 ppm of dichloroacetylene. Of those exposed, at least 85% were so affected.(2)

A number of fatalities attributed to dichloroacetylene have been reported by British physicians in the 1940's.(4,5) Humphrey and McClelland(4) reported on 13 cases of cranial nerve palsy, 9 with labial herpes following exposure to dichloroacetylene as a decomposition product of trichloroethylene. Other symptoms included extreme nausea, headache, intense pain in the jaw and vomiting. All cases showed a definite incubation period ranging from 24 hours to three days. One patient died on the third day and another on the sixteenth day with autopsies showing edema at the base of the brain.

Dichloroacetylene seems to have a different order of toxicity than most chlorinated hydrocarbons. A ceiling limit no higher than 0.1 ppm appears necessary to prevent disabling nausea and other more serious systemic effects. Whether this TLV is low enough to provide adequate protection against prolonged occupational exposure is uncertain.

Personal Protective Methods: Wear appropriate clothing to prevent any possibility of skin contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash immediately when skin is wet or contaminated. Remove clothing immediately if wet or contaminated to avoid flammability hazard. Provide emergency showers and eyewash.

Respirator Selection:

25 ppm: SAF/SCBAF
50 ppm: SAF:PD,PP,CF
Escape: GMSF/SCBAF

Disposal Method Suggested: Controlled incineration (oxides of nitrogen are removed from the effluent gas by scrubbers and/or thermal devices).

References

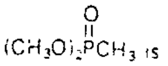
(1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Hydrazines,* NIOSH Doc. No. 78-172, Washington, DC (1978).

(2) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans,* Lyon, France 4, 137 (1974).

(3) See Reference (A-60).

(4) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 4,* No. 3, 60-67, New York, Van Nostrand Reinhold Co. (1984).

DIMETHYL METHYLPHOSPHONATE

Description:  $(CH_3O)_2P(=O)CH_3$ is a colorless liquid which boils at 180°C at 760 mm pressure.

Code Numbers: CAS 756-79-6 RTECS SZ912000

DOT Designation: –

Synonyms: Phosphonic acid, methyl-, dimethyl ester; DMMP.

Potential Exposure: May be used as a gasoline additive, hydraulic fluid additive, as a heavy metal extractor, as a solvent, as a simulant for nerve gas agents, and as an additive flame retardant in plastics.

Permissible Exposure Limits in Air: No standards set.

Permissible Concentration in Water: No criteria set.

Harmful Effects and Symptoms: DMMP is not very toxic; the oral LD-50 in mice and rats is greater than 5,000 mg/kg. There are some indications of alteration in reproductive functions of rats exposed to doses of 250 mg/kg, however.

References

(1) U.S. Environmental Protection Agency, *Chemical Hazard Information Profile Draft Report: Dimethyl methylphosphonate* Washington, DC (September 2, 1983).

2,4-DIMETHYLPHENOL

- Hazardous substance (EPA)
- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

Description: $C_8H_{10}O$, $HOC_6H_3(CH_3)_2$, **is a colorless crystalline solid melting** at 27° to 28°C. The 2,4-isomer is one of 5 isomers of this formula.

Code Numbers: CAS 105-67-9 RTECS ZE5600000

DOT Designation: —

Synonyms: 2,4-Xylenol; 1-hydroxy-2,4-dimethylbenzene; m-xylenol; 2,4-DMP.

Potential Exposure: 2,4-DMP finds use commercially as an important chemical feedstock or constituent for the manufacture of a wide range of commercial products for industry and agriculture. 2,4-Dimethylphenol is used in the manufacture of phenolic antioxidants, disinfectants, solvents, pharmaceuticals, insecticides, fungicides, plasticizers, rubber chemicals, polyphenylene oxide, wetting agents, and dyestuffs, and is an additive or constituent of lubricants, gasolines, and cresylic acid. 2,4-Dimethylphenol (2,4-DMP) is a naturally occurring, substituted phenol derived from the cresol fraction of petroleum or coal tars by fractional distillation and extraction with aqueous alkaline solutions. It is the cresylic acid or tar acid fraction of coal tar.

Workers involved in the fractionation and distillation of petroleum or coal and coal tar products comprise one group at risk. Workers who are intermittently exposed to certain commercial degreasing agents containing cresol may also be at risk. Cigarette and marijuana smoking groups and those exposed to cigarette smoke inhale μg quantities of 2,4-dimethylphenol. The National Institute for Occupational Safety and Health has estimated that 11,000 people in the United States are occupationally exposed to cresol containing 2,4-dimethylphenol.

Permissible Exposure Limits in Air: No standards set.

Permissible Concentration in Water: To protect freshwater aquatic life—2,120 μg/ℓ on an acute toxicity basis. To protect saltwater aquatic life—no criterion established due to insufficient data. To protect human health—in view of the relative paucity of data on the mutagenicity, carcinogenicity, teratogenicity and long term oral toxicity of 2,4-dimethylphenol, estimates of the effects of chronic oral exposure at low levels cannot be made with any confidence. It is recommended that studies to produce such information be conducted before limits in drinking water are established. A criterion of 400 μg/ℓ is suggested by EPA (1) on an organoleptic basis.

Determination in Water: Methyl chloride extraction followed by gas chromatography with flame ionization or electron capture detection (EPA Method 604) or gas chromatography plus mass spectrometry (EPA Method 625).

Harmful Effects and Symptoms: 2,4-Dimethylphenol appears to be a topical cocarcinogen, but its role as a primary cancer-producing agent is uncertain. Its potential role in cancer production warrants consideration of further testing. An in vitro mutagenicity assay should be carried out to further evaluate its mutagenic potential.

Disposal Method Suggested: Incineration.

Reference

(1) U.S. Environmental Protection Agency, *2,4-Dimethylphenol: Ambient Water Quality Criteria*, Washington, DC (1980).
(2) U.S. Environmental Protection Agency, *2,4-Dimethylphenol*, Health and Environmental Effects Profile No. 87, Washington, DC, Office of Solid Waste (April 30, 1980).

quired an 8-hour exposure at about 6000 ppm (35° C) to kill four of six rats. Signs of gross overexposure were varying degrees of ataxia, prostration, and respiratory distress followed by narcosis. Those that survived appeared to recover without significant signs of exposure.(1)

Shell Chemical Corporation(1) presents the following observations in respect to sensory responses reported by unconditioned personnel during or following 5-minute exposures to the vapor:

Threshold odor	6 ppm
50% Threshold, eye irritation	50 ppm
50% Threshold, nose irritation	50 ppm

No incidents of illness caused by industrial handling of EAK have been reported. Workers may complain of odor and transient eye irritation when handled in poorly ventilated areas when the concentration exceeds 25 ppm, but experience shows that transient responses do not lead to significant systemic effects.(1)

Accordingly, the TLV of 25 ppm is recommended as a comfort level for unconditioned workers.(2)

References:

1. *Industrial Hygiene Bulletin SC 57 59*, Shell Chemical Corporation, NY (March 1958).
2. Communication from O. M. Banks, Ind. Hygienist, Shell Chemical Corporation, (May 23, 1965).

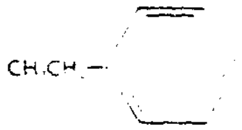
ETHYL BENZENE

Phenylethylene

C_8H_{10}

TLV, 100 ppm (≈ 435 mg/m³)

STEL, 125 ppm (≈ 545 mg/m³)



Ethyl benzene is a colorless, flammable liquid with an aromatic odor. It has a molecular weight of 106.16, a specific gravity of 0.86256 at 25° C and a vapor pressure of 7.1 mm Hg at 20° C. The vapor density is 3.7 times that of air. Saturated air with the vapor at 25° C and 760 mm is 1.32%. It boils at 136.2° C and freezes at −95.01° C. The closed cup flash point is 63° F; autoignition temperature is 810° F and is a fire risk. Ethyl benzene is only slightly soluble in water at 15° C (14 mg/100 mL), but is miscible with alcohol and ether.

This compound is employed as a solvent and as an intermediate in the production of styrene.

Ethyl benzene toxicity is characterized by its irritancy to the skin, and less markedly, to the mucous membranes. Repeated application of the liquid to the skin of rabbits causes reddening and some exfoliation and blistering. Oettel(3) characterized ethyl benzene as the most severe irritant of the benzene series.

On the eyes and nose, the vapor at 5000 ppm causes intolerable irritation; at 2000 ppm, eye irritation and lacrimation are immediate and severe, and are accompanied by moderate nasal irritation, decreasing somewhat in several minutes; at 1000 ppm, irritation and tearing, but tolerance develops rapidly; and at 200 ppm, the vapor has a transient irritant on human eyes.(4)

Like benzene, its acute toxicity is low; the dose fatal to guinea pigs in a few minutes was 10,000 ppm(4) and 5000 ppm dangerous to life in 30 to 60 minutes, animals dying from exposure had intense congestion and edema of the lungs, and generalized visceral hyperemia. The narcotic dose for animals was 10,000 ppm, reached in 18 minutes, preceded by vertigo, unsteadiness and ataxia.

Chronic inhalation exposure of guinea pigs, monkeys, rabbits and rats at concentrations from 400 ppm to 2,200 ppm, seven to eight hours/day, five days/week for as long as six months, produced no effects in all species except the rat, which showed a slight increase in the weights of the kidneys and livers, on the average, for those exposed at 400 ppm for 186 days. The investigators concluded that 400 ppm was the beginning effect level for chronic inhalation of the vapor.

It is apparent that as no systemic effects can be expected at levels producing distinctly disagreeable skin and eye irritation, the TLV must be based on the latter effects. For the prevention of disagreeable irritation, a TLV of 100 ppm and a STEL of 125 ppm are recommended.

Other recommendations: Czechoslovakia (1976) 45 ppm; Poland (1975) 25 ppm.

References:

1. **Gerarde, H.W.:** *Industrial Hygiene & Toxicology*, 2nd ed., Vol. II, p. 1231, Interscience, NY (1963).
2. **Wolf, M.A.** *et al.*: *Arch. Ind. Health* 14:387 (1956).
3. **Oettel, H.:** *Arch. Exp. Path. Pharmak.* 183:641 (1936).
4. **Yant, W.P., Schrenk, H.H., Waite, C.P., Patty, F.A.:** *Pub. Health Rept.* 45:1241 (1930).

Smaller diameter fibers have the ability to penetrate to the alveoli. This potential is cause for concern and the primary reason that fibers 3.5 μm or smaller are subject to special controls. Experimental studies in animals have demonstrated carcinogenic effects with the long (greater than 10 μm) and thin fibers (usually less than 1 μm in diameter). However, these studies were performed by implanting fibrous glass in the pleural or peritoneal cavities.

The data from studies with these routes of exposure cannot be directly extrapolated to conditions of human exposure. On the basis of available information, NIOSH does not consider fibrous glass to be a substance that produces cancer as a result of occupational exposure. The data on which to base this conclusion are limited. Fibrous glass does not appear to possess the same potential as asbestos for causing health hazard. Glass fibers are not usually of the fine submicron diameters as are asbestos fibrils and the concentrations of glass fibers in workplace air are generally orders of magnitude less than for asbestos. In one study, glass fibers were found to be cleared from the lungs more readily than asbestos.

Medical Surveillance: NIOSH recommends that workers subject to fibrous glass exposure have comprehensive preplacement medical examinations with emphasis on skin susceptibility and prior exposure in dusty trades. Subsequent annual examinations should give attention to the skin and respiratory system with attention to pulmonary function.

Personal Protective Methods: Protective clothing shall be worn to prevent fibrous glass contact with skin especially hands, arms, neck, and underarms. Safety goggles or face shields and goggles shall be worn during tear-out or blowing operations or when applying fibrous glass materials overhead. They should be used in all areas where there is a likelihood that airborne glass fibers may contact the eyes. Engineering controls should be used wherever feasible to maintain fibrous glass concentrations at or below the prescribed limits. Respirators should only be used when engineering controls are not feasible; for example, in certain nonstationary operations where permanent controls are not feasible.

Respirator Selection: See Reference (2).

Disposal Method Suggested: Fibrous glass waste and scrap should be collected and disposed of in a manner which will minimize its dispersal into the atmosphere. Emphasis should be placed on covering waste containers, proper storage of materials, and collection of fibrous glass dust. Cleanup of fibrous glass dust should be performed using vacuum cleaners or wet cleaning methods. Dry sweeping should not be performed.

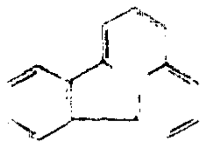
References

(1) National Institute for Occupational Safety and Health, *Occupational Exposure to Fibrous Glass: A Symposium*, NIOSH Doc. No. 76-151 (1976).
(2) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Fibrous Glass*, NIOSH Doc. No. 77-152 (1977).
(3) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Crystalline Silica*, NIOSH Doc. No. 75-120, Washington, DC (1975).

FLUORANTHENE

- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

Description: Fluoranthene, $C_{16}H_{10}$ has the structural formula:



It melts at 111°C.

Code Numbers: CAS 206-44-0 RTECS LL4025000 UN none

DOT Designation

Synonyms: Idryl; benzo[jk] fluorene, ?1,2 benzacenaphthene, 1,2-(1,8-naphthylene)benzene

Potential Exposure: Fluoranthene, a polynuclear aromatic hydrocarbon, is produced from the pyrolytic processing of organic raw materials such as coal and petroleum at high temperatures. It is also known to occur naturally as a product of plant biosynthesis. Fluoranthene is ubiquitous in the environment and has been detected in U.S. air, in foreign and domestic drinking waters and in foodstuffs. It is also contained in cigarette smoke.

Individuals living in areas which are heavily industrialized, and in which large amounts of fossil fuels are burned, would be expected to have greatest exposure from ambient sources of fluoranthene. In addition, certain occupations (e.g., coke oven workers, steel workers, roofers, automobile mechanics) would also be expected to have elevated levels of exposure relative to the general population.

Exposure to fluoranthene will be considerably increased among tobacco smokers or those who are exposed to smokers in closed environments (i.e., indoors).

Permissible Exposure Limits in Air: No standards set.

Determination in Air: Collection on a filter, extraction with benzene, chromatographic separation, spectrophotometric analysis (A-10).

Permissible Concentration in Water: The only existing standard which takes fluoranthene into consideration is a drinking water standard for PAHs. The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAHs not exceeding 0.2 µg/ℓ. This recommended standard is based upon the analysis of six PAHs in drinking water as follows: fluoranthene; benzo[a] pyrene; benzo[ghi] perylene; benzo[b] fluoranthene; benzo[k] fluoranthene; and indeno[1,2,3-cd] pyrene.

More recently EPA has established ambient water criteria as follows: To protect freshwater aquatic life: 3,980 µg/ℓ based on acute toxicity. To protect saltwater aquatic life: 40 µg/ℓ based on acute toxicity and 16 µg/ℓ based on chronic toxicity. To protect human health: 42 µg/ℓ

Determination in Water: Methylene chloride extraction followed by high pressure liquid chromatography with fluorescence as UV detection; or gas chromatography (EPA Method 610), or gas chromatography plus mass spectrometry (EPA Method 625).

Harmful Effects and Symptoms: There is concern about the toxicity of fluoranthene because it is widespread in the human environment and belongs to a class of compounds (polynuclear aromatic hydrocarbons) that contain numerous potent carcinogens. Experimentally, fluoranthene does not exhibit properties of a mutagen or primary carcinogen but it is a potent cocarcinogen. In the laboratory, fluoranthene has also demonstrated toxicity to various freshwater and marine organisms. This finding, coupled with the cocarcinogenic properties of the compound, points out the need to protect humans and aquatic organisms from the potential hazards associated with fluoranthene in water.

Disposal Method Suggested: Incineration.

References

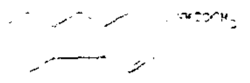
(1) U.S. Environmental Protection Agency, *Fluoranthene: Ambient Water Quality Criteria*, Washington, DC (1980).

(2) U.S. Environmental Protection Agency, *Fluoranthene*, Health and Environmental Effects Profile No. 103, Office of Solid Waste, Washington, DC (April 30, 1980).

N-2-FLUORENYL ACETAMIDE

- Carcinogen (HHS-NTP) (A-62, A-64)

Description: $C_{15}H_{13}NO$ is a crystalline solid melting at 194°C with the following structural formula



Code Numbers: CAS 53-96-3 RTECS AB9450000

DOT Designation: —

Synonyms: 2-Acetylaminofluorene, AAF

Potential Exposure: 2-Acetylaminofluorene (AAF) was intended to be used as a pesticide, but it was never marketed because this chemical was found to be carcinogenic.

AAF is used frequently by biochemists and technicians engaged in the study of liver enzymes and the carcinogenicity and mutagenicity of aromatic amines as a positive control. Therefore, these persons may be exposed to AAF.

AAF is distributed by several companies that deal in specialty chemicals. Information obtained from these distributors indicates that AAF is imported from Europe. A typical chemical distributor keeps approximately 9 lb of AAF in stock. The chemical is usually sold in 1-, 5-, or 25-g quantities. Based on this information, it is estimated that the total U.S. usage is less than 20 lb per year.

Human exposure to AAF may occur through inhalation and skin absorption. The occupations at greatest risk to AAF exposure are organic chemists, chemical stockroom workers, and biomedical researchers. Although neither NIOSH nor OSHA has estimated the number of U.S. workers exposed to AAF, perhaps fewer than 1,000 workers in 200 laboratories may come in contact with this animal carcinogen.

Permissible Exposure Limits in Air: No standards set.

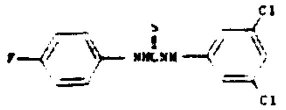
Permissible Concentration in Water: No criteria set.

Harmful Effects and Symptoms: Incorporation of this compound in feed caused increased incidences of malignant tumors in a variety of organs in the rat (1). Long-term studies in which mice were given 2-acetylaminofluorene in their

Crystals. mp 163-164.5°. Soly in water at 25°: 80 ppm; sol in acetone, ethanol, isopropanol, DMF and other organic solvents. LD_{50} orally in male rats, dogs: 89, > 10.000 mg/kg.

USE: Herbicide.

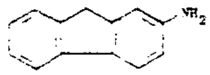
4034. Fluonilid®. *N-(3,5-Dichlorophenyl)-N'-(4-fluorophenyl)thiourea; 3,5-dichloro-4'-fluorothiocarbanilide.* $C_{13}H_9Cl_2FN_2S$; mol wt 315.21. C 49.53%, H 2.88%, Cl 22.50%, F 6.03%, N 8.89%, S 10.17%. Prepd from *p*-fluorophenyl isothiocyanate and 3,5-dichloroaniline or from 3,5-dichlorophenyl isothiocyanate and *p*-fluoroaniline: Belg. pat. 613,154 (1962 to Madan). *C.A.* 58, 474f (1963).



Crystals from ethanol, mp 148°. Soluble in ethyl oleate, isopropyl myristate.

THERAP CAT: Antifungal.

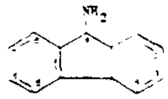
4035. 2-Fluorenamine. 2-Aminofluorene. $C_{13}H_{11}N$; mol wt 181.23. C 86.15%, H 6.12%, N 7.73%. Formation from 2-nitrofluorene: Kuhn, *Org. Syn.* 13, 74 (1933).



Needles from dil alc, mp 131-132°. uv max: 284 nm.

Addn compd with *sym*-trinitrobenzene, $C_{19}H_{14}N_4O_6$, mp 114-115°.

4036. 9-Fluorenamine. 9-Aminofluorene. $C_{13}H_{11}N$; mol wt 181.23. C 86.15%, H 6.12%, N 7.73%. Formation from fluorenone oxime: Ingold, Wilson, *J. Chem. Soc.* 1933, 1493.

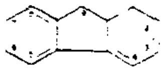


Crystals from hexane, mp 64-65°.

Hydrochloride, $C_{13}H_{12}ClN$, dec 257°.

Picrate, $C_{19}H_{14}N_4O_7$, mp about 240°.

4037. Fluorene. *o*-Biphenylenemethane; diphenylenemethane; 2,2'-methylenebiphenyl. $C_{13}H_{10}$; mol wt 166.21. C 93.94%, H 6.06%. Occurs in coal tar (about 1.6%). Isoln: Kruber, *Ber.* 70, 1556 (1937). Also found in coke-oven tar: Weiss, Downs, *Ind. Eng. Chem.* 15, 1022 (1923). From acetylene and hydrogen in red-hot tube: Meyer, *Ber.* 45, 1609 (1912); Meyer, Taeger, *Ber.* 53, 1261 (1921). From charcoal by boiling with fuming HNO_3: Dimroth, Kerkovius, *Ann.* 399, 120 (1913). From 2,2'-dibromodiphenylmethane on boiling with hydrazine hydrate in presence of Pd: Busch, Weber, *J. Prakt. Chem.* [2] 146, 47 (1936). Reactions: Rieveschl Jr., Ray, *Chem. Rev.* 23, 287 (1938).



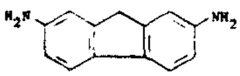
Dazzling white leaflets or flakes from alc. d 1.202. Sublimes easily in high vacuum. mp 116-117°. bp 295°. Absorption spectrum: Mayneord, Roe, *Proc. Roy. Soc. London* A158, 634 (1937). Freely sol in glacial acetic acid; sol in carbon disulfide, ether, benzene, hot alcohol. Soly data: Mortimer, *J. Am. Chem. Soc.* 45, 633 (1923).

Compound with 1,3,5-trinitrobenzene, $2C_{13}H_{10}.3C_6H_3N_3O_6$, golden yellow plates, mp 105° (also $3C_{13}H_{10}.4C_6H_3N_3O_6$, mp 105°).

Compound with picryl chloride, $C_{13}H_{10}.C_6H_2N_3O_6Cl$, orange crystals, mp 70°.

Compound with picric acid, $C_{19}H_{13}N_3O_7$, reddish-brown prisms (unstable), dec 80-82°.

4038. 2,7-Fluorenediamine. 2,7-Diaminofluorene. $C_{13}H_{12}N_2$; mol wt 196.24. C 79.56%, H 6.16%, N 14.28%. Prepd by nitrating fluorene and reducing the 2,7-dinitrofluorene formed with tin and hydrochloric acid: Schmidt, Hinderer, *Ber.* 64, 1793 (1931).

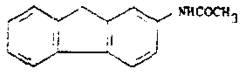


Needles from water, mp 165°. Slightly sol in cold water, more sol in hot water. Readily sol in alc.

Hydrochloride, $C_{13}H_{12}N_2.HCl$, crystals, readily sol in hot water.

USE: Detection of bromide, chloride, nitrate, persulfate, cadmium, copper, cobalt, zinc.

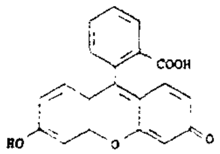
4039. *N*-2-Fluorenylacetamide. *N-9H-Fluoren-2-ylacetamide;* 2-acetylaminofluorene; AAF; 2-FAA. $C_{15}H_{13}NO$; mol wt 223.26. C 80.69%, H 5.87%, N 6.28%, O 7.17%. Synthesis: Hayashi, Nakayama, *J. Soc. Chem. Ind. Japan* [Suppl] 36, 127B (1933). Toxicity studies: Haley *et al.*, *Proc. Soc. Exp. Biol. Med.* 143, 1117 (1973); 146, 648 (1974).



Crystals from alcohol + water, mp 194°. uv max: 285 nm. Insol in water; sol in alcohols, glycols, fat solvents.

Caution: The FDA has declared this substance a carcinogen.

4040. Fluorescein. *3',6'-Dihydroxyspiro[isobenzofuran-1(3H),9'-[9H]xanthen]-3-one;* 9-(*o*-carboxyphenyl)-6-hydroxy-3*H*-xanthen-3-one; 3',6'-dihydroxyfluoran; 3',6'-fluorandiol; 9-(*o*-carboxyphenyl)-6-hydroxy-3-isoxanthenone; resorcinolphthalein; C.I. Acid Yellow 73; C.I. 45350; D & C Yellow no. 7. $C_{20}H_{12}O_5$; mol wt 332.30. C 72.28%, H 3.64%, O 24.07%. Made by heating phthalic anhydride with resorcinol: Fischer, Bollmann, *J. Prakt. Chem.* 104, 123 (1922); McKenna, Sowa, *J. Am. Chem. Soc.* 60, 124 (1938). Structure: Ramart-Lucas, *Compt. Rend.* 205, 864 (1937); Nagase *et al.*, *J. Pharm. Soc. Japan* 73, 1033, 1039 (1953).



Yellowish-red to red powder, mp 314-316° in sealed tube, with decompn. Insol in water, benzene, chloroform, ether; sol in hot alcohol or glacial acetic acid; also sol in alkali hydroxides or carbonates with a bright green fluorescence appearing red by transmitted light. Absorption max: 493.5, 460 nm. LD orally in rabbits: 2.5 g/kg.

USE: *See* Fluorescein Sodium.

THERAP CAT: Diagnostic aid (corneal trauma indicator).

4041. Fluorescein Paper. Zellner's paper. Paper charged with a black, substantive, neutral dye, then impregnated with a fluorescein soln and dried. Prepn and application: Zellner, Ger. pat. 124,922 (1901); *Chem. Zentralbl.* 1901, II, 1032; *Pharm. Zentralh.* 1901, 521; 1902, 297; *E. Merck's Jahresber.* 1901, 161-162.

USE: Exceedingly sensitive to alkalies (1:3,000,000) and particularly to ammonia (1:5,000,000) in spring or well waters; usable with dark or strongly colored liqs.

4042. Fluorescein Sodium. Soluble fluorescein; resorcinol phthalein sodium; uranine; uranine yellow; C.I. Acid Yellow 73; C.I. 45350. $C_{20}H_{10}Na_2O_5$; mol wt 376.27. C

14

LEAD

```
 HE
ENTER CHEMICAL NAME
LEAD
 YPE WHAT INFORMATION YOU REQUIRE:
 ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
EXPO

 RMISSIBLE EXPOSURE LIMIT
  50 UG(PB)/M3 OSHA TWA
  150 UG(PB)/M3 ACGIH TWA
  0.10 MG(PB)/M3 NIOSH RECOMMENDED TWA
  INDEFINITE ANIMAL CARCINOGEN (IARC)
  ANIMAL TERATOGEN (RTEC)
  POSITIVE MUTAGEN (RTEC)
  REPORTABLE QUANTITIES - 1 LB CWA 311(B)
  CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 1 -
    PERSISTENCE 3

  TOXICOLOGY:  LEAD IS A CUMULATIVE NEUROTOXIN.  THE PRINCIPAL SYMPTOMS OF
  POISONING ARE GASTROINTESTINAL UPSET, PERIPHERAL NEUROPATHY, AND ANEMIA.
    ACUTE POISONING FOLLOWING INGESTION OF SOLUBLE LEAD COMPOUNDS CAUSES
  METALLIC TASTE, ABDOMINAL PAIN, VOMITING, DIARRHEA, BLACK STOOLS,
  OLIGURIA, COLLAPSE AND COMA.
    CHRONIC EXPOSURE FROM INGESTION, INHALATION, OR SKIN ABSORPTION IS
  CHARACTERIZED BY CENTRAL NERVOUS SYSTEM AND GASTROINTESTINAL DISTURBAN-
  CES AND ANEMIA.
    THE THRESHOLD LIMIT VALUE WAS SET TO PREVENT SYSTEMIC EFFECTS.
  ORL-WMN TDLO: 450 MG/KG 6 YR
  ORL-PGN LDLO: 160 MG/KG
  IPR-RAT LDLO:1000 MG/KG
  PE WHAT INFORMATION YOU REQUIRE:
 LL/. SPECIFIC INFORMATION (BY 4-LETTER COMMAND),  HELP/, OR  NONE/.
PROP

 EMICAL AND PHYSICAL PROPERTIES
  MOLECULAR WEIGHT: 207.19
  BOILING POINT AT 1 ATM, F: 3164 F
  SOLUBILITY IN WATER, G/100 G WATER AT 20C: INSOLUBLE
  FLASH POINT, CLOSED CUP, F (OR OPEN CUP IF OC): INCOMBUSTABLE
  VAPOR PRESSURE @ 20 C, MMHG: 0.00MM
  MELTING POINT, F: 622 F
  UPPER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: INCOMBUSTABLE
  LOWER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: INCOMBUSTABLE
  SPECIFIC GRAVITY: 11.3437 AT 61 F
  PE WHAT INFORMATION YOU REQUIRE:
 LL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
  IO

 OMPATIBILITIES
  STRONG OXIDIZERS
  PEROXIDES
  ACTIVE METALS
  SODIUM
  POTASSIUM
```

```
LL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND/,  HELP/, OR /NONE/.
OT                                                                      2/4

ERSONAL PROTECTIVE EQUIPMENT
 29CFR1910.1025 LEAD
   (G) PROTECTIVE WORK CLOTHING AND EQUIPMENT
  1. PROVISION AND USE.  IF AN EMPLOYEE IS EXPOSED TO LEAD ABOVE THE PEL,
 WITHOUT REGARD TO THE USE OF RESPIRATORS OR WHERE THE POSSIBILITY OF
 SKIN OR IRRITATION EXISTS, THE EMPLOYER SHALL PROVIDE AT NO COST TO THE
 EMPLOYEE AND ASSURE THAT THE EMPLOYEE USES THE APPROPRIATE PROTECTIVE
 WORK CLOTHING AND EQUIPMENT SUCH AS, BUT NOT LIMITED TO:
  (I) COVERALLS OR SIMILAR FULL-BODY WORK CLOTHING.
  (II) GLOVES, HATS, AND SHOES OR DISPOSABLE SHOE COVERLETS; AND
  (III  FACE SHIELDS, VENTED GOGGLES, OR OTHER APPROPRIATE PROTECTIVE
 EQUIPMENT WHICH COMPLIES WITH SECTION 1910.133 OF THIS PART.
PE WHAT INFORMATION YOU REQUIRE:
ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND/,  HELP/, OR /NONE/.
 [illegible]

CIFIC EMERGENCY PROVISIONS
 EYE-WASH FOUNTAIN WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEE. EYES MAY
   BE EXPOSED TO SUBSTANCE
 QUICK DRENCHING FACILITIES WITHIN IMMEDIATE WORK AREA WHERE EMPLOYEES
   MAY BE EXPOSED TO SUBSTANCE
 PE WHAT INFORMATION YOU REQUIRE:
LL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND/,  HELP/, OR /NONE/.
[illegible]

SPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

.5 MG/M3
     HIGH-EFFICIENCY PARTICULATE RESPIRATOR


.5 MG/M3
  - HIGH-EFFICIENCY PARTICULATE RESPIRATOR
     WITH A FULL FACE-PIECE


0 MG/M3
  - POWERED AIR-PURIFYING RESPIRATOR
     WITH A HIGH-EFFICIENCY FILTER
  - TYPE  C  SUPPLIED-AIR RESPIRATOR
  - SUPPLIED-AIR RESPIRATOR
     OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
      MODE


    MG/M3
    TYPE  C  SUPPLIED-AIR RESPIRATOR
  - SUPPLIED-AIR RESPIRATOR
     WITH A FULL FACE-PIECE
     OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
      MODE
  - TYPE  C  SUPPLIED-AIR RESPIRATOR
  - SUPPLIED-AIR RESPIRATOR
     WITH A FULL FACE-PIECE, HELMENT, OR HOOD
     OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
      MODE


IREFIGHTING
  - SELF-CONTAINED BREATHING APPARATUS
     WITH A FULL FACE-PIECE
     OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
```

```
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
ROUT

   ITE OF ENTRY INTO BODY
   INGESTION
   INHALATION
   SKIN ABSORPTION
   SKIN OR EYE CONTACT
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
 FIR

FIRST AID PROCEDURES FOLLOWING EXPOSURE
   IF THIS CHEMICAL GETS INTO THE EYES, IMMEDIATELY WASH THE EYES
   WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE LOWER AND
   UPPER LIDS.  GET MEDICAL ATTENTION IMMEDIATELY.  CONTACT LENSES
   SHOULD NOT BE WORN WHEN WORKING WITH THIS CHEMICAL.

   IF THIS CHEMICAL GETS ON THE SKIN, IMMEDIATELY WASH CONTAMINATED
   SKIN WITH SOAP OR MILD DETERGENT & WATER.  IF THIS CHEMICAL
   SOAKS CLOTHING, IMMEDIATELY REMOVE CLOTHING & WASH SKIN WITH
   SOAP OR MILD DETERGENT & WATER.  GET MEDICAL ATTENTION PROMPTLY.

   IF A PERSON BREATHES IN LARGE AMOUNTS OF THIS CHEMICAL, MOVE THE
   EXPOSED PERSON TO FRESH AIR AT ONCE.  IF BREATHING HAS STOPPED,
   PERFORM ARTIFICIAL RESPIRATION.  KEEP THE AFFECTED PERSON WARM
   AND AT REST.  GET MEDICAL ATTENTION AS SOON AS POSSIBLE.

   INGESTED LEAD:
   EMERGENCY TREATMENT - REMOVE BY GASTRIC LAVAGE WITH DILUTE
   MAGNESIUM SULFATE OR SODIUM SULFATE SOLUTION OR BY EMESIS.
   TREAT CEREBRAL EDEMA WITH MANNITOL AND PREDNISOLONE OR OTHER
   CORTICOSTEROID.
   ANTIDOTE - INITIATE URINE FLOW. GIVE 10% DEXTROSE IN WATER
   INTRAVENOUSLY. 10-20 ML/KG, FOR ONE TO TWO HOURS. IF URINE
   FLOW DOES NOT START. GIVE 20% SOLUTION OF MANNITOL. 5-10
   ML/KG INTRAVENOUSLY. OVER TWENTY MINUTES. LIMIT FLUID TO
   REQUIREMENTS. AND CATHETERIZATION MAY BE NECESSARY IN COMA.
   URINE OUTPUT SHOULD BE 350-500 ML/M2/DAY. EXCESSIVE FLUIDS
   MAY INCREASE EDEMA. FOR ACUTE ENCEPHALOPATHY. GIVE DIMERCAPROL.
   4 MG/KG INTRAMUSCULARLY, EVERY FOUR HOURS FOR 30 DOSES.
   FOUR HOURS LATER. GIVE CALCIUM DISODIUM EDETATE AT SEPARATE
   INJECTION SITE. 12.5 MG/KG INTRAMUSCULARLY. EVERY FOUR HOURS
   AS 20% SOLUTION. WITH 0.5% PROCAINE ADDED. FOR TOTAL OF 30
   DOSES. IF SIGNIFICANT IMPROVEMENT DOES NOT OCCUR BY FOURTH
   DAY. INCREASE NUMBER OF INJECTIONS BY TEN FOR EACH DRUG. FOR
   PATIENTS RESPONDING WELL WITHOUT ENCEPHALOPATHY, DISCONTINUE
   DIMERCAPROL AFTER THIRD OR FOURTH DAY AND REDUCE EDETATE TO
   50 MG/KG/DAY FOR REMAINING FIVE DAYS. TWO TO THREE WEEKS AFTER
   FIRST COURSE. IF BLOOD LEAD LEVEL REMAINS ABOVE 80 UG/DL. GIVE
   SECOND COURSE OF THIRTY INJECTIONS EACH OF BOTH DRUGS. COURSES
   OF CALCIUM DISODIUM EDETATE SHOULD NOT EXCEED 500 MG/KG, WITH
   AT LEAST ONE WEEK BETWEEN COURSES.
        FOR OTHER SYMPTOMATIC PATIENTS, THE COURSE OF DIMERCAPROL
   AND CALCIUM DISODIUM EDETATE CAN BE SHORTENED OR CALCIUM
   DISODIUM EDETATE ONLY CAN BE GIVEN IN A DOSAGE OF 50 MG/KG
   INTRAVENOUSLY AS 0.5% SOLUTION IN 5% DEXTROSE IN WATER OR
   NORMAL SALINE BY INFUSION OVER NOT LESS THAN EIGHT HOURS
   FOR NOT MORE THAN FIVE DAYS. FOLLOW WITH PENICILLAMINE. 500-
   750 MG DAY ORALLY FOR ONE TO TWO MONTHS OR UNTIL URINE LEAD
   LEVEL DROPS BELOW 0.3 MG/24 HOURS.
```

FURTHER TREATMENT - TREAT ACUTE ENCEPHALOPATHY.
SPECIAL TREATMENT - DIALYSIS IS MANDATORY FOR IMPAIRED RENAL FUNCTION. CORRECT WRIST AND FOOT DROP BY SPLINTING. TOXICITY OF TETRAETHYL LEAD AND TETRAMETHYL LEAD DOES NOT RESPOND TO CHELATION THERAPY. GIVE DIAZEPAM TO CONTROL HYPERACTIVITY.
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

ACUTE RENAL FAILURE - TREAT SHOCK. FOR HEMOLYTIC REACTIONS. GIVE SODIUM BICARBONATE, 5 G EVERY 1-2 HOURS AS NECESSARY TO MAINTAIN AN ALKALINE URINE.
(MEDICATION MUST BE GIVEN BE QUALIFIED MEDICAL PERSONNEL)
(DREISBACH. HANDBOOK OF POISONING. 11TH ED.)

HYPERACTIVITY/DELIRIUM/MANIA - PROTECT PATIENT FROM PHYSICAL INJURY. AVOID MECHANICAL RESTRAINTS. REASSURE PATIENT IN A CALM, QUIET MANNER. AVOID STRANGE SENSORY STIMULI. ABSOLUTE SILENCE SHOULD BE AVOIDED. HOWEVER. USE RELATIVES AND FRIENDS AS ATTENDANTS TO REDUCE APPREHENSION. USE ONE OF THE FOLLOWING DRUGS:

- PARALDEHYDE. 4-16 ML ORALLY IN CRACKED ICE. MILK. FRUIT JUICE. OR WHISKEY; OR 8-12 ML IN TWO VOLUMES OF VEGETABLE OIL RECTALLY.
- SCOPOLAMINE HYDROBROMIDE. 0.5 MG SUBCUTANEOUSLY.
- CHLORPROMAZINE (THORAZINE), 25-50 MG BY DEEP INTRAMUSCULAR INJECTION OR ORALLY. REPEAT AT INTERVALS OF 4-6 HOURS.
- PROMAZINE (SPARINE), [illegible]-100 MG ORALLY. INTRAMUSCULARLY. OR INTRAVENOUSLY AT INTERVALS OF 4-6 HOURS.
- DIAZEPAM. 2-5 MG INTRAVENOUSLY AT A RATE OF 1 MG/MIN.

(MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM. MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY LIFTING THE CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF TEETH. DO NOT FORCE. BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK, IT MAY HAVE ENTERED TRACHEA.

AFTER TUBE IS PLACED IN STOMACH. ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION. AND REPEAT INTRODUCTION AND WITHDRAWAL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES, ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVING LARGE QUANTITIES OF WATER.

MASSAGE OF EPIGASTRIUM WHILE STOMACH TUBE IS BEING ASPIRATED MAY AID IN POISON REMOVAL.

IF PATIENT COMATOSE. INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE.
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

```
ENTER NAME, KEYWORD, SYMPTOM, STLA, NAMELIST, HELP, OR QUIT
NAME
ENTER CHEMICAL NAME
 MERCURY
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
  NM

CHEMICAL NAME
  MERCURY
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP , OR /NONE/.
SYNM

SYNONYMS
  METALLIC MERCURY
  INORGANIC MERCURY
  MERCURY, METALLIC
  MERCURY, INORGANIC
  QUICKSILVER
  NA 2809
  COLLOIDOL MERCURY
  NCI-C60399
  QUICK SILVER
  QUECKSILBER
  OHS14020
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
EXPO

PERMISSIBLE EXPOSURE LIMIT
  0.1 MG M3 OSHA CEILING
  50 UG/M3 ACGIH TWA
  150 UG/M3 ACGIH STEL
  0.05 MG(HG)/M3 NIOSH RECOMMENDED TWA
  INDEFINITE ANIMAL CARCINOGEN (RTEC)
  REPORTABLE QUANTITIES - 1 LB CWA 307(A) - 1 LB CWA 311
    1 LB RCRA 3001 - 1 LB PROPOSED
  CERCLA HAZARD RATINGS - TOXICITY 3 - IGNITABILITY 0 - REACTIVITY 0 -
    PERSISTENCE 3

  TOXICOLOGY:  MERCURY IS A PRIMARY SKIN IRRITANT, SKIN SENSITIZER,
  NEPHROTOXIN AND NEUROTOXIN.
    ACUTE POISONING FOLLOWING INGESTION CAUSES METALLIC TASTE, THIRST,
  ABDOMINAL PAIN, VOMITING AND BLOODY DIARRHEA.  DEATH MAY OCCUR FROM
  UREMIA.  INHALATION OF VAPOR RESULTS IN DYSPNEA, COUGH, FEVER, NAUSEA,
  VOMITING, DIARRHEA, STOMATITIS, SALIVATION AND METALLIC TASTE.  PULMON-
  ARY DISTURBANCES MAY FOLLOW.  ANURIA MAY OCCUR.
    CHRONIC INGESTION CAUSES SKIN DISORDERS, SALIVATION, DIARRHEA, ANEMIA,
  LEUKOPENIA, LIVER AND KIDNEY DAMAGE.  INHALATION MAY RESULT IN TREMORS,
  SALIVATION, STOMATITIS, LOSSENING OF THE TEETH, BLUE GUM LINE,
  PERIPHERAL NEUROPATHY, NEPHRITIS, DIARRHEA, ANXIETY, HEADACHE, WEIGHT
  LOSS, ANOREXIA, AND PSYCHIC DISTURBANCES.
    THE THRESHOLD LIMIT VALUE WAS SET TO PREVENT CHRONIC POISONING.
  IHL-WMN TCLO:150 UG/M3/46 DAYS
  IHL-RBT LCLO: 29 MG/M3/30 HR
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
PROP

CHEMICAL AND PHYSICAL PROPERTIES
  MOLECULAR WEIGHT: 201
  BOILING POINT AT 1 ATM, F: 674 F
```

```
  [illegible]
  VAPOR PRESSURE @ [illegible] F, MMHG: [illegible] MM
  MELTING POINT, F: -38 F
  LOWER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: NOT APPLICABLE
  SPECIFIC GRAVITY: 13.6 [illegible]
  VAPOR DENSITY (AIR=1): 7.
TYPE WHAT INFORMATION YOU REQUIRE:
 /ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
  [illegible]

INCOMPATIBILITIES
  ACETYLENE GAS
  AMMONIA
TYPE WHAT INFORMATION YOU REQUIRE:
 /ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
CLOT

PERSONAL PROTECTIVE EQUIPMENT
  FOLLOWING INFORMATION FROM NIOSH OSHA 'OCCUPATIONAL HEALTH GUIDELINES
   FOR CHEMICAL HAZARDS':

  PREVENT SKIN CONTACT. WHERE SKIN CONTACT MAY OCCUR
    WEAR IMPERVIOUS CLOTHING
    WEAR GLOVES
    WEAR FACESHIELD (8 INCH MINIMUM)

  PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL
    LAUNDERED OR DISCARDED
  IF CLOTHING IS TO BE LAUNDERED, INFORM PERSON PERFORMING OPERATION OF
    CONTAMINANT'S HAZARDOUS PROPERTIES
TYPE WHAT INFORMATION YOU REQUIRE:
 /ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
RESP

 RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

1 MG/M3
    - SUPPLIED-AIR RESPIRATOR
    - SELF-CONTAINED BREATHING APPARATUS


  [illegible] MG/M3
    - SUPPLIED-AIR RESPIRATOR
       WITH A FULL FACE-PIECE
    - SELF-CONTAINED BREATHING APPARATUS
       WITH A FULL FACE-PIECE


[illegible] MG/M3
    - TYPE 'C' SUPPLIED-AIR RESPIRATOR
    - SUPPLIED-AIR RESPIRATOR
       OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
        MODE


ESCAPE
    - GAS MASK
       WITH AN ORGANIC VAPOR CANISTER
       (CHIN-STYLE OR FRONT- OR BACK-MOUNTED CANISTER)
    - SELF-CONTAINED BREATHING APPARATUS


28 MG/M3
    - TYPE 'C' SUPPLIED-AIR RESPIRATOR
       OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
```

```
[illegible]
      GAS MASK
       WITH A CANISTER
       PROVIDING PROTECTION AGAINST SPECIFIC COMPOUND OF CONCERN
       (FRONT- OR BACK-MOUNTED)



TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
ROUT

ROUTE OF ENTRY INTO BODY
  INHALATION
  INGESTION
  SKIN OR EYE CONTACT
TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
SYMP

SYMPTOMS
  COUGHING
  DYSPNEA
  DERMATITIS
  SALIVATION
  LACRIMATION
  THIRST
  METALLIC TASTE
  NAUSEA
  VOMITING
  GASTROINTESTINAL PAIN
  RESPIRATORY EDEMA
  PNEUMONIA
  BRONCHITIS
  ACIDOSIS
  LEUKOPENIA
  HEMATURIA
  PROTEINURIA
  DIARRHEA
  BLOODY STOOLS
  GINGIVAL LEAD LINE
  CENTRAL NERVOUS SYSTEM DEPRESSION
  DYSARTHRIA
  HEADACHE
  FATIGUE
  WEAKNESS
  IRRITABILITY
  INSOMNIA
  DIZZINESS
  INCOORDINATION
  NERVOUSNESS
  MENTAL DEPRESSION
  HALLUCINATIONS
  STOMATITIS
  PARESTHESIA
  ANEMIA
  ANOREXIA
  WEIGHT LOSS
  TREMORS
  CONVULSIONS
  CARDIAC DEPRESSION
  PHOTOPHOBIA
  NEPHRITIS
```

```
    [illegible]
   ANURIA
   LIVER DAMAGE
   HEMATURIA
   KIDNEY DAMAGE
   NUMBNESS EXTREMITIES
TYPE WHAT INFORMATION YOU REQUIRE:
 (ALL), SPECIFIC INFORMATION (BY 4-LETTER COMMAND), (HELP), OR (NONE).
   [illegible]

FIRST AID PROCEDURES FOLLOWING EXPOSURE
   IF THIS CHEMICAL GETS INTO THE EYES, IMMEDIATELY WASH THE EYES
   WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE LOWER AND
   UPPER LIDS.  GET MEDICAL ATTENTION IMMEDIATELY.  CONTACT LENSES
   SHOULD NOT BE WORN WHEN WORKING WITH THIS CHEMICAL.

   IF THIS CHEMICAL GETS ON THE SKIN, IMMEDIATELY WASH CONTAMINATED
   SKIN WITH SOAP OR MILD DETERGENT & WATER.  IF THIS CHEMICAL
   SOAKS CLOTHING, IMMEDIATELY REMOVE CLOTHING & WASH SKIN WITH
   SOAP OR MILD DETERGENT & WATER.  GET MEDICAL ATTENTION PROMPTLY.

   IF A PERSON BREATHES IN LARGE AMOUNTS OF THIS CHEMICAL, MOVE THE
   EXPOSED PERSON TO FRESH AIR AT ONCE.  IF BREATHING HAS STOPPED
   PERFORM ARTIFICIAL RESPIRATION.  KEEP THE AFFECTED PERSON WARM
   AND AT REST.  GET MEDICAL ATTENTION AS SOON AS POSSIBLE.

   INGESTED MERCURY:
   (EMERGENCY TREATMENT - REMOVE BY GASTRIC LAVAGE WITH TAP
   WATER OR BY EMESIS AND CATHARSIS.
   ANTIDOTE - GIVE DIMERCAPROL. HEMODIALYSIS SPEEDS REMOVAL
   OF MERCURY-DIMERCAPROL COMPLEX. PENICILLAMINE IS ALSO
   EFFECTIVE. PENICILLAMINE/DIMERCAPROL TREATMENT IS INEFFEC-
   TIVE FOR NEUROLOGIC EFFECTS OF ALKYL MERCURY COMPOUNDS. THE
   USE OF N-ACETYL-D,L-PENICILLAMINE IS EFFECTIVE FOR ALKYL
   MERCURY IN EXPERIMENTAL ANIMALS. CONTINUE WITH CHELATION
   TREATMENT UNTIL URINE MERCURY FALLS BELOW 50 UG/24 HOURS.
   FURTHER TREATMENT - TREAT ANURIA AND SHOCK. TREAT STENOTIC
   LESIONS OF GASTROINTESTINAL TRACT AFTER ENDOSCOPY. FUSTAM
   SUGGESTS NEOSTIGMINE, 15-22.5 MG. AND ATROPINE, 1-3 MG,
   DAILY IN DIVIDED DOSES. INCREASES MUSCLE STRENGTH IN LATER
   STAGES OF ALKYL MERCURY POISONING.
    (ANTIDOTES MUST BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL)
    DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

   GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO
   PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH
   HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT
   WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM
   MOUTH TO EPIGASTRIUM. MARK TUBE WITH INDELIBLE MARKING
   OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM
   MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY
   LIFTING THE CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK
   OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION
   IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF TEETH,
   DO NOT FORCE, BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL
   TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER.
   IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE
   MARK, IT MAY HAVE ENTERED TRACHEA.
        AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO
   REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH
   CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND
   WITHDRAWAL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS
   OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT
   BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE
   50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH.
```

```
[illegible]
CASE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE.
AVOID GIVING LARGE QUANTITIES OF WATER.
    MASSAGE OF EPIGASTRIUM WHILE STOMACH TUBE IS BEING
RETRACTED MAY AID IN POISON REMOVAL.
    IF PATIENT COMATOSE, INTUBATE TRACHEA WITH CUFFED ENDO-
TRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUAL
IFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATH-
ETER PRIOR TO PASSAGE OF STOMACH TUBE.
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

CATHARSIS - GIVE 30 GRAMS OF SODIUM SULFATE DISSOLVED
IN A GLASS OF WATER OR 15-60 ML OF FLEET'S PHOSPHO-SODA
DILUTED 1:4. CATHARTIC EFFECT SHOULD OCCUR WITHIN 30-60
MINUTES.
    - DO NOT USE CATHARSIS IN PATIENT SHOWING ELECTROLYTE
IMBALANCE.
    - DO NOT GIVE MAGNESIUM-CONTAINING CATHARTICS TO PATIENT
WITH RENAL DISEASE OR THOSE EXPOSED TO NEPHROTOXINS, OR TO
PATIENT WITH POSSIBLE MYOGLOBINURIA OR HEMOGLOBINURIA.
    - HYPERTONIC CATHARTICS AND ENEMAS ARE HAZARDOUS IN THE
PRESENCE OF IMPAIRED RENAL FUNCTION.
    - DO NOT GIVE CATHARTIC FOR TREATMENT OF INGESTED COR-
ROSIVE.
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

ACUTE RENAL FAILURE - TREAT SHOCK. FOR HEMOLYTIC REACTIONS,
GIVE SODIUM BICARONATE, 5 G EVERY 1-2 HOURS AS NECESSARY TO
MAINTAIN AN ALKALINE URINE.
(MEDICATION MUST BE GIVEN BE QUALIFIED MEDICAL PERSONNEL)
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

CIRCULATORY FAILURE SHOCK - PLACE PATIENT IN SUPINE POSITION
WITH FEET ELEVATED. ESTABLISH AND MAINTAIN AN ADEQUATE AIRWAY.
MAINTAIN BODY WARMTH BY APPLICATION OF BLANKETS, BUT DO NOT
APPLY EXTERNAL HEAT. RELIEVE PAIN WITH MORPHINE SULFATE, 10
MG/70 KG SUBCUTANEOUSLY OR INTRAVENOUSLY, FOR OTHERWISE UNCON-
TROLLABLE PAIN. DO NOT GIVE MORPHINE TO CHILDREN UNDER 5 YEARS
OF AGE OR TO UNCONSCIOUS OR STUPOROUS PATIENTS. PATIENTS WITH
DEPRESSED RESPIRATION SHOULD NOT BE GIVEN MORPHINE UNLESS PER-
SONNEL AND EQUIPMENT TO MAINTAIN RESPIRATION ARE IMMEDIATELY
AVAILABLE. RESTORE AND MAINTAIN ADEQUATE BLOOD VOLUME. GET
FURTHER MEDICAL TREATMENT IMMEDIATELY.
 (MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL)
 (DREISBACH, HANDBOOK OF POISONING, 11TH ED.)


TYPE WHAT INFORMATION YOU REQUIRE:
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
ORGN

ORGANS
  SKIN
  EYES
  RESPIRATORY SYSTEM
  KIDNEYS
  LIVER
  CENTRAL NERVOUS SYSTEM
  TYPE WHAT INFORMATION YOU REQUIRE:
 /ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND), /HELP/, OR /NONE/.
NONE
ENTER NAME, KEYWORD, SYMPTOM, SILA, NAMELIST, HELP, OR QUIT
NAME
ENTER CHEMICAL NAME
ARSENIC
```

4. Avery, H.L., Fitzpatrick, M.S., Scheel, L.D.: Report on Survey of Air-borne Diisocyanate during Spray Application of Polyurethane Foam. Div. of Occup. Health, USPHS, Cincinnati, OH (March 1963).

5. Konzen, R.B., Craft, B.F., Scheel, L.D., Gorski, C.H.: Am. Ind. Hyg. Assoc. J. 27:121 (1966).

6. Bruckner, H.C., Avery, S.B., Stetson, D.M., Dodson, V.N., Ronayne, J.J.: Arch. Env. Health 16:619 (1968).

METHYLENE CHLORIDE

Dichloromethane

CH_2Cl_2

TLV, 100 ppm (≈ 360 mg/m³)

STEL, 500 ppm (≈ 1700 mg/m³)

Methylene chloride is a colorless volatile liquid soluble in water to only 1% by weight but completely miscible with most organic solvents. It has a sweetish odor like most chlorinated hydrocarbons. The molecular weight is 84.94, a specific gravity is 1.335, boiling point is 40° C and it solidifies at −95° C. With its high vapor pressure, 375 mm Hg at room temperature (22.5° C), substantial concentrations of vapor are readily achieved whenever methylene chloride is spilled or spread out over a large surface even in a space that is not closely confined. It is non-flammable by standard tests but will burn in extreme conditions.

Methylene chloride is widely used in paint removers, [illegible] solvent for plastics, as a degreasing agent, in propellant mixtures for aerosol sprays [illegible] in foams. The odor [illegible] concentrations of [illegible] ppm reported [illegible]

Liquid methylene chloride is painful and irritating if splashed in the eyes or if confined on the skin [illegible] paint remover formulations. A burn can result [illegible] promptly removed from the eyes and skin [illegible] the LD50 [illegible] rats is about 2000 mg/kg.

[illegible] several species of animals. The [illegible] hours exposure [illegible] given [illegible] ppm. Rats exposed [illegible] ppm showed slight liver changes which were [illegible] 50 days. Rats exposed four to eight days at 7200 ppm [illegible] four weeks were found to have kidney and liver changes. Heppel and associates [illegible] found that daily seven-hour exposures at 5000 ppm [illegible] months had no discernible effect on dogs and rabbits and [illegible] reduction in the rate of growth of guinea pigs. At 10,000 ppm four hours a day for seven and one-half weeks dogs and guinea pigs but not monkeys, rabbits or rats developed liver injury. Moskowitz and Shapiro[illegible] reported four cases of poisoning with one fatality apparently due to narcotic action. Collier[illegible] reported two cases of poisoning in painters who suffered from headache, giddiness, stupor, irritability, numbness and tingling in the limbs. Kuzelova and Vlasak[illegible] noted complaints of headache, fatigue and irritation of the eyes and respiratory passages by workers exposed at concentrations up to 5000 ppm. Neurasthenic disorders were found in 50% and digestive disturbances in 30% of the persons exposed. Three acute poisonings, one involving loss of consciousness, were recorded without serious after-effects.

Weiss[illegible] stated that a chemist after a year's exposure developed toxic encephalosis with acoustical and optical delusions and hallucinations. Concentrations frequently exceeded 500 ppm; values of 900 ppm, 300 ppm and near the floor, 3600 ppm were noted.

Golubovskii and Kamchatnova[illegible] found liver disease in workers exposed to methylene chloride and methanol which they attributed to the former. Exposure concentrations were not reported.

In the early 1940's methylene chloride was considered the least toxic of the chlorinated hydrocarbon solvents when a safe industrial air limit of 500 ppm was proposed by Heppel et al.[illegible] and later adopted by the TLV Committee as protective enough to prevent any significant narcotic effects or liver injury.

Subsequently, Stewart et al.[illegible] reported that significant quantities of carbon monoxide and carboxyhemoglobin were produced in humans receiving single exposures at 500-1000 ppm of methylene chloride. The carboxyhemoglobin concentrations reported by Stewart approximated those considered [illegible] due to inhalation of carbon monoxide.

More [illegible] examination [illegible] methylene chloride was [illegible] reported by the same investigators [illegible] human volunteers exposed to methylene chloride [illegible] ppm for two hours. 2000 ppm-hours [illegible] permitted for an 8-hour exposure at 500 ppm resulted in carboxyhemoglobin levels in excess of those permitted [illegible] from exposure to CO alone.

This [illegible] the body's capacity to metabolize methylene chloride to CO was confirmed by Ratney, Wegman and [illegible] that a group of workers exposed to [illegible] ppm methylene chloride. Such daily repeated exposures [illegible] carboxyhemoglobin [illegible] that decreased [illegible] The difference [illegible] carboxyhemoglobin of 3% [illegible] ppm of methylene chloride [illegible] same as that developed from a daily exposure to CO at its TLV of 50 ppm.

DiVincenzo [illegible] found that humans exposed to [illegible] ppm methylene chloride for 2 hours had a carboxyhemoglobin (COHb) value of [illegible] whereas an 8-hour exposure at 150 ppm produced [illegible] COHb level, and an 8-hour exposure at 200 ppm resulted in COHb level of [illegible] ± 0.65%.

In an extensive study several healthy adults of both sexes were exposed from 2-10 times to methylene chloride vapor concentrations of 0, 50, 100, 250 or 500 ppm for periods of 1, 3 and 7.5 hours in a controlled environment chamber. These studies were designed to simulate the type of exposures encountered in the industrial setting and consisted of both steady, non-fluctuating vapor concentrations. Exposure resulted in a prompt elevation of carboxyhemoglobin. The elevation persisted longer than COHb from CO alone since metabolism of the absorbed methy-

[illegible] COHb continued after exposure ceased. This subsequently-produced COHb is apparently added to the body burden of carbon monoxide derived from other sources.

This study corroborated previous single exposure studies in that no deleterious effects upon the health or performance of healthy adults could be detected when they were repeatedly exposed to 250 ppm or less for 7.5 hours per day, five days per week for 2 weeks, or in the case of the male subjects, to 500 ppm on two consecutive days.[17] Among the parameters studied were complete blood count, clinical chemistry (SMA 12), EKG, serum triglycerides, blood pressure, subjective signs and symptoms, urinalysis (C-Multistix), urinary urobilinogen, neurological tests, EEG, visual evoked response, pulmonary function and cognitive alertness, time estimation, coordination, arithmetic and inspection tests.

The increase in COHb was related to the magnitude of the vapor exposure. Both duration of exposure and vapor concentration were factors. Seven and one-half hour exposures to concentrations as low as 100 ppm for 5 days resulted in COHb elevations about 5 percent in nonsmokers. The odor was not objectionable at 250 ppm and many subjects could not detect it at 50 or 100 ppm.

Since the toxic effects of methylene chloride are due in part to its conversion to carbon monoxide, they would presumably be augmented by the presence of carbon monoxide in the air. Fodor et al. found the effects of CO and the COHb from methylene chloride to be additive in short-term tests in rats. Therefore, whenever there is a combined exposure to the vapors of methylene chloride and carbon monoxide, the appropriate equation for mixtures should be used in determining whether or not the exposure is acceptable.

A time-weighted average TLV of 100 ppm is recommended for methylene chloride in the absence of occupational exposure to carbon monoxide. This recommendation is based upon experimental data obtained from nonsmoking males at rest, and should keep COHb levels well below 5 percent. A STEL of 500 ppm is recommended since data indicate that neither undesirable CNS responses nor COHb values are likely to occur with such exposures to methylene chloride [illegible] exposure [illegible] carbon monoxide [illegible] physical activity [illegible] require [illegible] exposure and adjustment for the combined effect.

Other recommendations: NIOSH (1976) 75 ppm; West Germany (1979) and Elkins (1959) 200 ppm; ANSI (1969) 500 ppm; USSR (1970) 15 ppm; East Germany (1973), Romania (1975), Yugoslavia (1971) and Czechoslovakia (1976) 140 ppm; Sweden (1974) 100 ppm; others 200 or 250 ppm.

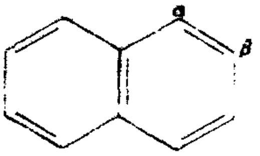
References:

1. **Lehmann, K.B., Flury, F.:** *Toxicology & Hygiene of Industrial Solvents*, pp 138-158. Williams & Wilkins, Baltimore, MD (1943).
2. **von Oettingen, W.F.:** *Halogenated Hydrocarbons: Toxicity & Potential Dangers*. *Pub Health Service Publication #414*, pp 35-41 (1955).
3. **Svirbely, J.L., Highman, B., Alford, W.C., von Oettingen, W.F.:** *J Ind Hyg & Tox* 29:382 (1947).
4. **Heppel, L.A., Neal, P.A., Perrin, T.L., Orr, M.L., Porterfield, V.T.:** *Ibid* 26:8 (1944).
5. **Moskowitz, S., Shapiro, H.:** *Arch Ind Hyg & Occup Med* 6:116 (1952).
6. **Collier, H.:** *Lancet* 1:594 (1936).
7. **Kuzelova, M., Vlasak, R.:** *Pracovni Lekarstvi* 18:167 (1966); abstr. in *Scientific Reports on Industrial Hygiene and Occupational Diseases in Czechoslovakia*, p 69, Prague (1966).
8. **Weiss, G.:** *Zentralblatt Arbeitsmed u Arbeitsschutz* 17:282 (1967).
9. **Golubovskii, I.E., Kamchatnova, V.P.:** *Hygiene & Sanitation* 29:145, USSR (1964).
10. **Stewart, R.D., Fisher, T.N., Hosko, M.J., Peterson, J.E., Baretta, E.D., Dodd, H.C.:** *Science* 176:295 (1972).
11. **Stewart, R.D., Fisher, T.N., Hosko, M.J., Peterson, J.E., Baretta, E.D., Dodd, H.C.:** *Arch Env Health* 25:342 (1972).
12. **Ratney, R.S., Wegman, D.H., Elkins, H.B.:** *Ibid* 28:223 (1974).
13. **Raleigh, Robert L., M.D.:** Letter report from Director, Health & Safety Laboratory, Eastman Kodak Company, Rochester, NY (April 3, 1975).
14. **Stewart, R.D., Hake, C.L., Forster, H.V., Lebrun, A.J., Peterson, J.E., Wu, A.:** *Methylene Chloride: Development of a Biologic Standard for the Industrial Worker by Breath Analysis*.
15. **Fodor, G.G., Prajsnar, D., Schlipkoter, H.W.:** Endogenous CO Formation by Incorporated Halogenated Hydrocarbons of the Methane Series. *Staub-Reinhalt Luft* 33:260-261 (1973).
16. **NIOSH:** *Criteria for a Recommended Standard—Occupational Exposure to Methylene Chloride*. US HEW Publication No. (NIOSH) 76-138 (March 1976).
17. **Stewart, R.D., Forster, H.V., Hake, C.L., Lebrun, A.J., Peterson, J.E.:** *Human Responses to Controlled Exposures of Methylene Chloride Vapor*. Report No. NIOSH-MCOW-ENVM-MC-73-7. The Medical College of Wisconsin, Dept of Environmental Medicine, Milwaukee, WI (December 1973).
18. **Winneke, G.:** *Behavioral Effects of Methylene Chloride and Carbon Monoxide as Assessed by Sensory and Psychomotor Performance*. C. Xintaras, B.L. Johnson, I. de Groot, Eds. *Behavioral Toxicology — Early Detection of Occupational Hazards*. HEW Pub No. (NIOSH) 74-126, pp 130-144. US DHEW, Center for Disease Control, NIOSH (1974).
19. **Hake, C.L., Stewart, R.D., Forster, H.V., Lebrun, A.J., Peterson, J.E., Wu, A.:** *Results of Controlled Exposure of Human Females to Vapor of Methylene Chloride*. Report No. NIOSH-MCOW-ENVM-MC-74-3. The Medical College of Wisconsin, Dept of Environmental Medicine, Milwaukee, WI (March 1974).
20. **Gamberale, F., Annwall, B.A., Hultengren, M.:** Exposure to Methylene Chloride — II. Psychological Functions. *Scand J Work Env Health* 1:95-103 (1975).

NAPHTHA

See, RUBBER SOLVENT

NAPHTHALENE



$C_{10}H_8$

TLV, 10 ppm (≈ 50 mg/m³)

STEL, 15 ppm (≈ 75 mg/m³)

Naphthalene occurs commonly as white, crystalline flakes which have a strong coal tar odor. It has a molecular weight of 128.16 and a specific gravity of 1.145. It melts at 80.2° C, boils at 217.96° C and has a vapor pressure at 25° C of approximately 0.087 mm Hg. The open cup flash point is 176° F and closed cup is 190° F. Insoluble in water, it dissolves in most organic solvents.

Crystalline naphthalene finds household use as a moth repellent, scientific use in scintillation counters. It is an important raw material for the manufacture of phthalic anhydride, naphthol, hydrongenated naphthalenes and halogenated naphthalenes. It or its derivatives are employed in dyes, explosives, lubricants, tanning agents and emulsion breakers.

According to Flury and Zernik(1) and Patty,(2) the inhalation of naphthalene vapor may cause headache, loss of appetite and nausea. Optical neuritis and injuries to the cornea and, in addition, kidney damage have also been reported. Ghetti and Mariani(3) reported opacities of the lens in 8 of 21 workers who had been exposed to naphthalene for about five years. Ingestion of naphthalene in relatively large amounts has reportedly caused severe hemolytic anemia and hemoglobinuria.(4) A hypersusceptibility, probably genetically based, is recognized.(5)

The oral LD_{50} for rats is 1760 mg/kg.(6) It was used as an anthelmintic for many years at dose levels, for adults, of 0.1 to 0.5 gram three times a day,(7) several times higher than the lowest reported lethal dose for man of 50 mg/kg.(6) An incident in which blankets containing naphthalene caused acute hemolytic effects in infants, in some cases fatal, has been described.(8)

Patty suggested 25 ppm as a tentative limit for naphthalene vapor in air. He noted that this corresponds to a saturation pressure of approximately 25% at 25° C. This value has been used at the Los Alamos Laboratories, according to Hyatt and Milligan.(9) Robbins,(10) however, reported that concentrations in excess of about 15 ppm resulted noticeable irritation of the eyes.

Gerarde(11) also suggested 25 ppm as a tentative limit noting that it represents 25% of the concentration of naphthalene vapor in air saturated at 25° C.

In view of the fact that irritation is experienced at 15 ppm and that continued exposure may result in fairly serious eye effects, a limit lower than 25 ppm would seem in order. The value of 10 ppm TLV and 15 ppm STEL are recommended to prevent ocular effects but possibly not blood changes in hypersusceptibles.

Other recommendations: West Germany, 10 ppm; East Germany and USSR, 4 ppm.

References:

1. **Flury, F., Zernik, F.:** Schadliche Gase, p. 290; Springer, Berlin (1931)
2. **Patty, F.A.:** *Industrial Hygiene & Toxicology*, vol. II, p. 770, Interscience, NY (1949)
3. **Ghetti, G., Mariani, L.:** *Med. d. Lavoro* 47 533 (1956)
4. **Zuelzer, W.W., Apt, L.:** *J.A.M.A.* 141 185 (1949)
5. **Stokinger, H.E., Mountain, J.T.:** *Arch. Env. Health* 6 495 (1963)
6. **NIOSH:** *Registry of Toxic Effects of Chemical Substances* (1977)
7. **Am. Ind. Hyg. Assoc.:** *Hygienic Guide Series-Naphthalene* (1967)
8. **Valoes, T., Doxiadis, S.A., Fassas, P.:** *J. Ped.* 63 904 (1963). Cited in ref. 7
9. **Hyatt, E.C., Milligan, M.F.:** *Am. Ind. Hyg. Assoc. Q.* 14 289 (1953)
10. **Robbins, M.C.:** *Arch. Ind. Hyg. & Occup. Med.* 4 85 (1951)
11. **Gerarde, H.W.:** *Toxicology & Biochemistry of Aromatic Hydrocarbons*, p. 230, Elsevier Pub. Co., NY (1960)

Nickel 11.3

```
NAME
ENTER CHEMICAL NAME
NICKEL
TYPE WHAT INFORMATION YOU REQUIRE
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND, /HELP/, OR /NONE/.
ALL

CHEMICAL NAME
  NICKEL

FORMULA
  NI

SYNONYMS
  NICKEL CATALYST, WET
  RANEY NICKEL
  C.I. 77775
  NICKEL SPONGE
  PULVERIZED NICKEL
  UN 1378
  RANEY ALLOY
  NICKEL CATALYST
  NI 270
  NICKEL 270
  NICKEL PARTICLES
  NI 0901-S
  NI 4303T
  NP 2
  RCH 55/5
  QR5950000

PERMISSIBLE EXPOSURE LIMIT
  1 MG/M3 OSHA TWA
  1 MG/M3 ACGIH TWA
  15 UG/M3 NIOSH RECOMMENDED TWA
  ANIMAL CARCINOGEN (IARC)
  HUMAN CARCINOGEN (NTP) REFINING
  TERATOGENIC DATA (RTEC)
  MUTAGENIC DATA (RTEC)
  [illegible] HAZARD RATINGS - TOXICITY 3 - FLAMMABILITY 3 - REACTIVITY 1 -
    PERSISTENCE 3

  TOXICOLOGY:  NICKEL METAL IS A PULMONARY  SENSITIZER, PRIMARY SKIN IRRI-
  TANT AND SKIN SENSITIZER.  EXPOSURE TO NICKEL DURING REFINING CAUSES
  LUNG CANCER.
    CONTACT WITH NICKEL COMPOUNDS CAUSES 'NICKEL ITCH', A FORM OF SENSITI-
  ZATION WITH ITCHING, BURNING, ERYTHEMA, AND ECZEMA.
    INHALATION OF NICKEL SALTS IRRITATES THE RESPIRATORY TRACT, CAUSING
  PNEUMONITITIS AND FEVER.  INGESTION OF ASTRINGENT NICKEL SALTS PRODUCES
  VOMITING AND COLLAPSE.  OTHER SYMPTOMS INCLUDE CORROSION, WATERY OR
  BLOODY DIARRHEA, HEMOLYSIS, HEMATURIA, ANURIA, JAUNDICE, & CONVULSIONS.
    EPIDEMIOLOGICAL STUDIES SHOW AN INCREASED INCIDENCE OF CANCER OF THE
  NASAL CAVITY, LUNG, AND POSSIBLY THE LARYNX IN NICKEL REFINERY WORKERS.
  THE SPECIFIC NICKEL COMPOUND(S) RESPONSIBLE HAVE NOT BEEN IDENTIFIED.
    THE THRESHOLD LIMIT VALUE IS PROBABLY NOT LOW ENOUGH TO PREVENT DERM-
  ATITIS OR SENSITIZATION FROM SOLUBLE SALTS AND MISTS.
  ORL-GPG LDLO:  5 MG/KG
  SCU-GPG LDLO:500 MG/KG
  IVN-MUS LDLO: 50 MG/KG
  IVN-DOG LDLO: 10 MG/KG
  ITR-RAT LDLO: 12 MG/KG

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONCENTRATION
  NOT APPLICABLE
```

PHYSICAL DESCRIPTION
LUSTROUS SILVERY-WHITE, HARD, FERROMAGNETIC METAL; ODORLESS.

CHEMICAL AND PHYSICAL PROPERTIES
MOLECULAR WEIGHT: 58.7
BOILING POINT AT 1 ATM, F: 4946 F
SOLUBILITY IN WATER, G/100 G WATER AT 20C: INSOLUBLE
FLASH POINT, CLOSED CUP, F (OR OPEN CUP IF OC): NA
VAPOR PRESSURE @ 20 C, MMHG: 0.00
MELTING POINT, F: 2651 F
UPPER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: NA
LOWER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: NA
SPECIFIC GRAVITY: 8.90

INCOMPATIBILITIES
STRONG ACIDS
SULFUR
COMBUSTIBLE SUBSTANCES
WOOD
METAL IN POWDERED FORM IS EXPLOSIVE

PERSONAL PROTECTIVE EQUIPMENT
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':

EMPLOYERS SHALL PROVIDE AND ENSURE THAT EMPLOYEES USE APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT NECESSARY TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE. FACE SHIELDS SHALL COMPLY WITH 29CFR1910.133(A)(2), (A)(4), (A)(5), AND (A)(6).

EMPLOYERS SHALL ENSURE THAT CLOTHING CONTAMINATED WITH THIS SUBSTANCE IS PLACED IN CLOSED CONTAINERS FOR STORAGE UNTIL IT CAN BE DISCARDED OR UNTIL THE EMPLOYER PROVIDES FOR THE REMOVAL OF THE CONTAMINANT FROM THE CLOTHING. IF THE CLOTHING IS TO BE LAUNDERED OR OTHERWISE CLEANED TO REMOVE THE CONTAMINANT, THE EMPLOYER SHALL INFORM THE PERSON PERFORMING THE CLEANING OF THE HAZARDOUS PROPERTIES OF THE SUBSTANCE.

GOGGLES
NOT APPLICABLE

WASHING CHEMICALS FROM THE SKIN
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':

EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE SKIN BECOMES CONTAMINATED WITH THIS SUBSTANCE PROMPTLY WASH OR SHOWER WITH SOAP OR MILD DETERGENT AND WATER TO REMOVE ANY CONTAMINANT FROM THE SKIN.

EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHO HANDLE THIS SUBSTANCE WASH THEIR HANDS THOROUGHLY WITH SOAP OR MILD DETERGENT AND WATER BEFORE EATING, SMOKING, OR USING TOILET FACILITIES.

ROUTINE CHANGING OF WORK CLOTHING
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':

EMPLOYERS SHALL ENSURE THAT EMPLOYEES WHOSE CLOTHING MAY HAVE BECOME CONTAMINATED WITH THIS SUBSTANCE CHANGE INTO UNCONTAMINATED CLOTHING BEFORE LEAVING THE WORK PREMISES.

CLOTHING REMOVAL FOLLOWING ACCIDENTAL CONTAMINATION
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES FOR CHEMICAL HAZARDS':

CONTAMINATED WITH THIS SUBSTANCE BE REMOVED PROMPTLY AND NOT REWORN
UNTIL THE SUBSTANCE IS REMOVED FROM THE CLOTHING.

SPECIFIC EMERGENCY PROVISIONS
FOLLOWING INFORMATION FROM NIOSH/OSHA 'OCCUPATIONAL HEALTH GUIDELINES
FOR CHEMICAL HAZARDS':

EMPLOYERS SHALL ENSURE THAT AREAS IN WHICH EXPOSURE TO NICKEL METAL AND SOLUBLE NICKEL COMPOUNDS MAY OCCUR BE IDENTIFIED BY SIGNS OR OTHER APPROPRIATE MEANS, AND ACCESS TO THESE AREAS BE LIMITED TO AUTHORIZED PERSONS.

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

10 MG/M3
- FUME OR HIGH-EFFICIENCY PARTICULATE RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

50 MG/M3
- HIGH-EFFICIENCY PARTICULATE RESPIRATOR
  WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE. HELMET, OR HOOD
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE

1000 MG/M3
- POWERED AIR-PURIFYING RESPIRATOR
  WITH A HIGH-EFFICIENCY PARTICULATE FILTER
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
  MODE

2000 MG/M3
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE
  OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE, HELMET, OR HOOD
  OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
  MODE

ESCAPE
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE
  OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE
  OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW
  MODE
- AUXILIARY SELF-CONTAINED BREATHING APPARATUS
  OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS

OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

ROUTE OF ENTRY INTO BODY
INHALATION
INGESTION
SKIN OR EYE CONTACT

SYMPTOMS
DERMATITIS
ASTHMA
SENSITIZATION DERMATITIS
DIARRHEA
NAUSEA
VOMITING
RESPIRATORY HEMORRHAGE
LARYNGEAL CANCER
RESPIRATORY EDEMA
PARANASAL SINUS CANCER
LUNG CANCER
PNEUMONITIS
ECZEMA
ERYTHEMA
STOMATITIS
FEVER
ANOSMIA
HEMOLYSIS
HEMATURIA
KIDNEY DAMAGE
ANURIA
LIVER DAMAGE
JAUNDICE
COLLAPSE
CONVULSIONS
GINGIVITIS
FACE/NECK FLUSHED
SKIN PIGMENTATION
SOMNOLENCE
REPRODUCTIVE EFFECTS IN EXPERIMENTAL ANIMALS

FIRST AID PROCEDURES FOLLOWING EXPOSURE

IF THIS CHEMICAL GETS INTO THE EYES, IMMEDIATELY WASH THE EYES WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE LOWER AND UPPER LIDS. GET MEDICAL ATTENTION IMMEDIATELY. CONTACT LENSES SHOULD NOT BE WORN WHEN WORKING WITH THIS CHEMICAL.

IF THIS CHEMICAL GETS ON THE SKIN, IMMEDIATELY WASH CONTAMINATED SKIN WITH SOAP OR MILD DETERGENT & WATER. IF THIS CHEMICAL SOAKS CLOTHING, IMMEDIATELY REMOVE CLOTHING & WASH SKIN WITH SOAP OR MILD DETERGENT & WATER. GET MEDICAL ATTENTION PROMPTLY.

IF A PERSON BREATHES IN LARGE AMOUNTS OF THIS CHEMICAL, MOVE THE EXPOSED PERSON TO FRESH AIR AT ONCE. IF BREATHING HAS STOPPED PERFORM ARTIFICIAL RESPIRATION. KEEP THE AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION AS SOON AS POSSIBLE.

WHEN THIS CHEMICAL HAS BEEN SWALLOWED, DO NOT INDUCE VOMITING. REMOVE BY GASTRIC LAVAGE AND CATHARSIS.
INGESTED SALTS OF ALUMINUM, COPPER, NICKEL, TIN, AND ZINC:
EMERGENCY TREATMENT - DILUTE WITH WATER OR MILK. REMOVE BY GASTRIC LAVAGE UNLESS PATIENT IS VOMITING.
ANTIDOTE - FOR COPPER AND ZINC SALTS, GIVE CALCIUM DISODIUM

FURTHER TREATMENT - TREAT HYPOTENSION. RELIEVE IRRITATION BY GIVING MILK OR CORNSTARCH BY DISSOLVING 10 GRAMS CORNSTARCH OR FLOUR IN 1 LITER OF WATER. REPLACE FLUIDS WITH 5% DEXTROSE IN SALINE. KEEP PATIENT WARM AND QUIET. RELIEVE PAIN WITH MEPERIDINE OR MORPHINE.
(MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL)

SPECIAL TREATMENT - TREAT ANURIA AND LIVER DAMAGE.
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

GASTRIC LAVAGE - GIVE PATIENT GLASS OF WATER PRIOR TO PASSING OF STOMACH TUBE. LAY PATIENT ON ONE SIDE, WITH HEAD LOWER THAN WAIST. IMMOBILIZE A STRUGGLING PATIENT WITH A SHEET OR BLANKET. MEASURE DISTANCE ON TUBE FROM MOUTH TO EPIGASTRIUM, MARK TUBE WITH INDELIBLE MARKING OR TAPE. REMOVE DENTURES AND OTHER FOREIGN OBJECTS FROM MOUTH. OPEN MOUTH, USE GAG IF NECESSARY. EXTEND HEAD BY LIFTING THE CHIN. PASS TUBE OVER TONGUE AND TOWARD BACK OF THROAT WITHOUT EXTENDING HEAD OR NECK. IF OBSTRUCTION IS MET BEFORE THE MARK ON TUBE REACHES LEVELS OF TEETH. DO NOT FORCE. BUT REMOVE TUBE AND REPEAT PROCEDURE UNTIL TUBE PASSES TO MARK. PLACE END OF TUBE IN GLASS OF WATER. IF TUBE IS OBSTRUCTED WHEN INTRODUCED ABOUT HALFWAY TO THE MARK. IT MAY HAVE ENTERED TRACHEA.

AFTER TUBE IS PLACED IN STOMACH, ASPIRATE FIRST TO REMOVE STOMACH CONTENTS BY IRRIGATION SYRINGE. SAVE STOMACH CONTENTS FOR EXAMINATION, AND REPEAT INTRODUCTION AND WITHDRAWAL OF 100-300 ML WARM WATER UNTIL AT LEAST 3 LITERS OF CLEAR RETURN ARE OBTAINED. USE ACTIVATED CHARCOAL AT BEGINNING OF LAVAGE TO AID IN POISON INACTIVATION. LEAVE 50 GRAMS OF CHARCOAL SUSPENDED IN WATER IN THE STOMACH. IF INTRODUCTION AND REMOVAL OF LAVAGE FLUID BY GRAVITY REQUIRES MORE THAN FIVE MINUTES. ASSIST WITH ASEPTO SYRINGE. PREVENT ASPIRATION WITH CUFFED ENDOTRACHEAL TUBE. AVOID GIVING LARGE QUANTITIES OF WATER.

MASSAGE OF EPIGASTRIUM WHILE STOMACH TUBE IS BEING ASPIRATED MAY AID IN POISON REMOVAL.

IF PATIENT COMATOSE. INTUBATE TRACHEA WITH CUFFED ENDOTRACHEAL TUBE. SUCCINYLCHLORINE MAY BE ADMINISTERED BY QUALIFIED MEDICAL PERSONNEL TO EASE INSERTION OF TRACHEAL CATHETER PRIOR TO PASSAGE OF STOMACH TUBE.
DREISBACH. HANDBOOK OF POISONING, 11TH ED.

PAIN - MORPHINE SULFATE. 5-15 MG SUBCUTANEOUSLY, ORALLY, OR SLOWLY INTRAVENOUSLY. MORPHINE CAN CAUSE NAUSEA AND VOMITING. CENTRAL NERVOUS SYSTEM DEPRESSION. AND SLOWING OF RESPIRATION. USE CAUTIOUSLY OR NOT AT ALL IN CENTRAL NERVOUS SYSTEM DEPRESSION. RESPIRATORY DIFFICULTY, HYPEREXCITABILITY, AND HEPATIC DISEASE.

- MEPERIDINE HYDROCHLORIDE (DEMEROL. DOLANTIN), 50-150 MG ORALLY OR INTRAMUSCULARLY.
(MEDICATION MUST BE GIVEN BY QUALIFIED MEDICAL PERSONNEL)
(DREISBACH, HANDBOOK OF POISONING. 11TH ED.)

ACUTE RENAL FAILURE - TREAT SHOCK. FOR HEMOLYTIC REACTIONS. GIVE SODIUM BICARONATE, 5 G EVERY 1-2 HOURS AS NECESSARY TO MAINTAIN AN ALKALINE URINE.
(MEDICATION MUST BE GIVEN BE QUALIFIED MEDICAL PERSONNEL)
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

LIVER DAMAGE - REMOVE FROM EXPOSURE TO ALL CHEMICALS AND DRUGS. MAINTAIN COMPLETE BED REST. AVOID ANESTHESIA OR SURGICAL PROCEDURES. AVOID DEHYDRATION OR OVERHYDRATION. IF VOMITING SEVERE AND ORAL FLUIDS NOT RETAINED, REPLACE VOMITUS WITH AN EQUAL QUANTITY OF 100% DEXTROSE IN NORMAL SALINE. IN RENAL FUNCTION ADEQUATE, GIVE 1 LITER OF 5%

F 10% DEXTROSE OR INVERT SUGAR IN DISTILLED WATER INTRAVENOUSLY EVERY TWENTY-FOUR HOURS.
(DREISBACH, HANDBOOK OF POISONING, 11TH ED.)

S
ASAL SEPTUM
LUNGS
KIN

ATUS OF REGULATOR: ENFORCEMENT
OSHA STANDARD 29CFR1910.1200 HAZARD COMMUNICATION
REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS HAVING WORKPLACES IN THE MANUFACTURING DIVISION, STANDARD INDUSTRIAL CLASSIFICATION CODES 20 THROUGH 39, TO PROVIDE INFORMATION TO THEIR EMPLOYEES CONCERNING HAZARDOUS CHEMICALS BY MEANS OF HAZARD COMMUNICATION PROGRAMS INCLUDING LABELS, MATERIAL SAFETY DATA SHEETS, TRAINING, AND ACCESS TO WRITTEN RECORDS
48FR53280 11/25/83

FOLLOWING OSHA STANDARDS APPLICABLE TO SUBSTANCES LISTED 29CFR1910. OTHERWISE ADVISE:

OSHA STANDARD 29CFR1910.1000 AIR CONTAMINANTS
TABLE Z-1

OSHA STANDARD 29CFR1910.94 VENTILATION

OSHA STANDARD 29CFR1910.134 RESPIRATORY PROTECTION

OSHA STANDARD 29CFR1910.20 ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL RECORDS

OSHA STANDARD 29CFR1910.132 PERSONAL PROTECTIVE EQUIPMENT

OSHA STANDARD 29CFR1910.141 SANITATION

OSHA STANDARD 29CFR1910.151 MEDICAL SERVICES AND FIRST AID

OSHA STANDARD 29CFR1910.133 EYE AND FACE PROTECTION
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT ALLEGED TO HAVE BEEN CAUSED BY A SUBSTANCE OR MIXTURE. EPA MAY INSPECT AND REQUIRE REPORTING OF SUCH RECORDS.
48FR38179 08/22/83

SUBSTANCE LISTED TOXIC SUBSTANCES CONTROL ACT INVENTORY

SUBSTANCE ESTABLISHED AS CONFIRMED OR SUSPECTED CARCINOGEN (POTENTIAL CARCINOGEN) BY THE INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC)

SUBSTANCE LISTED AS 'KNOWN TO BE CARCINOGENIC' OR 'MAY REASONABLY BE ANTICIPATED TO BE CARCINOGENIC' IN NATIONAL TOXICOLOGY PROGRAM (NTP) THIRD ANNUAL REPORT ON CARCINOGENS

SUBSTANCE LISTED AS TOXIC POLLUTANT UNDER CLEAN WATER ACT (CWA) SECTION 307(A)

40CFR122.21 TESTING REQUIREMENTS FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT APPLICATIONS

48FR14153 04/01/83

49CFR172.101 TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION, PROPER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER REQUIREMENTS
DESIGNATED IN HAZARDOUS MATERIALS TABLE AS HAZARDOUS MATERIAL FOR THE PURPOSE OF TRANSPORTATION.
41FR15996 04/15/76
45FR34588 05/22/80 (AMENDMENT)
45FR46420 07/10/80 (AMENDMENT)
45FR62080 09/18/80 (AMENDMENT)
45FR74649 11/10/80 (AMENDMENT)
46FR17739 03/19/81 (AMENDMENT)
46FR19235 03/30/81 (AMENDMENT)

49CFR172.102 TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION, PROPER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER REQUIREMENTS
DESIGNATED IN OPTIONAL HAZARDOUS MATERIALS TABLE WITH ALTERNATIVES TO CORRESPONDING REQUIREMENTS IN 49CFR172.101 FOR INTERNATIONAL SHIPMENTS AS AUTHORIZED BY 49CFR171.12
41FR15996 04/15/76
46FR29393 06/01/81 (AMENDMENT)
46FR32250 06/22/81 (AMENDMENT)

SUBSTANCES LISTED APPENDIX A - CONSENT DECREE LIST OF INDUSTRIES AND TOXIC POLLUTANTS. SETTLEMENT AGREEMENT BETWEEN U.S. EPA AND NATIONAL RESOURCES DEFENSE COUNCIL, ET AL U.S. DISTRICT COURT DISTRICT OF COLUMBIA, JUNE 7, 1976. SITE 8ERC2120, DDC 1976. MODIFIED MARCH 9, 1979, SITE 12ERC1833, DDC 1979 AND AGAIN ON OCTOBER 26, 1982.

SUBSTANCE TESTED FOR HYPERTENSION BY THE DEPARTMENT OF ENERGY (DOE)

TECHNICAL ASSISTANCE DATA COMPLETED/PUBLISHED CLEAN WATER ACT (CWA) SECTION 311

PREREGULATORY ASSESSMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)

MONITORING/LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT (CWA)

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED CLEAN AIR ACT (CAA)

RISK DOCUMENTATION/ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT (CWA)

ANALYTICAL METHODS DEVELOPMENT COMPLETED/PUBLISHED CLEAN AIR ACT (CAA)

CONTROL TECHNOLOGY DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT (CWA)

MONITORING/LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)

SOURCE/EXPOSURE ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

SOURCE/EXPOSURE ASSESSMENT COMPLETED/PUBLISHED CLEAN AIR ACT (CAA)

WATER ACT (CWA)
ANALYTICAL METHODS DEVELOPMENT IN DEVELOPMENT/PROGRESS RESOURCE
CONSERVATION AND RECOVERY ACT (RCRA)

CRITERIA DOCUMENT IN DEVELOPMENT/PROGRESS CLEAN WATER ACT (CWA)
SECTION 304(A)

RISK DOCUMENTATION/ASSESSMENT COMPLETED/PUBLISHED SAFE DRINKING
WATER ACT (SDWA)

SOURCE/EXPOSURE ASSESSMENT COMPLETED/PUBLISHED CLEAN AIR
ACT (CAA)

RISK DOCUMENTATION/ASSESSMENT IN DEVELOPMENT/PROGRESS CLEAN AIR
ACT (CAA)

CONTROL TECHNOLOGY DEVELOPMENT COMPLETED/PUBLISHED CLEAN
WATER ACT (CWA)

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED CLEAN WATER
ACT (CWA)

CONTROL TECHNOLOGY DEVELOPMENT IN DEVELOPMENT/PROGRESS CLEAN
AIR ACT (CAA)

SUBSTANCE SUBJECT TO REQUIREMENTS OF GENERAL INDUSTRY SAFETY ORDER
(GISO) 5194 OR TITLE 8 OF CALIFORNIA ADMINSTRATIVE CODE AND DIVISION 5,
CHAPTER 2.5 OF CALIFORNIA LABOR CODE

SUBSTANCE LISTED HAZARDOUS
STATE OF CALIFORNIA ADMINISTRATIVE CODE
TITLE 22. SOCIAL SECURITY
DIVISION 4. ENVIRONMENTAL HEALTH
CHAPTER 30. MINIMUM STANDARDS FOR MANAGEMENT OF HAZARDOUS AND
EXTREMELY HAZARDOUS WASTES

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K082: EMISSION CONTROL DUST
OR SLUDGE FROM PAINT MANUFACTURING. (T)

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K081: WASTEWATER TREATMENT
SLUDGES FROM PAINT MANUFACTURING. (T)

DRAFT HEALTH ASSESSMENT DOCUMENT PREPARED BY THE EPA OFFICE
OF HEALTH AND ENVIRONMENTAL ASSESSMENT OF THE OFFICE OF RESEARCH AND DEVELOPMENT.

THIS SUBSTANCE TESTED FOR PULMONARY TOXICITY
BY THE ENVIRONMENTAL PROTECTION AGENCY (EPA)

CLEAN WATER ACT (CWA) SECTION 304(A)
WATER QUALITY CRITERION FOR NICKEL:
0.01 OF THE 96-HOUR LC50 FOR FRESHWATER AND MARINE
AQUATIC LIFE

MEDICAL SURVEILLANCE REQUIRED
GENERAL MEDICAL HISTORY
ATTENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS
40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES
CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES
MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES

[redacted]

[illegible] (EFFECTIVE DATE CORRECTION)
RESPIRATORY HISTORY
PRE-PLACEMENT AND ANNUAL EXAMS
PHYSICIAN EXAMINATION
INDUSTRIAL EXPOSURE HISTORY
CHRONIC RESPIRATORY DISEASE
14 BY 17 CHEST P.A. X-RAY
SKIN EXAM
PULMONARY FUNCTIONS
SPECIAL ATTENTION TO SKIN
SPUTUM CYCTOLOGY
WITH EMPHASIS ON:
NASAL SEPTUM
ATTENTION TO SMOKING, ALCOHOL, MEDICATION, AND EXPOSURE TO CARCINOGENS

9|.3

CERTIFICATIONS
HEALTH STATUS CLASSIFICATION

NUCLEAR REG. 0041

OSHA RESPIRATOR CERTIFICATION 29CFR1910.134
DEPARTMENT OF TRANSPORTATION IF OPERATES HEAVY EQUIPMENT

EMPLOYEE HAZARDOUS MATERIALS EDUCATION RECEIPT

EMPLOYEE MEDICAL RECORDS RECEIPT

TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS. CONTACT: JACK P. MCCARTHY, OFFICE OF TOXIC SUBSTANCES, EPA (800)424-1404. 48FR38178 8/22/83

MEDICAL WARNING REQUIRED FOR MEDICAL EXAM REFUSAL SIGNED BY EMPLOYEE

SPECIAL DIAGNOSTIC TESTS
ELECTROCARDIOGRAM
SPUTUM GRAM STAIN AND CULTURE
DIFFERENTIAL WHITE BLOOD CELL COUNT

LEAKS AND SPILL PROCEDURES
A REPORTABLE QUANTITY OF ONE POUND APPLIES TO THIS SUBSTANCE ESTABLISHED BY SECTIONS 101(14) AND 102(B) OR ADJUSTED UNDER SECTION 102(A) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (CERCLA). SECTIONS 103(A) AND 103(B) REQUIRE THAT PERSONS IN CHARGE OF A VESSEL OR FACILITY FROM WHICH A HAZARDOUS SUBSTANCE HAS BEEN RELEASED IN A QUANTITY EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THAT SUBSTANCE IMMEDIATELY NOTIFY THE NATIONAL RESPONSE CENTER (800) 424-8802; IN THE WASHINGTON, D.C. METROPOLITAN AREA (202) 426-2675
50FR13456 04/04/85

A**

DEPARTMENT OF TRANSPORTATION HAZARD

49CFR172.101 HAZARDOUS MATERIALS TABLE

101.5

FLAMMABLE SOLID

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS
49CFR172.101 (SUBJECT TO ADDITIONAL LABELING REQUIREMENTS OF
49CFR172.402)

FLAMMABLE SOLID

****

INTERGOVERNMENTAL MARITIME ORGANIZATION HAZARD CLASS
49CFR172.102 OPTIONAL HAZARDOUS MATERIALS TABLE

CLASS 4.2-SPONTANEOUSLY COMBUSTIBLE

INTERGOVERNMENTAL MARITIME ORGANIZATION LABELING SPECIFICATIONS FOR
DOMESTIC AND EXPORT SHIPMENTS
49CFR172.102

SPONTANEOUSLY COMBUSTIBLE

****

FOLLOWING INFORMATION FROM BUREAU OF EXPLOSIVES 'EMERGENCY HANDLING OF
HAZARDOUS MATERIALS':

IF MATERIAL ON FIRE OR INVOLVED IN FIRE:
* EXTINGUISH FIRE USING AGENT SUITABLE FOR TYPE OF SURROUNDING FIRE
(MATERIAL ITSELF DOES NOT BURN OR BURNS WITH DIFFICULTY)

IF MATERIAL IS NOT ON FIRE AND IS NOT INVOLVED IN FIRE:
* KEEP MATERIAL OUT OF WATER SOURCES AND SEWERS
* BUILD DIKES TO CONTAIN FLOW AS NECESSARY

PERSONNEL PROTECTION:
* KEEP UPWIND
* WEAR BOOTS, PROTECTIVE GLOVES AND GAS TIGHT GOGGLES
* AVOID BREATHING DUST/VAPORS/FUMES FROM MATERIAL
* WASH AWAY ANY MATERIALS WHICH MAY HAVE CONTACTED THE BODY WITH
COPIOUS AMOUNTS OF WATER OR SOAP AND WATER

LAND SPILL:
* DIG A PIT, POND, LAGOON OR HOLDING AREA TO CONTAIN LIQUID OR SOLID
MATERIAL
* COVER SOLIDS WITH A PLASTIC SHEET TO PREVENT DISSOLVING IN RAIN OR
FIREFIGHTING WATER

WATER SPILL:
* USE NATURAL DEEP WATER POCKETS, EXCAVATED LAGOONS,
OR SAND BAG BARRIERS TO TRAP MATERIAL AT BOTTOM
* IF DISSOLVED, APPLY ACTIVATED CARBON AT 10 TIMES SPILLED
AMOUNT AT 10PPM OR GREATER CONCENTRATION
* REMOVE TRAPPED MATERIAL WITH SUCTION HOSES
* USE MECHANICAL DREDGES OR LIFTS TO REMOVE IMMOBILIZED MASSES
OF POLLUTION AND PRECIPITATES

-NO REPORTING OF RELEASES OF MASSIVE FORMS OF THIS METAL
REQUIRED UNDER CERCLA SUPERFUND NOTIFICATION 40CFR302 IF
DIAMETER OF PIECES RELEASED IS EQUAL TO OR EXCEEDS 100
MICROMETERS (0.004 INCHES)

WASTE
THIS MATERIAL LISTED AS HAZARDOUS SUBSTANCE, AS DEFINED IN SECTION
101(14) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND

49CFR172.101 HAZARDOUS MATERIALS TABLE

FLAMMABLE SOLID

DEPARTMENT OF TRANSPORTATION LABELING REQUIREMENTS
49CFR172.101 (SUBJECT TO ADDITIONAL LABELING REQUIREMENTS OF
49CFR172.402)

FLAMMABLE SOLID

****

INTERGOVERNMENTAL MARITIME ORGANIZATION HAZARD CLASS
49CFR172.102 OPTIONAL HAZARDOUS MATERIALS TABLE

CLASS 4.2-SPONTANEOUSLY COMBUSTIBLE

INTERGOVERNMENTAL MARITIME ORGANIZATION LABELING SPECIFICATIONS FOR
DOMESTIC AND EXPORT SHIPMENTS
49CFR172.102

SPONTANEOUSLY COMBUSTIBLE

****

FOLLOWING INFORMATION FROM BUREAU OF EXPLOSIVES 'EMERGENCY HANDLING OF HAZARDOUS MATERIALS':

IF MATERIAL ON FIRE OR INVOLVED IN FIRE:
* EXTINGUISH FIRE USING AGENT SUITABLE FOR TYPE OF SURROUNDING FIRE (MATERIAL ITSELF DOES NOT BURN OF BURNS WITH DIFFICULTY)

IF MATERIAL IS NOT ON FIRE AND IS NOT INVOLVED IN FIRE:
* KEEP MATERIAL OUT OF WATER SOURCES AND SEWERS
* BUILD DIKES TO CONTAIN FLOW AS NECESSARY

PERSONNEL PROTECTION:
* KEEP UPWIND
* WEAR BOOTS, PROTECTIVE GLOVES AND GAS TIGHT GOGGLES
* AVOID BREATHING DUST/VAPORS/FUMES FROM MATERIAL
* WASH AWAY ANY MATERIALS WHICH MAY HAVE CONTACTED THE BODY WITH COPIOUS AMOUNTS OF WATER OR SOAP AND WATER

LAND SPILL:
* DIG A PIT, POND, LAGOON OR HOLDING AREA TO CONTAIN LIQUID OR SOLID MATERIAL
* COVER SOLIDS WITH A PLASTIC SHEET TO PREVENT DISSOLVING IN RAIN OR FIREFIGHTING WATER

WATER SPILL:
* USE NATURAL DEEP WATER POCKETS, EXCAVATED LAGOONS, OR SAND BAG BARRIERS TO TRAP MATERIAL AT BOTTOM
* IF DISSOLVED, APPLY ACTIVATED CARBON AT 10 TIMES SPILLED AMOUNT AT 10PPM OR GREATER CONCENTRATION
* REMOVE TRAPPED MATERIAL WITH SUCTION HOSES
* USE MECHANICAL DREDGES OR LIFTS TO REMOVE IMMOBILIZED MASSES OF POLLUTION AND PRECIPITATES

-NO REPORTING OF RELEASES OF MASSIVE FORMS OF THIS METAL REQUIRED UNDER CERCLA SUPERFUND NOTIFICATION 40CFR302 IF DIAMETER OF PIECES RELEASED IS EQUAL TO OR EXCEEDS 100 MICROMETERS (0.004 INCHES)

WASTE

THIS MATERIAL LISTED AS HAZARDOUS SUBSTANCE, AS DEFINED IN SECTION

FOLLOWING:

- FEDERAL WATER POLLUTION CONTROL ACT (FWPCA) SECTION 311(B)(2)(A)
- SOLID WASTE DISPOSAL ACT SECTION 3001
- CLEAN WATER ACT (CWA) SECTION 307(A)
- CLEAN AIR ACT (CAA) SECTION 112
- TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 7
- COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT (CERCLA) SECTION 102

EPA HAZARDOUS WASTE NUMBER D001
IGNITABLE WASTE

40CFR260 HAZARDOUS WASTE MANAGEMENT SYSTEM: GENERAL

PROVIDES DEFINITIONS OF TERMS, GENERAL STANDARDS, AND OVERVIEW INFORMATION APPLICABLE TO 40CFR PARTS 260-265

40CFR261 IDENTIFICATION AND LISTING OF HAZARDOUS WASTE

IDENTIFIES THOSE SOLID WASTES WHICH ARE SUBJECT TO REGULATION AS HAZARDOUS WASTES UNDER 40CFR PARTS 262-265, 270, 271, AND 124 AND WHICH ARE SUBJECT TO THE NOTIFICATION REQUIREMENTS OF SECTION 3010 OF THE RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) AND IDENTIFIES ONLY SOME OF THE MATERIALS WHICH ARE HAZARDOUS WASTES UNDER SECTIONS 3007 AND 7003 OF RCRA

40CFR262 STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE

ESTABLISHES STANDARDS FOR GENERATORS OF HAZARDOUS WASTE

40CFR263 STANDARDS APPLICABLE TO TRANSPORTERS OF HAZARDOUS WASTE

ESTABLISHES STANDARDS WHICH APPLY TO PERSONS TRANSPORTING HAZARDOUS WASTE WITHIN THE UNITED STATES IF THE TRANSPORTATION REQUIRES A MANIFEST UNDER 40CFR262

40CFR264 STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

ESTABLISHES MINIMUM NATIONAL STANDARDS WHICH DEFINE THE ACCEPTABLE MANAGEMENT OF HAZARDOUS WASTE

40CFR265 INTERIM STATUS STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES

ESTABLISHES MINIMUM NATIONAL STANDARDS WHICH DEFINE THE ACCEPTABLE MANAGEMENT OF HAZARDOUS WASTE DURING THE PERIOD OF INTERIM STATUS

40CFR267 INTERIM STANDARDS FOR OWNERS AND OPERATORS OF NEW HAZARDOUS WASTE LAND DISPOSAL FACILITIES

ESTABLISHES MINIMUM NATIONAL STANDARDS THAT DEFINE THE ACCEPTABLE MANAGEMENT OF HAZARDOUS WASTE FOR NEW LAND DISPOSAL FACILITIES

40CFR270 EPA ADMINISTERED PERMIT PROGRAMS: THE HAZARDOUS WASTE PERMIT PROGRAM

```
     ESTABLISHES PROVISIONS FOR THE HAZARDOUS WASTE PERMIT PROGRAM UNDER
   SUBTITLE C OF THE SOLID WASTE DISPOSAL ACT, AS AMENDED BY THE RESOURCE
   CONSERVATION AND RECOVERY ACT



 CAS NUMBER
   7440-02-0
 REGISTRY TOXIC CHEMICALS NUMBER
   QR5950000

 BULLETINS

 SPECIAL INFORMATION
 TYPE WHAT INFORMATION YOU REQUIRE
 /ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND, /HELP/, OR /NONE/.
 NONE
 NICKEL - NO MORE HITS IN DATABASE.

 ENTER NAME. KEYWORD. SYMPTOM. STLA. NAMELIST. HELP. OR QUIT.
 QUIT
 ENTER WHICH OHS SERVICE YOU WISH TO ACCESS:
 IF YOU WISH TO ACCESS HAZARDLINE. TYPE /HAZARD/
 IF YOU WISH TO ACCESS ENVIRONMENTAL HEALTH NEWS. TYPE /EHN/
 IF YOU WISH TO ACCESS MATERIAL SAFETY DATA SHEET. TYPE /MSDS/
 IF YOU WISH TO EXIT THE SYSTEM. TYPE /LOGOFF/
 PRESS RETURN AFTER THIS COMMAND AND EVERY COMMAND.
 LOGOFF

 LOGGED OFF LINE # 02 DATE = 06/27/85 TIME = 15-06-39
 LOGOFF COMPLETED - GOODBYE FOR NOW!!!!
```

Occupational Health Guideline for Pentachlorophenol

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: C_6Cl_5OH
- Synonyms: PCP; penta
- Appearance and odor: Light brown solid with a pungent odor when hot.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for pentachlorophenol is 0.5 milligram of pentachlorophenol per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Pentachlorophenol can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

Exposure to pentachlorophenol may cause irritation of the eyes and respiratory tract. Bronchitis has been reported to occur. Systemic effects from either a large exposure or repeated smaller exposures include weakness, loss of appetite, nausea, vomiting, shortness of breath, chest pain, excessive sweating, headache, and dizziness. In fatal cases the temperature is often very high and death may occur as early as three hours after the onset of symptoms. The risk of serious intoxication is greater in hot weather. Persons with decreased liver or kidney functions are more susceptible to poisoning from this chemical. Repeated exposure to pentachlorophenol may cause an acne-like skin rash and liver damage. Commercial pentachlorophenol may be contaminated with dioxin compounds which are much more toxic than pentachlorophenol.

- **Reporting signs and symptoms:**

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to pentachlorophenol.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to pentachlorophenol at potentially hazardous levels:

1. *Initial Medical Examination:*

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the cardiovascular system, eyes, upper respiratory tract, liver, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders. Analysis of the urine for pentachlorophenol may be helpful in estimating the extent of absorption.

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis.

- **Summary of toxicology**

Pentachlorophenol dust and mist cause irritation of the eyes and upper respiratory tract, absorption results in an increase in metabolic rate and hyperpyrexia, prolonged skin exposure causes an acneform dermatitis. Human exposure to dust or mist concentrations greater than 1 mg/m^3 causes pain in the nose and throat, violent sneezing, and cough; 0.3 mg/m^3 may cause some nose irritation; persons acclimated to pentachlorophenol can tolerate concentrations up to 2.4 mg/m^3. Pentachlorophenol readily penetrates the skin; systemic intoxication is cumulative and has been fatal. Intoxication is characterized by weakness, anorexia, weight loss, and profuse sweating; there also may be headache, dizziness, nausea, vomiting, dyspnea, and chest pain. In fatal cases, the body temperature is frequently extremely high and

---

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

September 1978

death has occurred as early as 3 hours after the onset of symptoms. The risk of serious intoxication is increased during hot weather; persons with impaired liver or kidney function are more susceptible to the effects of pentachlorophenol. The dust, mist, and vapor cause eye irritation. Prolonged exposure of workers has caused an acneform dermatitis; 10 workers engaged in production of pentachlorophenol for 5 to 10 months developed a widely disseminated skin eruption characterized by small and large furuncles, brown pigmentation, and some cicatrization; 7 workers also developed severe bronchitis; all but 1 worker still showed signs of extensive acne more than a year after cessation of exposure, and 4 still complained of bronchitis. On the skin, solutions of pentachlorophenol as dilute as 1% may cause irritation if contact is repeated or prolonged.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 266.3
2. Boiling point (760 mm Hg): 311 C (592 F) (decomposes)
3. Specific gravity (water = 1): 2.0
4. Vapor density (air = 1 at boiling point of pentachlorophenol): Not applicable
5. Melting point: 182 – 190 C (360 – 374 F)
6. Vapor pressure at 20 C (68 F): 0.00017 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.002
8. Evaporation rate (butyl acetate = 1): Not applicable

- **Reactivity**

1. Conditions contributing to instability: None.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen chloride, chlorinated phenols, and carbon monoxide) may be released when pentachlorophenol decomposes.
4. Special precautions: None.

- **Flammability**

1. Not combustible

- **Warning properties**

1. Odor Threshold: The AIHA *Hygienic Guide* states that pentachlorophenol has a characteristic odor. No quantitative information is available, however, concerning the odor threshold of this substance.
2. Irritation Levels: The *Documentation of TLV's* states that "dusts are particularly irritating to the eyes and nose, in concentrations appreciably greater than 1 mg/m^3, but some irritation of the nose may occur at 0.3 mg/m^3. Hardened workers can tolerate up to 2.4 mg/m^3."
3. Evaluation of Warning Properties: Through its irritant effects, pentachlorophenol can be detected within three times of the permissible exposure limit. For the purposes of this guideline, therefore, pentachlorophenol is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

An analytical method for pentachlorophenol is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 4, 1978, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00317-3).

- Gleason, M. N., Gosselin, R. E., Hodge, H. C., and Smith, R. P.: *Clinical Toxicology of Commercial Products* (3rd ed.), Williams and Wilkins, Baltimore, 1969.

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with pentachlorophenol or liquids containing pentachlorophenol.
- If employees' clothing has had any possibility of being contaminated with pentachlorophenol or liquids containing pentachlorophenol, employees should change into uncontaminated clothing before leaving the work premises.

- Clothing which has had any possibility of being contaminated with pentachlorophenol should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of pentachlorophenol from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the pentachlorophenol, the person performing the operation should be informed of pentachlorophenol's hazardous properties.
- Where there is any possibility of exposure of an employee's body to pentachlorophenol or liquids containing pentachlorophenol, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with pentachlorophenol should be removed immediately and not reworn until the pentachlorophenol is removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of pentachlorophenol or liquids containing pentachlorophenol contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to pentachlorophenol or liquids containing pentachlorophenol, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with pentachlorophenol should be immediately washed or showered with soap or mild detergent and water to remove any pentachlorophenol.
- Workers subject to skin contact with pentachlorophenol or liquids containing pentachlorophenol should wash with soap or mild detergent and water any areas of the body which may have contacted pentachlorophenol at the end of each work day.
- Eating and smoking should not be permitted in areas where pentachlorophenol or liquids containing pentachlorophenol are handled, processed, or stored.
- Employees who handle pentachlorophenol or liquids containing pentachlorophenol should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to pentachlorophenol may occur and control methods which may be effective in each case:

Operation	Controls
Formulation of preservatives, pesticides, and fungicides	Process enclosure; local exhaust ventilation; personal protective equipment
Application as a preservative for wood, starch, paint, adhesives, leather, latex, and oils; use in slime-algae control; use as a pesticide, herbicide, and snail control agent	Personal protective equipment
Manufacture of pentachlorophenol	Process enclosure; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If pentachlorophenol or liquids containing pentachlorophenol get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If pentachlorophenol or liquids containing pentachlorophenol get on the skin, immediately wash the contaminated skin using soap or mild detergent and water. If pentachlorophenol or liquids containing pentachlorophenol penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation is present after washing, get medical attention.

- **Breathing**

If a person breathes in large amounts of pentachlorophenol, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When pentachlorophenol or liquids containing pentachlorophenol have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.
- If pentachlorophenol is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. Collect spilled material in the most convenient and safe manner and depost in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing pentachlorophenol should be absorbed in vermiculite, dry sand, earth, or a similar material.

- Waste disposal method:

Pentachlorophenol may be disposed of in sealed containers in a secured sanitary landfill.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Pentachlorophenol," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- American Industrial Hygiene Association: "Pentachlorophenol and Sodium Pentachlorophenate," *Hygienic GuideSeries*, Detroit, Michigan, 1970.
- Baader, E. W., and Bauer, H. J.: "Industrial Intoxication Due to Pentachlorophenol," *Industrial Medicine and Surgery*, 20:286-290, 1951.
- Bergner, H., et al.: "Industrial Pentachlorophenol Poisoning in Winnipeg," *Canadian Medical Association Journal*, 92:448-451, 1965.
- Christensen, H. E., and Luginbyhl, T. L. (eds.): *NIOSH Toxic Substances List*, 1974 Edition, HEW Publication No. 74-134, 1974.
- Fairhall, L. T.: *Industrial Toxicology* (2nd ed.), Williams and Wilkins, Baltimore, 1957
- Gleason, M. N., Gosselin, R. E., Hodge, H. C., and Smith, R. P.: *Clinical Toxicology of Commercial Products* (3rd ed.), Williams and Wilkins, Baltimore, 1969. *1969.*
- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.
- Hayes, W. J., Jr.: *Clinical Handbook on Economic Poisons, Emergency Information for Treating Poisoning*, U.S. Public Health Service Publication No. 476, U.S. Government Printing Office, Washington, D.C., 1963.
- Hunter, D.: *Diseases of Occupations* (4th ed.), Little, Brown, Boston, 1969.
- International Labour Office: *Encyclopedia of Occupational Health and Safety*, McGraw-Hill, New York, 1971.
- Johnstone, R. T., and Miller, S. E.: *Occupational Disease and Industrial Medicine*, Saunders, Philadelphia, 1960.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.
- Spector, W. S. (Vols. I, II), Negherbon, W. O. (Vol. III), Grebe, R. M. (Vol. IV), and Dittmer, D. S. (Vol. V) (eds.): *Handbook of Toxicology*, Saunders, Philadelphia, 1956-1959.
- Thienes, C. H., and Haley, T. J.: *Clinical Toxicology* (5th ed.), Lea and Febiger, Philadelphia, 1972.

The TLV of 0.5 mg/m³ is believed low enough to minimize the incidence of chloracne and prevent serious injury to the liver. However, in view of the fact that hepatic changes in rats resulted from 143 eight-hour exposures at 1.44 mg/m³ of a mixture of penta- and hexachloronaphthalenes,[5] the margin of safety of the 0.5 mg/m³ limit for pentachloronaphthalene may be rather small. At this time, a STEL of 2 mg/m³ is suggested.

References:

1. **von Oettingen, W.F.:** *The Halogenated Hydrocarbons, Their Toxicity & Potential Dangers.* Public Health Service Pub. #414 p. 313 (1955).
2. **Cotter, L.H.:** *J.A.M.A. 125*:273 (1944).
3. *Annual Report of the Chief Inspector of Factories for 1938,* p. 67, H.M.S.O., London (1939).
4. **Drinker, C.K., Warren, M.F., Bennett, G.A.:** *J. Ind. Hyg. & Tox. 19*:283 (1937).
5. **Bennett, G.A., Drinker, C.K., Warren, M.F.:** *Ibid. 20*:97 (1938).
6. **Drinker, C.K.** *Ibid.* 2:155 (1939).
7. **Bell, W.B.:** *Vet. Med. 48*:135 (1953).

PENTACHLOROPHENOL

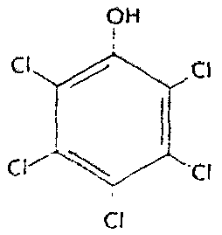
PCP; Chem-Tol; Permacide; Penta; Santophen 20; Dowicide 7

C_6HCl_5O

Skin

TLV, 0.5 mg/m³

STEL, 1.5 mg/m³



Pentachlorophenol is a colorless, noncombustible solid with a phenolic odor and a pungent taste. The molecular weight is 266.35, specific gravity is 1.978 at 20° C and, at the same temperature, the reported vapor pressure of 0.00017 mm Hg. It is volatile with steam and noncorrosive to metals. Its melting point is 190° C with a boiling point of 310° C. The compound is soluble in water to the extent of 14 ppm at 20° C. Its solubility in organic solvents depends greatly on the nature of the solvent. Barely soluble in alkanes, pentachlorophenol is most soluble in methyl alcohol.

It is a contact herbicide, fungicide, wood preservative and molluscicide.

The most important effect of PCP inhalation is acute poisoning centering in the circulatory system with accompanying heart failure. Kehoe et al[1] found no evidence of chronic poisoning in rabbits. The smallest lethal intravenous dose was 22 mg/kg. The compound penetrates the skin readily. Physiologic injury is mainly vascular with heart failure. Industrial hygiene experience shows that PCP and its sodium salt are capable of inducing discomfort and local as well as systemic effects. Dusts are particularly irritating to the eyes and nose in concentrations greater than 1 mg/m³.[2] Some irritation of the nose may occur at 0.3 mg/m³.[2] Hardened workers can tolerate up to 2.4 mg/m³.[2] PCP is highly poisonous with a wide range of acute action but no pronounced cumulative properties. It has been demonstrated[3] that dermal penetration is the most dangerous pathway of PCP exposure. The acute gastric LD_{50}s for mice and rats are 130 and 184 mg/kg, respectively.[3] The dermal LD_{50} in rats is 96 mg/kg. The inhalation LD_{50} for rats is 335 mg/m³ and for mice 225 mg/m³.[3] The rat embryo was shown to be most susceptible to the toxic effects of PCP during the early phases of organogenesis.[4] The world literature reveals about 51 cases of PCP poisoning from its use as a herbicide, molluscicide or wood preservative of which 30 out of 51 resulted in death.[5] The survivors of PCP intoxication suffer with impairments in autonomic function, circulation, visual damage and an acute type of scotoma.[6] Other damage included acute inflammation of the conjunctiva and characteristically shaped corneal opacity, corneal numbness and slight mydriasis.[6] Other symptoms involve excessive sweating, tachycardia, tachypnea, respiratory distress, hepatic enlargement and metabolic acidosis.

The 0.5 mg/m³ TLV and the STEL of 1.5 mg/m³ are derived by analogy with other compounds of similar action and toxicity in addition to the specific available information. They are believed low enough to prevent vascular injury.

References:

1. **Kehoe, R.A., Deichmann-Gruebler, W., Kitzmiller, K.V.:** *J. Ind. Hyg. & Tox. 21*:160 (1939).
2. **Patty, F.A.:** *Industrial Hygiene & Toxicology,* 2nd ed., Vol. II, p. 1401 Interscience, NY (1963).
3. **Demidenko, N.M.:** *Gigiena Truda i Prof. Zabolevaniya 13(9)*:58 (1969).
4. **Schwetz, B.A., Gehring, P.J.:** *Tox. Appl. Pharm. 24(3)*:455 (1973).
5. **Anonymous:** *Calif. Health 27(12)*:13 (1970).
6. **Imaizum, K.:** *Atsumi. K. Gankai 3(7)*:717 (1971).

SYNS:

- ISOAMYL PHENYLAMINOACETATE HYDROCHLORIDE
- ISOPENTYL-2-PHENYLGLYCINATE HYDROCHLORIDE
- 3-METHYLBUTYL ALPHA-AMINOBENZENEACETATE HYDROCHLORIDE (±)-
- PHENYLAMINOACETIC ACID ISOAMYL ESTER HYDROCHLORIDE
- d,l-2-PHENYLGLYCINISOAMYLESTERHYDROCHLORID (GERMAN)

TOXICITY DATA: 3-2	CODEN:
orl-mus LD50:2600 mg/kg	PHARAT 33,749,78
ipr-mus LD50:415 mg/kg	PHARAT 30,765,75
ivn-mus LD50:77 mg/kg	PHARAT 33,749,78

THR: HIGH ipr, ivn; MOD orl.
Disaster Hazard: When heated to decomp it emits very tox fumes of Cl^- and NO_x.

PHENANTHRA-ACENAPHTHENE

CAS RN: 7258915 NIOSH #: QI 9400000
mf: $C_{24}H_{16}$; mw: 304.40

SYN: 4,5-DIHYDRO-NAPHTHA(1,2-K)ACEPHENANTHRYLENE

TOXICITY DATA: 3	CODEN:
skn-mus TDLo:1250 mg/kg/52W-I:ETA	PRLBA4 117,318,35

THR: An exper ETA via skn in mus.
Disaster Hazard: When heated to decomp it emits acrid smoke and fumes.

PHENANTHRENE

CAS RN: 85018 NIOSH #: SF 7175000
mf: $C_{14}H_{10}$; mw: 178.24

Solid or monoclinic crystals. mp: 100°, bp: 339°, d: 1.179 @ 25°, vap. press: 1 mm @ 118.3°, vap. d: 6.14. Insol in water; sol in CS_2 benzene, hot alcohol; very sol in ether.

SYN: PHENANTHREN (GERMAN)

TOXICITY DATA: 3	CODEN:
dnd-sal:spr 3 gm/L	BIPMAA 5,477,67
dnd-sal:tes 5 ug/1H-C	BIJOAK 110,159,68
dnd-ham:kdy 5 mg/L	BCPCA6 20 1297,71
mma-sat 100 ug/plate	APSXAS 17,189,80
dnd-ham:fbr 5 mg/L/24H	BCPCA6 20,1297,71
cyt-ham:lng 40 mg/L/27H	MUREAV 66,277,79
sce-ham-ipr 900 mg/kg/24H	MUREAV 66,65,79
sce-ham:fbr 10 umol/L	JNCIAM 58,1635,77
skn-mus TDLo:71 mg/kg:NEO	JNCIAM 50,1717,73
skn-mus TD:22 gm/kg/10W-I:ETA	BJCAAI 10,363,56
orl-mus LD50:700 mg/kg	HYSAAV 29,19,64
ivn-mus LD50:56 mg/kg	CSLNX* NX#00190

"NIOSH Manual of Analytical Methods" VOL 1 206. Reported in EPA TSCA Inventory, 1980. EPA TSCA 8(a) Preliminary Assessment Information Proposed Rule FERREAC 45,13646,80.
THR: MUT data. An exper NEO, ETA. HIGH ivn. MOD orl. A hmn skn photosensitizer. A slight fire hazard.
To Fight Fire: water, foam, CO_2, dry chemical.
Disaster Hazard: When heated to decomp it emits acrid smoke and fumes.

PHENANTHRENE-3,4-DIHYDRODIOL

NIOSH #: SF 7353
.. $C_{14}H_{12}O_2$; mw: 212.26

SYNS:

- 3,4-DIHYDROMORPHOL
- 3,4-DIHYDRO-3,4-PHENANTHRENEDIOL

TOXICITY DATA: 3	CODEN:
skn-mus TDLo:85 mg/kg:ETA	CNREA8 39,4069,79

THR: An exper ETA.
Disaster Hazard: When heated to decomp it emits smoke and fumes.

PHENANTHRENE EPOXIDE

NIOSH #: SF 7704500
mf: $C_{14}H_8O$; mw: 192.22

TOXICITY DATA:	CODEN:
otr-ham:emb 5 mg/L	CNREA8 32,1391,72

THR: MUT data.

9,10-PHENANTHRENE OXIDE

CAS RN: 585080 NIOSH #: SF 7352000
mf: $C_{14}H_{10}O$; mw: 194.24

Colorless needles; mp: 152°-153°; very slightly sol in water; very sol in alc, ether.

SYNS:

- 9,10-EPOXY-9,10-DIHYDROPHENANTHRENE
- PHENANTHRENE-9,10-EPOXIDE
- 1A,9B-DIHYDROPHENANTHRO(9,10-B)OXIRENE,(9CI)

TOXICITY DATA: 3	CODEN:
mma-sat 100 ug/plate	MUREAV 66,337,79
skn-mus TDLo:40 mg/kg:ETA	JNCIAM 39,1217,67

THR: MUT data. An exper ETA.
Disaster Hazard: When heated to decomp it emits acrid smoke and fumes.

PHENANTHRENEQUINONE

CAS RN: 84117 NIOSH #: SF 7875000
mf: $C_{14}H_8O_2$; mw: 208.22

Orange needles; d: 1.405 @ 4°; mp: 206.5°-207.5°; bp: > 300° subl; very slightly sol in water; sol in hot alc, benzene; slightly sol in ether.

SYNS:

- 9,10-PHENANTHRAQUINONE
- 9,10-PHENANTHRENEDIONE
- 9,10-PHENANTHRENEQUINONE

TOXICITY DATA: 3	CODEN:
skn-mus TDLo:800 mg/kg/29W-C:ETA	PIATA? 16,309,40
ipr-mus LDLo:165 mg/kg	HBTXAC 5,110,59

Reported in EPA TSCA Inventory, 1980.
THR: An exper ETA. HIGH acute ipr.
Disaster Hazard: When heated to decomp it emits acrid smoke and fumes.

Occupational Health Guideline for Phenol

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: C_6H_5OH
- Synonyms: Carbolic acid; monohydroxybenzene
- Appearance and odor: Colorless to pink solid or thick liquid with a characteristic, sweet, tarry odor

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for phenol is 5 parts of phenol per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 19 milligrams of phenol per cubic meter of air (mg/m³). NIOSH has recommended that the permissible exposure limit be changed to 20 mg/m³ averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling of 60 mg/m³ averaged over a 15-minute period. The NIOSH Criteria Document for Phenol should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Phenol can affect the body if it is inhaled, comes in contact with the eyes or skin, or is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

1. Short-term Exposure: Phenol has a marked corrosive effect on any tissue. When it comes in contact with the eyes, it may cause severe damage and blindness. On contact with the skin, it does not cause pain but causes a whitening of the exposed area. If the chemical is not removed promptly, it may cause a severe burn or systemic poisoning. Systemic effects may occur from any route of exposure, especially after skin contact.

2. Long-term Exposure: Repeated or prolonged exposure to phenol may cause chronic phenol poisoning. The symptoms of chronic poisoning include vomiting, difficulty in swallowing, diarrhea, lack of appetite, headache, fainting, dizziness, dark urine, mental disturbances, and possibly a skin rash. Liver damage and discoloration of the skin may occur.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to phenol.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to phenol at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a history of convulsive disorders or abnormalities of the skin, respiratory tract, liver, or kidneys would be expected to be at increased risk from exposure. Examination of the liver, kidneys, and respiratory tract should be stressed. The skin should be examined for evidence of chronic disorders.

—Urinalysis: Darkening of the urine has occurred in persons exposed to phenol after accidental ingestion or skin contact. A urinalysis should be performed, including at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment. Urinary phenol is useful if good individual background levels are available.

—Liver function tests: Since liver damage has been observed in humans exposed to phenol, a profile of liver function should be performed by using a medically acceptable array of biochemical tests.

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

September 1978

2. *Periodic Medical Examination:* The aforementioned medical examinations should be repeated on an annual basis.

- **Summary of toxicology**

Phenol in the vapor form or in solution is an irritant to the eyes, mucous membranes, and skin; systemic absorption causes central nervous system effects as well as liver and kidney damage. Sudden collapse is characteristic of gross overexposure. In animals, prolonged inhalation of the vapor at 30 to 60 ppm induced respiratory difficulty, lung damage, and paralysis. Systemic absorption by animals caused muscle twitching and severe convulsions. There are no reports of human fatalities from inhalation of the vapor, although one case of severe poisoning has been reported. Ingestion of lethal amounts (as little as 1 g) cause severe burns of the mouth and throat, marked abdominal pain, cyanosis, muscular weakness, collapse, coma, and death; tremors, convulsions, or muscle twitching were occasionally observed but were not severe. A laboratory technician repeatedly exposed to unknown vapor concentrations and liquid spilled on the skin developed anorexia, weight loss, weakness, muscle aches and pain, and dark urine; during several months of nonexposure there was gradual improvement in his condition, but after brief reexposure he suffered an immediate worsening of symptoms with prompt darkening of the urine and tender enlargement of the liver. Brief intermittent industrial exposures to vapor concentrations of 48 ppm of phenol (accompanied by 8 ppm of formaldehyde) caused marked irritation of eyes, nose, and throat. Concentrated phenol solutions are severely irritating to the human eye and cause conjunctival swelling; the cornea becomes white and hypesthetic; loss of vision has occurred in some cases. Solutions of phenol have a marked corrosive action on any tissue on contact; on skin, there is local anesthesia and a white discoloration, and the area may subsequently become gangrenous; severe dermatitis will result from contact with dilute solutions, and prolonged exposure may result in ochronosis. In workers making phenol-formaldehyde plastic, the urinary level of total phenol, free plus conjugated, was proportional to the air concentration of phenol up to 12.5 mg/m^3 of workroom air. Mice were treated twice weekly for 72 weeks by application of 1 drop of a 10% solution of phenol in benzene to the shaved dorsal skin; after 52 weeks of treatment there were papillomas in 5 of 14 mice, and 1 fibrosarcoma appeared at 58 weeks.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 94.11
2. Boiling point (760 mm Hg): 182 C (359 F)
3. Specific gravity (water = 1): 1.07 (solid); 1.05 (liquid)
4. Vapor density (air = 1 at boiling point of phenol): 3.24
5. Melting point: 41 C (106 F)
6. Vapor pressure at 20 C (68 F): 0.36 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 8.4
8. Evaporation rate (butyl acetate = 1): Less than 0.01

- **Reactivity**

1. Conditions contributing to instability: Heat
2. Incompatibilities: Contact with strong oxidizers (especially calcium hypochlorite) may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as carbon monoxide) may be released in a fire involving phenol.
4. Special precautions: Liquid phenol will attack some forms of plastics, rubber, and coatings. Hot liquid phenol will attack aluminum, magnesium, lead, and zinc metals.

- **Flammability**

1. Flash point: 79 C (174 F) (closed cup)
2. Autoignition temperature: 715 C (1319 F)
3. Flammable limits in air, % by volume: Lower: 1.7; Upper: 8.6
4. Extinguishant: Alcohol foam, carbon dioxide, dry chemical

- **Warning properties**

1. Odor Threshold: Summer reports that the odor threshold of phenol is 3 ppm; the Manufacturing Chemists Association reports 0.3 ppm; Thienes and Haley report 5 ppm.
2. Irritation Levels: The *Documentation of TLV's* reports that intermittent exposures to 48 ppm phenol have been observed to produce eye, nose, and throat irritation. Formaldehyde was also present in this atmosphere at a concentration of 8 ppm. The Respirator Review Committee considers the source of the eye irritation to be the 8 ppm formaldehyde rather than the phenol.
3. Evaluation of Warning Properties: Since the odor threshold of phenol is at or below the permissible exposure limit, phenol is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

- **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of phenol. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

- Method

Sampling and analyses may be performed by collection of phenol in a bubbler containing sodium hydroxide, followed by treatment with sulfuric acid, and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure phenol may be used. An analytical method for phenol is in the *NIOSH Manual of Analytical Methods,* 2nd Ed., Vol. 6, 1980, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00369-6).

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

- Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent any possibility of skin contact with solid or liquid phenol or liquids containing phenol.
- If employees' clothing has had any possibility of being contaminated with solid or liquid phenol or liquids containing phenol, employees should change into uncontaminated clothing before leaving the work premises.
- Clothing which has had any possibility of being contaminated with solid or liquid phenol or liquids containing phenol should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of phenol from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the phenol, the person performing the operation should be informed of phenol's hazardous properties.
- Where there is any possibility of exposure of an employee's body to solid or liquid phenol or liquids containing phenol, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.
- Non-impervious clothing which becomes contaminated with phenol should be removed immediately and not reworn until the phenol is removed from the clothing.
- Employees should be provided with and required to use dust- and splash-proof safety goggles where there is any possibility of solid or liquid phenol or liquids containing phenol contacting the eyes.
- Where there is any possibility that employees' eyes may be exposed to solid or liquid phenol or liquids containing phenol, an eye-wash fountain should be provided within the immediate work area for emergency use.

SANITATION

- Skin that becomes contaminated with phenol should be immediately washed or showered with soap or mild detergent and water to remove any phenol.
- Any clothing which becomes wet with liquid phenol or liquids containing phenol should be removed immediately and not reworn until the phenol is removed from the clothing.
- Eating and smoking should not be permitted in areas where solid or liquid phenol or liquids containing phenol are handled, processed, or stored.
- Employees who handle solid or liquid phenol or liquids containing phenol should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to phenol may occur and control methods which may be effective in each case:

Operation	Controls
Application and curing of bonding resin in plywood manufacture; application and curing of molding resins in manufacture of molded articles, such as	Process enclosure, local exhaust ventilation; personal protective equipment

electrical appliances, automotive parts, foundry sand molds, and utensil handles; manufacture of friction materials, bonded abrasives, coated abrasives, wood particle board, and insulation materials	
Use in industrial coatings in drum and can linings, milk and beer-processing equipment, water tanks and air-conditioning equipment, decorative laminates, and textile coatings	Process enclosure; local exhaust ventilation; personal protective equipment
Use in synthesis of thermosetting phenolic resins, epoxy, polycarbonate, phenoxy, and polysulfone; synthesis of aprolactam for use in nylon 6 fibers, plastics, and films	Process enclosure; local exhaust ventilation; personal protective equipment
Use in synthesis of agricultural chemicals and intermediates; synthesis of pharmaceuticals, rubber and plastic plasticizers, antioxidants, curing agents, and intermediates	Process enclosure; local exhaust ventilation; personal protective equipment
Use in synthesis of stabilizers and preservatives for dyes, perfumes, and fungicides	Process enclosure; local exhaust ventilation; personal protective equipment
Use during solvent refining of lubrication oil and wax; use in synthesis of additives for gasoline and lubricating fluids and intermediates	Process enclosure; local exhaust ventilation; personal protective equipment
Use in synthesis of intermediates in polyester production; production of corrosion-resistant polyester and polyester polyols; use in synthesis of dye intermediates	Process enclosure; local exhaust ventilation; personal protective equipment
Use in synthesis of surface-active agents and detergent intermediates; in synthesis of explosives	Process enclosure; local exhaust ventilation; personal protective equipment
Use in manufacture of disinfectant agents and products for industrial and household use	Process enclosure; local exhaust ventilation; personal protective equipment
Use in synthesis of synthetic cresols and xylenols	Process enclosure; local exhaust ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye Exposure**

If solid or liquid phenol or liquids containing phenol get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.

- **Skin Exposure**

If solid or liquid phenol or liquids containing phenol get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If solid or liquid phenol or liquids containing phenol penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Get medical attention immediately.

- **Breathing**

If a person breathes in large amounts of phenol, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

- **Swallowing**

When solid or liquid phenol or liquids containing phenol have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

- **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

- Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.
- If phenol is spilled or leaked, the following steps should be taken:

1. Ventilate area of spill.
2. If in the solid form, for small quantities, sweep onto paper or other suitable material, place in an appropriate container and burn in a safe place (such as a fume hood). Large quantities may be reclaimed; however, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber.
3. If in the liquid form, for small quantities, absorb on paper towels. Evaporate in a safe place (such as a fume hood). Allow sufficient time for evaporating vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber.

- Waste disposal methods:

Phenol may be disposed of:

1. If in the solid form, by making packages of phenol in paper or other flammable material and burning in a suitable combustion chamber, or by dissolving phenol in a flammable solvent (such as alcohol) and atomizing in a suitable combustion chamber.
2. If in the liquid form, by absorbing it in vermiculite, dry sand, earth or a similar material and disposing in a secured sanitary landfill, or by atomizing the liquid in a suitable combustion chamber.

REFERENCES

- American Conference of Governmental Industrial Hygienists: "Phenol," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.
- American Industrial Hygiene Association: "Phenol," *Hygienic Guide Series*, Detroit, Michigan, 1957.
- Baskin, A. D. (ed.): *Handling Guide for Potentially Hazardous Commodities*, Railway Systems and Management Association, Chicago, 1972.
- Boutwell, R. K., and Bosch, D. K.: "The Tumor-promoting Action of Phenol and Related Compounds for Mouse Skin," *Cancer Research*, 19:413-424, 1959.
- Christensen, H. E., and Luginbyhl, T. L. (eds.): *NIOSH Toxic Substances List*, 1974 Edition, HEW Publication No. 74-134, 1974.
- Community Air Quality Guides: "Phenol and Cresol," *American Industrial Hygiene Association Journal*, 30:425-428, 1969
- Deichmann, W. B., and Witherup, S.: "Phenol Studies VI: The Acute and Comparative Toxicity of Phenol and o-, m-, and p-Cresols for Experimental Animals," *Journal of Pharmacolology and Experimental Therapy*, 80, 233, 1944.
- Fairhall, L. T.: *Industrial Toxicology* (2nd ed.), Williams and Wilkins, Baltimore, 1957.
- Gleason, M. N., Gosselin, R. E., Hodge, H. C., and Smith, R. P.: *Clinical Toxicology of Commercial Products* (3rd ed.), Williams and Wilkins, Baltimore, 1969
- Grant, W. M.: *Toxicology of the Eye* (2nd ed.), C. C. Thomas, Springfield, Illinois, 1974.
- *Hygienic Information Guide No. 40 – Phenol*, Commonwealth of Pennsylvania, Department of Environmental Resources, Bureau of Occupational Health, 1968.
- Jacobs, M.: *The Analytical Chemistry of Industrial Poisons, Hazards, and Solvents*, Interscience, New York, 1956
- Manufacturing Chemists Association, Inc.: *Chemical Safety Data Sheet SD-4, Phenol*, Washington, D.C., 1964
- Merliss, R. R.: "Phenol Marasmus," *Journal of Occupational Medicine*, 14:55-56, 1972.
- National Institute for Occupational Safety and Health, U.S. Department of Health, Education, and Welfare: *Criteria for a Recommended Standard . . . . Occupational Exposure to Phenol*, HEW Publication No (NIOSH) 76-196, GPO No. 017-033-00184-7, U.S. Government Printing Office, Washington, D.C., 1976.
- Ohtsuji, H., and Ikeda, M.: "Quantitative Relationship between Atmospheric Phenol Vapour and Phenol in the Urine of Workers in Bakelite Factories," *British Journal of Industrial Medicine*, 29:70-73, 1972.
- Patty, F. A. (ed.): *Toxicology*, Vol. II of *Industrial Hygiene and Toxicology* (2nd ed. rev.), Interscience, New York, 1963.
- Sax, N. I.: *Dangerous Properties of Industrial Materials* (3rd ed.), Van Nostrand Reinhold, New York, 1968.
- Spector, W. S. (Vols. I, II), Negherbon, W. O. (Vol. III), Grebe, R. M. (Vol. IV), and Dittmer, D. S. (Vol. V) (eds.): *Handbook of Toxicology*, Saunders, Philadelphia, 1956-1959.
- Summer, W.: *Odor Pollution of Air: Causes and Control*, L. Hill, London, 1975.
- Thienes, C. H., and Haley, T. J.: *Clinical Toxicology* (5th ed.), Lea and Febiger, Philadelphia, 1972.
- Union Carbide Corporation, Industrial Medicine and Toxicology Department: *Toxicology Studies – Phenol*, New York, 1966.

RESPIRATORY PROTECTION FOR PHENOL

Condition	Minimum Respiratory Protection* Required Above 5 ppm
Vapor or Particulate Concentration	
50 ppm or less	Any chemical cartridge respirator with an organic vapor cartridge(s) and dust and mist filter(s). Any supplied-air respirator. Any self-contained breathing apparatus.
100 ppm or less	A chemical cartridge respirator with a full facepiece, organic vapor cartridge(s), and dust and mist filter(s). A gas mask with a chin-style or a front- or back-mounted organic vapor canister and dust and mist filter. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
Greater than 100 ppm** or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates. Any escape self-contained breathing apparatus.

---

*Only NIOSH-approved or MSHA-approved equipment should be used.

**Use of supplied-air suits may be necessary to prevent skin contact while providing respiratory protection from airborne concentrations of phenol; however, this equipment should be selected, used, and maintained under the immediate supervision of trained personnel. Where supplied-air suits are used above a concentration of 100 ppm, an auxiliary self-contained breathing apparatus operated in positive pressure mode should also be worn.

References:

1. **NIOSH:** *Toxic Substances List.* HEW Pub. No. (NIOSH) 74-134 (1974).
2. **Dow Chemical Company:** Communication to TLV Committee (1977).

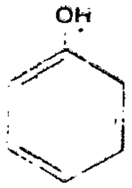
PHENOL

C_6H_5OH

Skin

TLV, 5 ppm (≈ 19 mg/m³)

STEL, 10 ppm (≈ 38 mg/m³)



Pure phenol is a solid at room temperature and is liquified by mixing with about 8% water. The molecular weight is 94.11 and the specific gravity is 1.071. It is white but often has a pinkish hue resulting from impurities or exposure to light and has a characteristic sweet, tarry odor. The solid has a boiling point of 182° C and, when free from water and cresols, it congeals at 41° C and melts at 43° C. At 25° C it has a vapor pressure of 0.35 mm Hg. It is soluble in water and most organic solvents and is combustible having a closed cup flash point of 172° F.

Its chief use is as a starting point in the manufacture of phenolic resins, bis-phenol-A, caprolactam and many other chemicals and drugs. It is employed as a disinfectant, in germicidal paints and as a slimicide.

Deichmann[1] reported results of animal experimentation in which guinea pigs were severely injured by inhalation for 20 days of phenol vapor at concentrations of from 25 to 50 ppm. Post mortem evidence of acute toxicity to the lungs, heart, liver and kidney was found.

Intermittent industrial exposure[2] (five to ten minutes per hour) inside a conditioning room for phenol-impregnated asbestos resulted in marked irritation of the nose, throat and eyes. The average phenol concentration in the room was 48 ppm, although formaldehyde (8 ppm) also was found. Urine sulfate ratios were 79.4 and 86.7 percent. Workers at the same plant, continuously exposed during winding operations, experienced no respiratory irritation although the odor of phenol was noticeable. The average concentration found was 4 ppm. Urine sulfate ratios averaged 74 percent.

Due in part to its low volatility, phenol does not frequently constitute a serious respiratory hazard in industry.[3] Formerly its use as an antiseptic in surgery resulted in numerous cases of sub-acute or chronic poisoning among surgeons and their assistants.[4] Urinary excretions of 2 grams per day, by patients, have been reported.[4] Absorption of 2 grams of phenol could result from eight hours inhalation at about 50 ppm.

According to Thomas and Back[5] the TLV of 5 ppm provides a sufficiently large factor of safety to prevent systemic poisoning if skin absorption is avoided.

In 1976 NIOSH published a criteria document in which the toxicology of phenol was reviewed.[6] The serious local and systemic effects of contact of the skin with phenol and its concentrated solutions were properly emphasized. Relatively little additional information on the effects of inhalation bearing on the TLV, however, turned up. A report by Petrov[7] of poisonings among workers in Russia who quenched coke with waste water containing 0.3 to 0.8 mg of phenol per liter is discussed. Air samples indicated phenol vapor concentrations of the order of 2 to 3 ppm, and the author believed that phenol might have been implicated in the intoxications, which were not described.

The NIOSH recommendation of 20 mg/m³ as a time-weighted average standard is essentially the same as the TLV of 5 ppm established in 1952. The NIOSH ceiling of 60 mg/m³ for any 15 minute period is higher than the STEL of 10 ppm (38 mg/m³).

Except for the USSR, which has set an MAC of 1.3 ppm, most of the published hygienic standards (East and West Germany, Sweden, Czechoslovakia) are either 19 or 20 mg/m³ or, for practical purposes, 5 ppm.

References:

1. **Deichmann, W.B., Kitzmiller, K.V., Witherup, S.:** Am. J. Clin. Path. 14:273 (1944).
2. **Connecticut Bur. of Ind. Hygiene:** Unpublished data.
3. **Elkins, H.B.:** The Chemistry of Industrial Toxicology, 2nd ed., p. [illegible] John Wiley & Sons, NY (1959).
4. **Patty, F.A.:** Industrial Hygiene & Toxicology, 2nd rev. ed., Vol. II, p. 1370. Interscience, NY (1963).
5. **Thomas, A.A., Back, K.C.:** A Symposium on Toxicity in the Closed Ecologic System, p. 135. Honma & Crosby, Ed. Lockheed Missiles & Space Co., Palo Alto, CA (1964).
6. **NIOSH:** *Criteria for a Recommended Standard—Occupational Exposure to Phenol.* HEW Publication No. (NIOSH) 76-196 (1976).
7. **Petrov, V.I.:** Cases of Phenol Vapor Poisoning During Coke Slaking with Phenol Water. In **Levine, B.S. (transl.):** *USSR Literature on Air Pollution and Related Occupational Diseases—A Survey.* U.S. Dept. of Commerce, National Technical Information Service 8:219 (1963) (NTIS 63-11570). Springfield, VA. Cited by NIOSH in ref. 6.

9. **Cook, W.A.:** *Ind. Med.* 14:936 (1945).
10. **Ouw, H.K., Simpson, G.R., Siyali, D.S.:** *Arch. Env. Health* 31: 189 (1976).
11. **NIOSH:** *Criteria for a Recommended Standard — Occupational Exposure to Polychlorinated Biphenyls* (1977)

CHLORODIPHENYL — 54% CHLORINE

Polychlorinated biphenyl; PCB; Arochlor 1254

$C_6H_2Cl_3C_6H_3Cl_2$

Skin

TLV, 0.5 mg/m³

STEL, 1.0 mg/m³

A pale yellow, viscous liquid with a mild hydrocarbon odor, 54% PCB has a molecular weight of 326. It has a distillation range of 365-390° C, a melting point of 10° C and a vapor pressure of 0.00006 mm Hg at 20° C. The closed cup flash point is 432° F. It is insoluble in water, glycerine and glycols, but is soluble in most common organic solvents.

PCB's are in insulating liquids (Askarel), synthetic rubber, plasticizers, flame retardants, floor tile, printer's ink, coatings for paper and fabric, brake linings, paints, automobile body sealants, investments casting waxes (decachlorobiphenyl wax), asphalt, adhesives and similar products.

Drinker,(1) on the basis of extensive animal experiments involving chlorodiphenyls and chloronaphthalenes, concluded that the permissible limit for occupational exposure should be 0.5 mg/m³ for chlorinated diphenyl containing 50 to 55% chlorine. Curiously he found the product containing 60% chlorine less toxic, and for it recommended a limit of 10 mg/m³.

Treon and associates(2) studied the effects of chlorinated diphenyl containing 54% chlorine in animals exposed daily for seven hours for a period of 150 days. Slight reversible liver changes were noted from 1.5 mg/m³, while 5.4 mg/m³ resulted in more serious liver injury. A TLV of 1 mg/m³ was recommended.

Largely because of their chemical stability, resistance to biodegradation and lipid solubility, the chlorodiphenyls (PCB's) have become significant contaminants of global ecosystems. Toxicity studies have concentrated on the effects of contaminations of diets with small amounts of various PCB's.(3)

It is clear that the chronic toxicities of these compounds, up to a chlorine content of 54% at least, increase as the degree of chlorination increases, although the location of the chlorine atoms in the molecule may also be important.(3,4) The status of fully chlorinated diphenyls (60% chlorine) in comparison with those containing 50 to 55% Cl is subject to debate. The degree of cancer risk from low dosages of these compounds is also uncertain.

The variety of symptoms of human PCB intoxication was observed in Japan in 1968,(6) when over 1,000 people consumed for a period of about three months rice oil contaminated with commercial PCB containing 48% chlorine (0.3% *Kanechlor 400*). This poisoning, known as *Yosho disease*, was manifested by acneform eruption; eye discharges; swelling of the upper eyelids and hyperemia of the conjunctiva; hyperpigmentation of skin, nails, and mucous membrane; chloracne; and distinctive hair follicles. Fever, hearing difficulties, limb spasms, headache, vomiting, and diarrhea were also reported. Thirteen babies born of mothers who had consumed contaminated rice oil during pregnancy exhibited some of the symptoms of PCB poisoning (jaundice, dermal chromopexy, excessive tear secretion). Polychlorinated dibenzofurans, mainly penta- and hexachloro-compounds, were found in tissues of three of the exposed persons who died in 1969 and 1972.(6) It is possible that the high toxicity of Kanechlor 400 was partly caused by impurities.

Bahn *et al*(6) drew attention to two malignant melanomas among 31 men working during the 1950's with *Arochlor 1254*. The exposure concentration is unknown

A TLV of 0.5 and a STEL of 1.0 mg/m³ are recommended at this time. A review of this value may be appropriate.

Other recommendations: NIOSH recognizes all chlorodiphenyls as potential carcinogens, and recommends an occupational exposure limit (TWA) of 0.001 mg/m³ or less.(6) Sweden (1978) also has one limit (0.01 mg/m³) for all PCB's. As of 1977, nine nations used the TLV of 0.5 mg/m³. The 1979 German list retains this value, with the added designation of potential carcinogen.

References:

1. **Drinker, C.K.:** *J. Ind. Hyg. & Tox.* 21:155 (1939).
2. **Treon, J.F., Cleveland, F.P., Cappel, J., Atchley, R.W.:** *Am. Ind. Hyg. Assoc. Q.* 17:204 (1956).
3. **Gage, J.C., Holm, S.:** *Tox. Appl. Pharm.* 36:555 (1976)
4. **Ecobichon, D.J., Comeau, A.M.:** *Ibid.* 33:94 (1975)
5. **Kimbrough, R.D.** *et al*: *Arch. Env. Health* 25:354 (1972)
6. **NIOSH:** *Criteria for a Recommended Standard—Occupational Exposure to Polychlorinated Diphenyls* (1977).

1-CHLORO,2,3-EPOXY-PROPANE

See, **Epichlorohydrin**

landfills have been approved for PCB disposal More recently treatment with metallic sodium has been advocated which yields a low molecular weight polyphenylene and sodium chloride.

References

(1) National Institute for Occupational Safety and Health, *Criteria for a Recommended Standard: Occupational Exposure to Polychlorinated Biphenyls*, NIOSH Doc. No. 77-225 (1977).

(2) U.S. Environmental Protection Agency, *Polychlorinated Biphenyls: Ambient Water Quality Criteria*, Washington, DC (1980).

(3) National Academy of Sciences, *Polychlorinated Biphenyls*, Washington, DC (1979).

(4) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, Lyon, France, 7, 261 (1974) and 18, 43 (1978).

(5) World Health Organization, *Polychlorinated Biphenyls and Triphenyls*, Environmental Health Criteria No. 2, Geneva, Switzerland (1976).

(6) See Reference (A-62). Also see Reference (A-64).

(7) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans*, Supplement 1, Lyon, France, p 41 (1979).

(8) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 3,* No. 4, 95-100, New York, Van Nostrand Reinhold Co. (1983).

(9) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety,* Third Edition, Vol. 2, pp 1753-55, Geneva, International Labour Office (1983).

(10) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. II, pp VII/644-60, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

POLYNUCLEAR AROMATIC HYDROCARBONS

- Carcinogen (Benzo[a]pyrene) (Animal positive, IARC) (8)
- Hazardous wastes (EPA)
- Priority toxic pollutants (EPA)

Description: The polynuclear aromatic hydrocarbons constitute a class of materials of which benzo[a]pyrene is one of the most common and also the most hazardous.

Benzo[a]pyrene, $C_{20}H_{12}$, is a yellowish crystalline solid, melting at 179°C. It consists of five benzene rings joined together. Other polynuclear aromatics which are discussed in separate sections in this volume are as follows: acenaphthene, fluoranthene and naphthalene. A variety of abbreviations are in common use for the polynuclear aromatics as shown below:

Abbreviation	Compound Designated
A	Anthracene
BaA	Benzo[a]anthracene (1,2-benzanthracene)
BaP (also BP)	Benzo[a]pyrene (3,4-benzopyrene)
BbFL (also BbF)	Benzo[b]fluoranthene
BeP	Benzo[e]pyrene
BjFL (also BjF)	Benzo[j]fluoranthene
BkFL (also BkF)	Benzo[k]fluoranthene (11,12-benzofluoranthene)
BPR	Benzo[ghi]perylene (1,12-benzoperylene)
CH (also CR)	Chrysene
DBA	Dibenzo[ah]anthracene (1,2,5,6-benzanthracene)
DBAc	Dibenz[a,h] and [a,j] acridine
DBC	Dibenzocarbazole

(continued)

Abbreviation	Compound Designated
DBP	Dibenzopyrene
F	Fluorene
FL (also F)	Fluoranthene
IP	Indeno[1,2,3-cd] pyrene
P	Pyrene
PA (also Phen)	Phenanthrene
PR (also Per)	Perylene

Note: These abbreviations are not endorsed by any body such as the International Union of Chemistry; rather they are a form of shorthand used by authors for convenience, and they vary with the author.

Code Numbers: (For benzo[a] pyrene) CAS 50-32-8 RTECS DJ3675000

DOT Designation: –

Synonyms: PNAs, PAHs, PPAHs (Particulate Polycyclic Aromatic Hydrocarbons) and POMs (Polynuclear Organic Materials). (Benzo[a] pyrene is also known as BAP.)

Potential Exposures: PNAs can be formed in any hydrocarbon combustion process and may be released from oil spills. The less efficient the combustion process, the higher the PNA emission factor is likely to be. The major sources are stationary sources, such as heat and power generation, refuse burning, industrial activity, such as coke ovens, and coal refuse heaps. While PNAs can be formed naturally (lightning-ignited forest fires), impact of these sources appears to be minimal. It should be noted, however, that while transportation sources account for only about 1% of emitted PNAs on a national inventory basis, transportation-generated PNAs may approach 50% of the urban resident exposures.

Because of the large number of sources, most people are exposed to very low levels of PNAs. BAP has been detected in a variety of foods throughout the world. A possible source is mineral oils and petroleum waxes used in food containers and as release agents for food containers. FDA studies have indicated no health hazard from these sources.

The air pollution aspects of the carcinogenic polynuclear aromatic hydrocarbons (PAH) and of benzo[a] pyrene (BAP) in particular have been reviewed in some detail by Olsen and Haynes (1). The total emissions of benzo[a] pyrene (BAP) and some emission factors for BAP are as presented by Goldberg (2).

Permissible Exposure Limits in Air: A TLV of 0.2 mg/m^3 as benzene solubles has been assigned by ACGIH. These materials are designated by ACGIH as human carcinogens.

There have been few attempts to develop exposure standards for PAHs, either individually or as a class. In the occupational setting, a Federal standard has been promulgated for coke oven emissions, based primarily on the presumed effects of the carcinogenic PAH contained in the mixture as measured by the benzene soluble fraction of total particulate matter. Similarly, the American Conference of Governmental Industrial Hygienists recommends a workplace exposure limit for coal tar pitch volatiles, based on the benzene-soluble fraction containing carcinogenic PAH.

The National Institute for Occupational Safety and Health has also recommended a workplace standard for coal tar products (coal tar, creosote, and coal tar pitch), based on measurements of the cyclohexane-extractable fraction. These standards are summarized on the following page.

Substance	Exposure Limit	Agency
Coke oven emissions	150 $\mu g/m^3$, 8 hr time-weighted average	U.S. Occupational Safety and Health Administration
Coal tar products	0.1 mg/m^3, 10 hr time-weighted average	U.S. National Institute for Occupational Safety and Health
Coal tar pitch and volatiles	0.2 mg/m^3 (benzene soluble fraction) 8 hr time-weighted average	American Conference of Governmental Industrial Hygienists

Determination in Air: Collection on a membrane filter, benzene extraction, chromatographic separation, measurement by fluorometry or using a UV detector (A-10).

Permissible Concentration in Water: A drinking water standard for PAH as a class has been developed. The 1970 World Health Organization European Standards for Drinking Water recommends a concentration of PAH not to exceed 0.2 $\mu g/\ell$. This recommended standard is based on the composite analysis of six PAHs in drinking water: fluoranthene, benzo[a]pyrene, benzo[ghi]-perylene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-cd]pyrene.

The US EPA addressed PAHs as one of the 65 priority toxic pollutants (3). They found that there was insufficient data to propose a criterion for the protection of freshwater or of saltwater aquatic life. For the protection of human health, the concentration is preferably zero. An additional lifetime cancer risk of 1 in 100,000 is posed by a concentration of 0.028 $\mu g/\ell$.

Determination in Water: Methylene chloride extraction followed by high performance liquid chromatography (HPLC) with fluorescence or UV detection or gas chromatography (EPA Method 610), or by gas chromatography plus mass spectrometry (EPA Method 625).

Routes of Entry: Inhalation of particulates, vapors.

Harmful Effects and Symptoms: Certain PNAs which have been demonstrated as carcinogenic in test animals at relatively high exposure levels are being found in urban air at very low levels. Various environmental fate tests suggest that PNAs are photo-oxidized, and react with oxidants and oxides of sulfur. Because PNAs are adsorbed on particulate matter, chemical half-lives may vary greatly, from a matter of a few hours to several days. One researcher reports that photo-oxidized PNA fractions of air extracts also appear to be carcinogenic. Environmental behavior/fate data have not been developed for the class as a whole.

It has been observed that PNAs are highly soluble in adipose tissue and lipids. Most of the PNAs taken in by mammals are oxidized and the metabolites excreted. Effects of that portion remaining in the body at low levels have not been documented.

Benzo[a]pyrene (BaP), one of the most commonly found and hazardous of the PNAs has been the subject of a variety of toxicological tests, which have been summarized by the International Agency for Research on Cancer. 50 to 100 ppm administered in the diet for 122 to 197 days produced stomach tumors in 70% of the mice studied. 250 ppm produced tumors in the forestomach of 100% of the mice after 30 days. A single oral administration of 100 mg of nine rats produced mammary tumors in eight of them. Skin cancers have been induced in a variety of animals at very low levels, and using a variety of solvents (length of application was not specified).

Lung cancer developed in 2 of 21 rats exposed to 10 mg/m^3 BaP and 3.5 ppm SO_2 for 1 hour per day, five days a week, for more than one year. Five of 21 rats receiving 10 ppm SO_2 for 6 hours per day, in addition to the foregoing dosage, developed similar carcinomas. No carcinomas were noted in rats receiving only SO_2. No animals were exposed only to BaP. Transplacental migration of BaP has been demonstrated in mice. Most other PNAs have not been subjected to such testing.

Medical Surveillance: Preplacement and regular physical examination are indicated for workers having contact with polynuclear aromatics in the workplace.

Personal Protective Methods: Good particulate emission controls are the indicated engineering control scheme where polynuclear aromatics are encountered in the workplace.

Disposal Method Suggested: Incineration.

References

(1) Olsen, D.A. and Haynes, J.L., *Air Pollution Aspects of Organic Carcinogens,* Report PB-188 090, Springfield, VA, Nat. Tech. Information Service (September 1969).

(2) Goldberg, A.J., *A Survey of Emissions and Controls for Hazardous and Other Pollutants,* Report PB-223 568, Springfield, VA, Nat. Tech. Information Service (Feb. 1973).

(3) U.S. Environmental Protection Agency, *Polynuclear Aromatic Hydrocarbons: Ambient Water Quality Criteria,* Washington, DC (1980).

(4) U.S. Environmental Protection Agency, *Status Assessment of Toxic Organic Chemicals: Polynuclear Aromatic Hydrocarbons,* Report EPA-600/2-79-210L, Cincinnati, OH (December 1979).

(5) National Academy of Sciences, *Medical and Biologic Effects of Environmental Pollutants: Particulate Polycyclic Organic Matter,* Washington, DC (1972).

(6) U.S. Environmental Protection Agency, *Health Assessment Document for Polycyclic Organic Matter,* Research Triangle Park, NC, Environmental Criteria and Assessment Office (1979).

(7) U.S Environmental Protection Agency, *Polynuclear Aromatic Hydrocarbons,* Health and Environmental Effects Profile No. 149, Office of Solid Waste, Washington, DC (April 30, 1980).

(8) International Agency for Research on Cancer, *IARC Monographs on the Carcinogenic Risks of Chemicals to Humans,* Lyon, France, 3, 91 (1973).

(9) See Reference (A-62) for: Benz[a]anthracene, Benzo[b]fluoranthene and Benzo[j]-fluoranthene, Dibenz[a,h]acridine and Dibenz[j]acridine, Dibenz[a,h]anthracene, Dibenzo[c,g]carbazole, Dibenzo[a,h]pyrene, Dibenzo[a,i]pyrene], and Indeno-[1,2,3-cd]pyrene].

(10) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 4,* No. 2, 35-37, New York, Van Nostrand Reinhold Co. (1984) (Acenaphthylene).

(11) Parmeggiani, L., Ed., *Encyclopedia of Occupational Health & Safety,* Third Edition, Vol. 2, pp 1755-59, Geneva, International Labour Office (1983).

POLYTETRAFLUOROETHYLENE DECOMPOSITION PRODUCTS

Description: Thermal decomposition of the fluorocarbon chain in air leads to the formation of oxidized products containing carbon, fluorine and oxygen. See the entry under "Carbonyl Fluoride" to cite one example.

DOT Designation: –

```
NAME
ENTER CHEMICAL NAME
FLUORENE
FLUORENE IS NOT IN DATABASE.

ENTER NAME, KEYWORD, SYMPTOM, STLA, NAMELIST, HELP, OR QUIT.
NAME
>INAME      IS NOT A VALID REPLY.
VALID REPLIES ARE:
NAME, KEYWORD, SYMPTOM, STLA, NAMELIST, HELP, OR QUIT
NAME
ENTER CHEMICAL NAME
PYRENE
TYPE WHAT INFORMATION YOU REQUIRE
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND, /HELP/, OR /NONE/.
ALL

CHEMICAL NAME
  PYRENE

FORMULA
  C16H10

SYNONYMS
  BENZO-PHENANTHRENE
  BENZO(DEF)PHENANTHRENE
  BETA-PYRINE
  OHS19950

PERMISSIBLE EXPOSURE LIMIT
  NONE ESTABLISHED (SEE COAL TAR PITCH VOLATILES)
  INDEFINITE ANIMAL CARCINOGEN (RTEC)
  MUTAGENIC DATA (RTEC)
  CERCLA HAZARD RATINGS - TOXICITY U - IGNITABILITY 0 - REACTIVITY 0 -
  PERSISTENCE 3



IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONCENTRATION
PHYSICAL DESCRIPTION
  BRIGHT YELLOW SOLID, ODORLESS

CHEMICAL AND PHYSICAL PROPERTIES
  MOLECULAR WEIGHT: 202.3
  BOILING POINT AT 1 ATM, F: 739 F
  SOLUBILITY IN WATER, G/100 G WATER AT 20C: INSOLUBLE
  FLASH POINT, CLOSED CUP, F (OR OPEN CUP IF OC): 330 F (OC)
  VAPOR PRESSURE @ 20 C, MMHG: 1 MM
  MELTING POINT, F: 313 F
  UPPER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: NA
  LOWER EXPLOSIVE LIMIT IN AIR, % BY VOLUME: NA
  SPECIFIC GRAVITY: 1.271 AT 73 F

INCOMPATIBILITIES
  STRONG OXIDIZERS

PERSONAL PROTECTIVE EQUIPMENT
  NO NIOSH/OSHA DATA: RECOMMEND
  PREVENT REPEATED OR PROLONGED SKIN CONTACT
    [illegible]
    WEAR GLOVES
    WEAR FACESHIELD ([illegible] MINIMUM)

  PLACE CONTAMINATED CLOTHING IN CLOSED CONTAINERS FOR STORAGE UNTIL
    LAUNDERED OR DISCARDED
```

PYRENE
1/7

2/7

GOGGLES
PREVENT ANY POSSIBILITY OF EYE CONTACT

WASHING CHEMICALS FROM THE SKIN
AT THE END OF EACH WORK SHIFT WHEN THERE IS REASONABLE PROBABILITY OF CONTACT WITH THE SUBSTANCE

ROUTINE CHANGING OF WORK CLOTHING
AFTER WORK SHIFT

CLOTHING REMOVAL FOLLOWING ACCIDENTAL CONTAMINATION
NO STANDARD REQUIREMENT, BUT ADVISE REMOVING IMMEDIATELY IF IT IS CONTAMINATED

SPECIFIC EMERGENCY PROVISIONS
EATING AND SMOKING SHOULD NOT BE PERMITTED IN IMMEDIATE WORK AREA
WATER FOUNTAIN PROHIBITED IN WORK AREA
CLOSED SYSTEM IF SUBSTANCE TO BE USED

RESPIRATOR SELECTION (UPPER LIMIT DEVICES PERMITTED)

2 MG/M3
- CHEMICAL CARTRIDGE RESPIRATOR
  WITH AN ORGANIC VAPOR CARTRIDGE
  WITH A FUME OR HIGH-EFFICIENCY FILTER
- SUPPLIED-AIR RESPIRATOR
- SELF-CONTAINED BREATHING APPARATUS

200 MG/M3
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW MODE
- POWERED AIR-PURIFYING RESPIRATOR
  WITH AN ORGANIC VAPOR CARTRIDGE
  WITH A HIGH-EFFICIENCY PARTICULATE FILTER

400 MG/M3
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE, HELMENT, OR HOOD
  OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE
- TYPE 'C' SUPPLIED-AIR RESPIRATOR
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE
  OPERATED IN PRESSURE-DEMAND, POSITIVE-PRESSURE, OR CONTINUOUS-FLOW MODE

ESCAPE
- GAS MASK
  WITH AN ORGANIC VAPOR CANISTER
  (CHIN-STYLE OR FRONT- OR BACK-MOUNTED CANISTER)
  WITH A HIGH-EFFICIENCY PARTICULATE FILTER
  INCLUDING PESTICIDE RESPIRATORS
- SELF-CONTAINED BREATHING APPARATUS

10 MG/M3
- CHEMICAL CARTRIDGE RESPIRATOR

- GAS MASK
  WITH AN ORGANIC VAPOR CANISTER
  (CHIN-STYLE OR FRONT- OR BACK-MOUNTED CANISTER)
  WITH A FUME OR HIGH EFFICIENCY FILTER
  WITH A FULL FACE-PIECE
- SUPPLIED-AIR RESPIRATOR
  WITH A FULL FACE-PIECE, HELMENT, OR HOOD
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE

3/7

FIREFIGHTING
- SELF-CONTAINED BREATHING APPARATUS
  WITH A FULL FACE-PIECE
  OPERATED IN PRESSURE-DEMAND OR POSITIVE-PRESSURE MODE

ROUTE OF ENTRY INTO BODY
INHALATION
SKIN OR EYE CONTACT

SYMPTOMS
RESPIRATORY IRRITATION
SKIN IRRITATION
KIDNEY IRRITATION
DERMATITIS
BRONCHITIS
COUGHING
DYSPNEA
REPRODUCTIVE EFFECTS

FIRST AID PROCEDURES FOLLOWING EXPOSURE

IF THIS CHEMICAL GETS INTO THE EYES, IMMEDIATELY WASH THE EYES WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING THE LOWER AND UPPER LIDS. GET MEDICAL ATTENTION IMMEDIATELY. CONTACT LENSES SHOULD NOT BE WORN WHEN WORKING WITH THIS CHEMICAL.

IF THIS CHEMICAL GETS ON THE SKIN, IMMEDIATELY WASH CONTAMINATED SKIN WITH SOAP OR MILD DETERGENT & WATER. IF THIS CHEMICAL SOAKS CLOTHING, IMMEDIATELY REMOVE CLOTHING & WASH SKIN WITH SOAP OR MILD DETERGENT & WATER. GET MEDICAL ATTENTION PROMPTLY. IF A PERSON BREATHES IN LARGE AMOUNTS OF THIS CHEMICAL, MOVE THE EXPOSED PERSON TO FRESH AIR AT ONCE. IF BREATHING HAS STOPPED PERFORM ARTIFICIAL RESPIRATION. KEEP THE AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION AS SOON AS POSSIBLE.

ORGANS
RESPIRATORY SYSTEM
LUNGS
KIDNEYS
SKIN
URINARY TRACT
REPRODUCTIVE SYSTEM

STATUS OF REGULATORY REQUIREMENT
OSHA STANDARD 29 CFR 1910.1200 HAZARD COMMUNICATION
REQUIRES CHEMICAL MANUFACTURERS AND IMPORTERS TO ASSESS THE HAZARDS OF CHEMICALS WHICH THEY PRODUCE OR IMPORT, AND ALL EMPLOYERS HAVING WORKPLACES IN THE MANUFACTURING DIVISION, STANDARD INDUSTRIAL CLASSIFICATION CODES 20 THROUGH 39, TO PROVIDE INFORMATION TO THEIR EMPLOYEES

INCLUDING LABELS, MATERIAL SAFETY DATA SHEETS, TRAINING, AND ACCESS TO
WRITTEN RECORDS
48FR53280 11/25/83

FOLLOWING OSHA STANDARDS APPLICABLE TO SUBSTANCES LISTED 29CFR1910,
OTHERWISE ADVISE:

4/7

OSHA STANDARD 29CFR1910.94 VENTILATION

OSHA STANDARD 29CFR1910.134 RESPIRATORY PROTECTION

OSHA STANDARD 29CFR1910.20 ACCESS TO EMPLOYEE EXPOSURE AND MEDICAL RECORDS

OSHA STANDARD 29CFR1910.1002 COAL TAR PITCH VOLATILES

OSHA STANDARD 29CFR1910.132 PERSONAL PROTECTIVE EQUIPMENT

OSHA STANDARD 29CFR1910.141 SANITATION

OSHA STANDARD 29CFR1910.151 MEDICAL SERVICES AND FIRST AID

OSHA STANDARD 29CFR1910.133 EYE AND FACE PROTECTION

40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT
REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT ALLEGED TO HAVE BEEN CAUSED BY A SUBSTANCE OR MIXTURE. EPA MAY INSPECT AND REQUIRE REPORTING OF SUCH RECORDS.
48FR39178 08/22/83

OSHA STANDARD 29CFR1910.1000 AIR CONTAMINANTS
TABLE Z-1

SUBSTANCE LISTED TOXIC SUBSTANCES CONTROL ACT INVENTORY

SUBSTANCE LISTED AS TOXIC POLLUTANT UNDER CLEAN WATER ACT (CWA) SECTION 307(A)

49CFR172.101 TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION, PROPER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER REQUIREMENTS
DESIGNATED IN HAZARDOUS MATERIALS TABLE AS HAZARDOUS MATERIAL FOR THE PURPOSE OF TRANSPORTATION.
41FR15996 04/15/76
45FR34588 05/22/80 (AMENDMENT)
45FR46420 07/10/80 (AMENDMENT)
45FR62080 09/19/80 (AMENDMENT)
45FR74649 11/10/80 (AMENDMENT)
46FR17739 03/19/81 (AMENDMENT)
46FR19235 03/30/81 (AMENDMENT)

49CFR172.102 TABLES OF HAZARDOUS MATERIALS, THEIR DESCRIPTION, PROPER SHIPPING NAME, CLASS, LABEL, PACKAGING, AND OTHER REQUIREMENTS
DESIGNATED IN OPTIONAL HAZARDOUS MATERIALS TABLE WITH ALTERNATIVES TO CORRESPONDING REQUIREMENTS IN 49CFR172.101 FOR INTERNATIONAL SHIPMENTS AS AUTHORIZED BY 49CFR171.12

517

40CFR261.33(F) DISCARDED COMMERCIAL CHEMICAL PRODUCTS, OFF-SPECIFICATION SPECIES, CONTAINERS, AND SPILL RESIDUES THEREOF
COMMERCIAL CHEMICAL PRODUCT OR MANUFACTURING CHEMICAL INTERMEDIATE IDENTIFIED AS TOXIC WASTE UNLESS OTHERWISE DESIGNATED.
45FR33084 05/19/80

THIS SUBSTANCE TESTED FOR MUTAGENESIS/GENETIC TOXICITY BY THE NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES (NIEHS)

ANALYTICAL METHODS DEVELOPMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED ENERGY RESEARCH AND DEVELOPMENT ACT (ERDA)

MONITORING/LEVELS MEASUREMENT IN DEVELOPMENT/PROGRESS CLEAN AIR ACT (CAA)

MONITORING/LEVELS MEASUREMENT COMPLETED/PUBLISHED CLEAN WATER ACT (CWA)
SUBSTANCES LISTED APPENDIX A - CONSENT DECREE LIST OF INDUSTRIES AND TOXIC POLLUTANTS. SETTLEMENT AGREEMENT BETWEEN U.S. EPA AND NATIONAL RESOURCES DEFENSE COUNCIL, ET AL
U.S. DISTRICT COURT DISTRICT OF COLUMBIA, JUNE 7, 1976.
SITE 9ERC2120, DDC 1976. MODIFIED MARCH 9, 1979, SITE 12ERC1833, DDC 1979 AND AGAIN ON OCTOBER 26, 1982.

SUBSTANCE SUBJECT TO REQUIREMENTS OF GENERAL INDUSTRY SAFETY ORDER (GISO) 5194 OR TITLE 8 OF CALIFORNIA ADMINSTRATIVE CODE AND DIVISION 5, CHAPTER 2.5 OF CALIFORNIA LABOR CODE

40CFR122, APPENDIX D - NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT APPLICATION TESTING REQUIREMENTS
TABLE II - ORGANIC TOXIC POLLUTANTS IN EACH OF FOUR FRACTIONS IN ANALYSIS BY GAS CHROMATOGRAPHY/MASS SPECTROSCOPY (GS/MS)
48FR14153 04/01/83

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K022: DISTILLATION BOTTOM TARS FROM THE PRODUCTION OF PHENOL/ACETONE FROM CUMENE. (T)

SUBSTANCE LISTED RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
40CFR261.32 EPA HAZARDOUS WASTE NO. K024: DISTILLATION BOTTOMS FROM THE PRODUCTION OF PHTHALIC ANHYDRIDE FROM NAPHTHALENE. (T)

15CFR399.2, SUPPLEMENT 1 - COMMODITY INTERPRETATION 24: CHEMICALS
VALIDATED LICENSE REQUIRED FOR EXPORT TO LIBYA, NORTH KOREA, VIETNAM, KAMPUCHEA, OR CUBA
45FR85942 12/30/80
46FR23942 04/29/81
47FR143 01/05/82
47FR41512 09/21/82
47FR51860 11/19/82
47FR59124 12/29/82

SUBSTANCE LISTED WEST VIRGINIA DEPARTMENT OF LABOR LISTING OF HAZARDOUS SUBSTANCE

MEDICAL SURVEILLANCE REQUIRED

40CFR717 RECORDS AND REPORTS OF ALLEGATIONS THAT CHEMICAL SUBSTANCES CAUSE SIGNIFICANT ADVERSE REACTIONS TO HEALTH OR THE ENVIRONMENT

TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS

6/7

48FR38187 08/22/83
48FR39225 08/30/83 (EFFECTIVE DATE CORRECTION)
RESPIRATORY HISTORY
PRE-PLACEMENT AND ANNUAL EXAMS
CARDIOVASCULAR DISEASE
CHRONIC RESPIRATORY DISEASE
14 BY 17 CHEST P.A. X-RAY
SKIN EXAM
SPUTUM CYTOLOGY
URINE CYTOLOGY
PULMONARY FUNCTION
VISION TEST
URINALYSIS
COMPLETE BLOOD COUNT
BLOOD CHEMISTRY
RENAL AND LIVER FUNCTIONS

KIDNEY FUNCTION
WARNING: PREGNANT WOMEN, SUBSTANCE ASSOCIATED WITH COAL TAR PITCH VOLATILES

CERTIFICATIONS
HEALTH STATUS CLASSIFICATION

NUCLEAR REG. 0041

OSHA RESPIRATOR CERTIFICATION 29CFR1910.134

DEPARTMENT OF TRANSPORTATION IF OPERATES HEAVY EQUIPMENT

EMPLOYEE HAZARDOUS MATERIALS EDUCATION RECEIPT

EMPLOYEE MEDICAL RECORDS RECEIPT

TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 8(C) RULE REQUIRES MANUFACTURERS AND CERTAIN PROCESSORS OF CHEMICAL SUBSTANCES AND MIXTURES TO KEEP RECORDS OF SIGNIFICANT ADVERSE REACTIONS TO EMPLOYEE HEALTH FOR 30 YEARS. CONTACT: JACK P. MCCARTHY, OFFICE OF TOXIC SUBSTANCES, EPA (800)424-1404. 48FR38178 8/22/83

UICC OR ILO X-RAY INTERPRETATION

MEDICAL WARNING REQUIRED FOR MEDICAL EXAM REFUSAL SIGNED BY EMPLOYEE

SPECIAL DIAGNOSTIC TESTS
NONE IN COMMON USE

LEAKS AND SPILL PROCEDURES
A REPORTABLE QUANTITY OF [illegible] POUND APPLIES TO THIS SUBSTANCE ESTABLISHED BY SECTIONS 101(14) AND 102(B) OR ADJUSTED UNDER SECTION 102(A) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (CERCLA). SECTIONS 103(A) AND 103(B) REQUIRE THAT PERSONS IN CHARGE OF A VESSEL OR FACILITY FROM WHICH A HAZARDOUS SUBSTANCE HAS BEEN

7/7

```
50FR13456 04/04/85

**********************************************************************

DEPARTMENT OF TRANSPORTATION HAZARD CLASS
  49CFR172.101 HAZARDOUS MATERIALS TABLE

NOT LISTED

**********************************************************************

INTERGOVERNMENTAL MARITIME ORGANIZATION HAZARD CLASS
  49CFR172.102 OPTIONAL HAZARDOUS MATERIALS TABLE

NOT LISTED

WASTE
  THIS MATERIAL NOT LISTED AS HAZARDOUS SUBSTANCE, AS DEFINED IN SECTION
  101(14) OF THE COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND
  LIABILITY ACT (CERCLA) OF 1980, PURSUANT TO ONE OR MORE OF THE
  FOLLOWING:

    * FEDERAL WATER POLLUTION CONTROL ACT (FWPCA) SECTION 311(B)(2)(A)
    * SOLID WASTE DISPOSAL ACT SECTION 3001
    * CLEAN WATER ACT (CWA) SECTION 307(A)
    * CLEAN AIR ACT (CAA) SECTION 112
    * TOXIC SUBSTANCES CONTROL ACT (TSCA) SECTION 7
    * COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY
      ACT (CERCLA) SECTION 102


CAS NUMBER
  129-00-0

REGISTRY TOXIC CHEMICALS NUMBER
  UR2450000

BULLETINS

SPECIAL INFORMATION
TYPE WHAT INFORMATION YOU REQUIRE
/ALL/, SPECIFIC INFORMATION (BY 4-LETTER COMMAND, /HELP/, OR /NONE/.
NONE
PYRENE - NO MORE HITS IN DATABASE.

ENTER NAME, KEYWORD, SYMPTOM, STLA, NAMELIST, HELP, OR QUIT.
```

Permissible Exposure Limits in Air: There are no Federal standards but ACGIH (1983/84) classifies silicon as a nuisance particulate with a TWA of 10 mg/m^3 and an STEL of 20 mg/m^3.

Determination in Air: Collection on a filter and gravimetric analysis (A-1).

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms: Silicon dust does not produce significant organic disease or toxic effect when exposures are kept under reasonable control (A-34). Unpleasant deposits may be caused in eyes, ears and nasal passages and injury to the skin and mucous membranes may be caused by the dust itself or by cleansing procedures used for its removal.

SILICON CARBIDE

Description: SiC is a bluish black crystalline substance which sublimes with decomposition at 2210°C.

Code Numbers: CAS 409-21-2 RTECS none UN none

DOT Designation: –

Synonyms: Carborundum®, Crystolon®, Carbonite®, Electrolon®.

Potential Exposure: Those involved in the manufacture of silicon carbide abrasives, refractories and semiconductors. Silicon carbide fibers are also produced in fibrous form as reinforcing fibers for composite materials.

Permissible Exposure Limits in Air: There are no Federal standards but ACGIH (1983/84) has classified silicon carbide as a nuisance particulate with a TWA of 10 mg/m^3 and an STEL of 20 mg/m^3.

Determination in Air: Collection on a filter and gravimetric analysis (A-1).

Permissible Concentration in Water: No criteria set.

Routes of Entry: Inhalation.

Harmful Effects and Symptoms: Silicon carbide can alter the course of inhalation tuberculosis leading to extensive fibrosis and progressive disease (A-34).

Points of Attack: Respiratory system.

References

(1) See Reference (A-60).

SILVER AND COMPOUNDS

- Hazardous substance (Silver Nitrate, EPA)
- Hazardous waste constituents (EPA), hazardous waste (Silver Cyanide) (EPA)
- Priority toxic pollutant (EPA)

Description: Ag, silver, is a white metal and is extremely ductile and malleable, insoluble in water but soluble in hot sulfuric and nitric acids. Perhaps the most common soluble silver compound is silver nitrate, $AgNO_3$; another is silver cyanide, AgCN.

Code Numbers:

Silver metal	CAS 7440-22-4	RTECS VW3500000	UN none
Silver nitrate	CAS 7761-88-8	RTECS VW4725000	UN 1493
Silver cyanide	CAS 506-64-9	RTECS VW3850000	UN 1684

DOT Designation: Silver metal, none; silver nitrate, oxidizer; and silver cyanide, Poison B.

Synonyms: none

Potential Exposure: Silver may be alloyed with copper, aluminum, cadmium, lead, or antimony. The alloys are used in the manufacture of silverware, jewelry, coins, ornaments, plates, commutators, scientific instruments, automobile bearings, and grids in storage batteries. Silver is used in chrome-nickel steels, in solders and brazing alloys, in the application of metallic films on glass and ceramics, to increase corrosion resistance to sulfuric acid, in photographic films, plates and paper, as an electroplated undercoating for nickel and chrome, as a bactericide for sterilizing water, fruit juices, vinegar, etc., in bus bars and windings in electrical plants, in dental amalgams, and as a chemical catalyst in the synthesis of aldehydes. Because of its resistance to acetic and other food acids, it is utilized in the manufacture of pipes, valves, vats, pasteurizing coils and nozzles for the milk, vinegar, cider, brewing, and acetate rayon silk industries.

Silver compounds are used in photography, silver plating, inks, dyes, coloring glass and porcelain, etching ivory, in the manufacture of mirrors, and as analytical chemical reagents and catalysts. Some of the compounds are also of medical importance as antiseptics or astringents, and in the treatment of certain diseases, particularly in veterinary medicine.

Incompatibilities: Acetylene, ammonia, hydrogen peroxide.

Permissible Exposure Limits in Air: The Federal standard for silver metal and soluble compounds is 0.01 mg/m^3. The ACGIH (1983/84) has adopted a TWA of 0.1 mg/m^3 for silver metal, but no STEL value for the metal or its compounds.

Determination in Air: Collection on membrane filter, solution in nitric acid, analysis by atomic absorption spectrophotometry (A-10).

Permissible Concentration in Water: To protect freshwater aquatic life–should not exceed

$$e^{[1.72\,\ln(\text{hardness}) - 6.52]}\ \mu g/\ell$$

at any time. To protect saltwater aquatic life–never to exceed 2.3 µg/ℓ. To protect human health–50 µg/ℓ (1). (The State of Illinois has recommended that silver in drinking water be held to 0.5 µg/ℓ).

Determination in Water: Digestion followed by atomic absorption or colorimetric determination (with Dithizone) or by inductively coupled plasma (ICP) optical emission spectrometry. This gives total silver. Dissolved silver may be determined by these same methods preceded by 0.45 µ filtration.

Routes of Entry: Inhalation of fumes or dust, ingestion of solutions or dust, eye and skin contact.

Harmful Effects and Symptoms: *Local* – The only local effect from metallic silver derives from the implant of small particles in the skin of the workmen (usually hands and fingers) which causes a permanent discoloration equivalent to the process of tattooing (local argyria). Silver nitrate dust and solutions are highly corrosive to the skin, eyes, and intestinal tract. The dust of silver nitrate may cause local irritation of the skin, burns of the conjunctiva, and blindness. Localized pigmentation of the skin and eyes may occur. The eye lesions are seen first in the caruncle, and then in the conjunctiva and cornea. The nasal septum and tonsillar pillars also are pigmented.

Systemic – All forms of silver are extremely cumulative once they enter body tissues, and very little is excreted. Studies on the occurrence of argyria following injection of silver arsphenamine indicate that the onset of visible argyria begins at a total dose of about 0.9 g of silver. Generalized argyria develops when silver oxide or salts are inhaled or possibly ingested by workmen who handle compounds of silver (nitrate, fulminate, or cyanide). The condition produces no constitutional symptoms, but it may lead to permanent pigmentation of the skin and eyes.

The workman's face, forehead, neck, hands, and forearms develop a dark, slate-grey color, uniform in distribution and varying in depth depending on the degree of exposure. Fingernails, buccal mucosa, toe nails, and covered parts of the body to a lesser degree, can also be affected by this discoloration process. The dust is also deposited in the lungs and may be regarded as a form of pneumoconiosis, although it carries no hazard of fibrosis. The existence of kidney lesions of consequence to renal function is improbable from occupational exposure.

Points of Attack: Nasal septum, skin, eyes.

Medical Surveillance: Special attention should be given to other sources of silver exposure, e.g., medications or previous occupational exposure. Inspection of the nasal septum, eyes, and throat will generally give incidence of pigmentation before generalized argyria occurs. This will usually be seen first in the ear lobes, face and hands.

First Aid: If this chemical gets into the eyes, irrigate immediately. If this chemical contacts the skin, flush with water. If a person breathes in large amounts of this chemical, move the exposed person to fresh air at once and perform artificial respiration. When this chemical has been swallowed, get medical attention. Give large quantities of water and induce vomiting. Do not make an unconscious person vomit.

Personal Protective Methods: Wear appropriate clothing to prevent any reasonable probability of skin contact. Wear eye protection to prevent any possibility of eye contact. Employees should wash promptly when skin is wet or contaminated. Work clothing should be changed daily if it is possible that clothing is contaminated. Remove nonimpervious clothing promptly if wet or contaminated. Provide emergency eyewash.

Respirator Selection:

0.5 mg/m^3: HiEPF/SAF/SCBAF
10 mg/m^3: PAPHiEF
20 mg/m^3: SAF:PD,PP,CF

Disposal Method Suggested: Recovery, wherever possible, in view of economic value of silver. Techniques for silver recovery from photoprocessing and electroplating wastewaters have been reviewed (A-57).

References

(1) U.S. Environmental Protection Agency, *Silver: Ambient Water Quality Criteria*, Washington, DC (1980).

3. **Grandjean, E.** *et al: Arch Ind. Health* 114 426-441 (1956)
4. **Dale, K.:** *Scand J. Resp Dis. 54(3)* 168-184 (1973)
5. **National Cancer Institute:** *Bioassay of Titanium Dioxide for Possible Carcinogenicity*, DHEW Pub No (NIH) 78-1347 Bethedsa, MD (1978)

000933

TOLUENE

Toluol

$C_6H_5CH_3$

Skin

TLV, 100 ppm ($\approx$ 375 mg/m³)

STEL, 150 ppm ($\approx$ 560 mg/m³)

Toluene is a colorless liquid with a typical aromatic hydrocarbon odor. Its molecular weight and specific gravity are 92.13 and 0.866, respectively. The boiling point is 110.7° C and solidifies at -95° C. At 25° C. the vapor pressure is 28 mm Hg. The closed cup flash point is 40° F. It is insoluble in water, but miscible with most organic solvents.

Formerly derived solely from coal tar, toluene is now obtained chiefly from petroleum, and is present in gasoline and many petroleum solvents. It is used as a solvent in paints and coatings, for rubber, oils, resins, etc., as a raw material for the manufacture of benzene and a host of other chemicals including TNT, TDI, and ingredients of detergents, dyes and drugs.

Because of its wide industrial use and chemical similarity to benzene, the literature of industrial toxicology and industrial medicine, particularly the latter, record numerous investigations of the toxic effects of toluene. According to Patty(1) the concentrations of toluene and benzene required to cause prostration of mice are apparently 3000 ppm and 4700 ppm, respectively. Death from acute poisoning results from 10,000 ppm toluene compared with 14,000 ppm of benzene. Several incidents of workers being overcome by toluene vapor, usually in confined spaces, have been reported. Longley and co-workers(2) describe such an event aboard ship where 26 men were overcome. There were no deaths or serious aftereffects. No irritation of eyes or respiratory passages was observed.

From the standpoint of chronic poisoning, toluene does not cause the severe injury to the bone marrow characteristic of benzene poisoning. Gerarde(3) stated that the myelotoxicity of benzene was completely absent in toluene and other alkyl derivatives of benzene. Von Oettingen *et al*(4) found that exposure of rats at 2500 to 5000 ppm of toluene caused a temporary decrease in the white-cell count, but no evidence of injury to blood-forming organs or liver. Greenburg and co-workers(5) studied a group of painters exposed to toluene in concentrations ranging from 100 to 1100 ppm. Their findings included enlargement of the liver, macrocytosis, moderate decrease in erythocyte count and absolute lymphocytosis, but no leukopenia.

Wilson(6) found that among workers exposed at less than 200 ppm of toluene there were some complaints of headache, lassitude and nausea, but physical findings were essentially negative. At concentrations between 200 and 500 ppm impairment of coordination, momentary loss of memory and anorexia were also present. Between 500 and 1500 ppm palpitation, extreme weakness, pronounced loss of coordination and impairment of reaction time were noted. The red cell count fell in many instances, and there were two cases of aplastic anemia, in which recovery followed intensive hospital treatment. A later comment by Wilson(7) however, suggests that he did not rule out the possibility that some of the above effects were due to a benzene impurity in the toluene used.

According to Fairhall,(8) severe exposure to toluene may result in a pronounced drop in the red count and partial destruction of the blood-forming elements of the bone marrow. However, Gerarde(9) stated that extensive animal studies clearly indicate that toluene is not a bone marrow poison. While there have been occasional reports of aplastic anemia attributed to toluene,(7) in some instances the presence of benzene was not precluded, and there have been no "epidemics" of this disease among toluene workers comparable to those which have resulted from benzene. Powars(10) reported six cases of aplastic anemia, one of them fatal, among glue sniffers. Although toluene was the solvent chiefly used, no analysis was given of the glue involved in the fatal case. Exposures in these cases are much greater than would normally arise from occupational use of toluene. Thus Knox and Nelson(11) described an instance of permanent encephalopathy involving a man who inhaled toluene regularly for over 14 years.

Von Oettingen and co-workers(4) found that human subjects exposed at 200 ppm suffered slight but definite changes in muscular coordination. They concluded that such concentrations were unlikely to have any discernible untoward effects on health. Gerarde(9) however, believed that von Oettingen's work did not justify the 200 ppm limit. Ogata *et al*(12) found that experimental human subjects exposed at 200 ppm for seven hours showed prolongation of reaction time, decrease in pulse rate and in systolic blood pressure. They consider 200 ppm too high as the MAC. Takeuchi(13) exposed rats at 200 ppm and higher concentrations of toluene for 32 weeks and then to benzene for 39 days. On the basis of differences found between the toluene-exposed animals and controls, e.g., changes in weight of adrenal glands, he suggested that the MAC of 200 ppm for toluene should be reconsidered.

Smyth *et al* reported an oral LD_{50} administered to rats to be 7.53 mL/kg.(14)

On the basis of the above data, a reduction in the TLV for toluene from 200 ppm to 100 ppm is recommended with a STEL of 150 ppm.

Other recommendations: Cook (1945) 200 ppm; Smyth (1956) comments that this limit may permit early signs of narcosis. Elkins (1959) 200 ppm; ANSI (1967) 200 ppm; USSR (1967) 14 ppm; Czechoslovakia (1969) 50 ppm; West Germany (1974) 200 ppm; Sweden (1975) 100 ppm; East Germany (1973) 50 ppm; NIOSH (1973) 100 ppm.

References:

1. **Patty, F.S.:** *Industrial Hygiene & Toxicology*, 2nd ed. Vol II p 1226, Interscience, NY (1963)
2. **Longley, E.Q., Jone, A.T., Lomaev, O.:** *Arch Env Health* 14 481 (1967).

Code Numbers: CAS 76-03-9 RTECS AJ7875000 UN 1839

DOT Designation: Corrosive material

Synonym: TCA.

Potential Exposures: TCA is used as an intermediate in pesticide manufacture (A-32) and in the production of sodium trichloroacetate which is itself a herbicide.

Permissible Exposure Limits in Air: There is no Federal standard but ACGIH (1983/84) has adopted a TWA of 1 ppm (5 mg/m^3). There is no STEL value. The Soviet standard is reported to be 0.75 ppm.

Permissible Concentration in Water: No criteria set.

Harmful Effects and Symptoms: TCA is corrosive to the skin and eyes but is not readily absorbed through the skin. The reader is recommended to consider the effects of 2,2-dichloropropionic acid (Dalapon) for analogies (A-34).

Points of Attack: Eyes, skin and respiratory tract.

First Aid: Get to fresh air, remove contaminated clothes, flush affected areas with water.

Personal Protective Methods: Wear close-fitting safety goggles, protective clothing, protective gloves.

Respirator Selection: Wear self-contained breathing apparatus.

References

(1) See Reference (A-60).
(2) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. I, pp VII/18, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

000934

1,2,4-TRICHLOROBENZENE

- Priority toxic pollutant (EPA)

Description: $C_6H_3Cl_3$ is a low-melting solid or liquid with a pleasant aroma. It melts at 17°C and boils at 213.5°C.

Code Numbers: CAS 120-82-1 RTECS DC2100000 UN 2321

DOT Designation: Label should bear St. Andrew's Cross (X).

Synonym: Unsym-trichlorobenzene.

Potential Exposures: 1,2,4-Trichlorobenzene is used as a dye carrier (46%), herbicide intermediate (28%) (A-32), a heat transfer medium, a dielectric fluid in transformers, a degreaser, a lubricant and a potential insecticide against termites. The other trichlorobenzene isomers are not used in any quantity.

Possible human exposure to trichlorobenzene (TCB) might occur from municipal and industrial wastewater and from surface runoff (1). Municipal and industrial discharges contained from 0.1 to 500 µg/ℓ. Surface runoff has been found to contain 0.006 to 0.007 µg/ℓ. In the National Organic Reconnaissance Survey conducted by EPA in 1975, TCB was found in drinking water at a level of 1.0 µg/ℓ.

Permissible Exposure Limits in Air: There is no Federal standard. The ACGIH has set a TWA at a ceiling of 5 ppm (40 mg/m^3) but no STEL value as of 1983/84.

Permissible Concentration in Water: To protect human health—no criterion developed due to insufficient data.

Determination in Water: Methylene chloride extraction followed by concentration, gas chromatography with electron capture detection (EPA Method 612) or gas chromatography plus mass spectrometry (EPA Method 625).

Harmful Effects and Symptoms: *Local* — Chlorinated benzenes are irritating to the skin, conjunctiva, and mucous membranes of the upper respiratory tract. Prolonged or repeated contact with liquid chlorinated benzenes may cause skin burns.

Systemic — In contrast to aliphatic halogenated hydrocarbons, the toxicity of chlorinated benzenes generally decreases as the number of substituted chlorine atoms increases. Basically, acute exposure to these compounds may cause drowsiness, incoordination, and unconsciousness. Animal exposures have produced liver damage. Chronic exposure may result in liver, kidney, and lung damage as indicated by animal experiments.

Points of Attack: Skin, eyes, liver, kidneys, lungs.

Medical Surveillance: Consider the points of attack in preplacement and periodic physical examinations.

Disposal Method Suggested: Incineration, preferably after mixing with another combustible fuel. Care must be exercised to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the halo acids produced.

References

(1) U.S. Environmental Protection Agency, *Chlorinated Benzenes: Ambient Water Quality Criteria*, Washington, DC (1980).
(2) See Reference (A-60).
(3) Sax, N.I., Ed., *Dangerous Properties of Industrial Materials Report, 4*, No. 3, 96-99, New York, Van Nostrand Reinhold Co. (1984).
(4) United Nations Environment Programme, *IRPTC Legal File 1983*, Vol. I, pp VII/96-7, Geneva, Switzerland, International Register of Potentially Toxic Chemicals (1984).

1,1,1-TRICHLOROETHANE

- Hazardous waste (EPA)
- Priority toxic pollutant (EPA)

Description: CH_3CCl_3, 1,1,1-trichloroethane, is a colorless, nonflammable liquid with an odor similar to chloroform. It boils at 74°C.

Code Numbers: CAS 71-55-6 RTECS KJ2975000 UN 2831

DOT Designation: ORM-A

Synonym: Methyl chloroform.

Potential Exposures: In recent years, 1,1,1-trichloroethane has found wide use as a substitute for carbon tetrachloride. In liquid form it is used as a degreaser and for cold cleaning, dip-cleaning, and bucket cleaning of metals. Other industrial applications of 1,1,1-trichloroethane's solvent properties include its use as a dry-cleaning agent, a vapor degreasing agent, and a propellant.

NIOSH has estimated worker exposure to 1,1,1-trichloroethane at 2,900,000 per year.

ZINC CHLORIDE

$ZnCl_2$

Fume

TLV, 1 mg/m³

STEL, 2 mg/m³

Zinc chloride may be in the form of a non-combustible, white powder or colorless crystals. Both are deliquescent and have a molecular weight of 136.29 and a specific gravity of 2.807 at 25° C. The fume of zinc chloride is white with an acrid odor. This compound boils at 732° C and melts at about 290° C. It is soluble in water, alcohol and ether.

The chloride is the common inorganic salt of zinc, and is used in soldering fluxes, galvanizing iron, as a wood preservative, in textiles, adhesives, dentrifices, deodorants, embalming fluids, and in organic synthesis and petroleum refining. Zinc chloride is the main ingredient of some screening smokes.

Exposure to zinc chloride fume can cause damage to the mucous membranes of the nasopharynx and respiratory tract. Exposed persons have experienced a pale gray cyanosis. Zinc chloride is caustic and can cause ulceration of exposed surfaces of the skin.[1] Inhalation may produce a severe pneumonitis resulting from irritation of the respiratory tract.[2]

Hunter[3] reported 10 deaths and 25 cases of non-fatal injury among 70 persons in a tunnel when 79 smoke generators caught fire in a storage area. Most of the patients began to recover on the tenth day and were up and about six weeks after the incident. In two necropsies performed on the fatal cases, membranes lining the larynx, trachea and bronchi were red and edematous, with spots of necrosis. Milliken and associates[4] reported a case of fatal, acute interstitial fibrosis from inhaling $ZnCl_2$ smoke from a smoke generator. In 18 days the patient developed advanced pulmonary fibrosis, acute cor pulmonale and right ventricular hypertrophy, and ultimately died from acute respiratory insufficiency.

Hardy[5] comments that zinc chloride is caustic and because of the way it is used in industry causes trouble disproportionate to its harmful nature. She cites references suggesting that zinc compounds may have chronic effects. Ferry,[6] in investigating a borderline condition, found that levels between 0.07 and 0.4 mg/m³ of zinc chloride fume for 30 minutes did not result in sensory effects, but was corrosive to metals.

To prevent respiratory irritation and other effects, a TLV of 1 mg/m³ and a STEL of 2 mg/m³ are recommended.

Although insoluble zinc compounds such as the oxide and stearate (q.v.) appear less hazardous, there are not enough data to categorize the relative hazards from other soluble zinc salts, such as the nitrate and sulfate

The Swedish limit (1978) for $ZnCl_2$ is also 1 mg/m³

References:

1. **Sax, N.I.:** *Dangerous Properties of Industrial Materials*, p. 1268, Reinhold Pub. Corp., NY (1957)
2. **Gafafer, W.M.:** Occupational Diseases, Pub. Health Serv. Publ. #1097, U.S. Gov. Printing Office, Washington, DC (1964)
3. **Hunter, D.:** *The Diseases of Occupation*, pp. 367-377, Little, Brown & Co., Boston, MA (1955).
4. **Milliken, J.A., Waugh, D., Kadish, M.E.:** *Can. Med. Assoc. J. 88*:36 (1963).
5. **Hamilton, A., Hardy, H.L.:** *Industrial Toxicology*, 3rd ed., p. 187, Publishing Sciences Group, Acton (1974)
6. **Ferry, J.:** Communication to TLV Committee (1966)

ZINC CHROMATES

$ZnCrO_4$; $ZnCr_2O_4$; $ZnCr_2O_7$

TLV, 0.05 mg/m³, as Cr, Appendix A2 — Suspected Carcinogen

The basic zinc chromate is yellow in color and exists in prism form; molecular weight 181.36, specific gravity 3.40. $ZnCr_2O_4$ has a molecular weight of 233.36 and a specific gravity of 5.30 at 15° C, and its cubes are dark green to black in color. The dichromate is an orange powder with a molecular weight of 281.35. All are soluble in acids, but sparingly soluble in water.

Although finding some use as colors, they are primarily employed in priming paints for metals, for which they provide resistance against corrosion. The pigment zinc yellow is potassium zinc chromate.

Because of their very slight solubility in water, zinc chromate is considered more likely to produce cancer of the respiratory passages, when inhaled, than are the water soluble chromates. While an increased incidence of lung cancer has reported among groups of pigment workers exposed to chromates,[1] including zinc chromate,[2] a classification of suspected, rather than actual human carcinogen seems appropriate at this time.

The TLV of 0.05 mg Cr/m³, the same as that of lead chromate, is retained for the present. A review would be in order, however, if the limit for the insoluble chromates was reduced

For additional information, see the documentation for chromium and its compounds in this book.

References:

1. **Equitable Environmental Health, Inc.:** *An Epidemiological Study of Workers in Lean Chromate Plants*, final report submitted to The Dry Color Manufacturers Assoc. (June 25, 1976)
2. **Langard, S., Norseth, T.:** *Brit. J. Ind. Med. 32*:62-65 (1975).

APPENDIX IV

FIELD EQUIPMENT MANUALS

CONTENTS

APPENDIX IV

HNU PI 101

1.0 INTRODUCTION

The Model 101 has been designed to measure the concentration of trace gases in many industrial or plant atmospheres. The instrument has similar capabilities outdoors. The analyzer employs the principle of photoionization for detection. This process is termed photoionization because the absorption of ultraviolet light (a photon) by a molecule leads to ionization via:

$$RH + hv \quad RH^{+} + e-$$

where RH = trace gas,
hv = a photon with an energy greater than or equal to an Ionization Potential of RH

The sensor consists of a sealed ultraviolet light source that emits photons which are energetic enough to ionize many trace species (particularly organics) but do not ionize the major components of air such as O_2, N_2, CO, CO_2, or H_2O. A chamber adjacent to the ultraviolet source contains a pair of electrodes. When a positive potential is applied to one electrode, the field created drives any ions, formed by absorption of UV light, to the collector electrode where the current (proportional to concentration) is measured. The useful range of the instrument is from a fraction of a ppm to about 2,000 ppm.

2.0 CALIBRATION

All operating procedures should be as specified by the manufacturer unless otherwise noted.

Equipment needed:

- o calibration gas
- o tubing and fittings
- o rotameter or bubble flowmeter

2.1 CDM employs a two-point standardization procedure to facilitate proper instrument calibration over the 0-20 ppm and 0-200 ppm operating ranges. Two distinct mixtures of isobutylene in air are used as the calibration gases. Each will give a 3/4 scale deflection of its respective operating range. Isobutylene was chosen because the instrument's relative sensitivity to it is high and it is a non-toxic gas.

2.2 Prior to using the PI 101, check the function switch on the control panel to make sure it is in the OFF position. The probe nozzle, electrode casing and connector cable are stored inside the instrument cover. The probe is assembled by screwing the probe nozzel into the casing. The 12 pin interface connector for the probe is located just below the span adjustment on the face of the instrument. Carefully match the Alignment Key in the probe connector to the 12 pin connector on the control panel and then twist the probe connector until a distinct snap and lock is felt.

When calibrating the instrument, refer to and completely fill out the PI 101 Recalibration form.

2.3 Turn the function switch to the BATTERY CHECK position. The needle on the meter should read within or above the green battery arc on the scaleplate. If the needle is in the lower portion of the battery arc, or the red LED comes on, the instrument should be recharged prior to making any measurements.

2.4 If the battery needs recharging, place the mini phone plug into jack on left side of the bezel connector prior to plugging charger into 120V AC. When disconnecting charger, remove from 120V AC before removing mini phone plug. The battery is completely recharged overnight (ca. 14 hours). To ensure that the charger is functioning, turn the function switch to the battery check position, place phone plug into jack and plug charger into AC outlet. The meter should go upscale if the charger is working and is correctly inserted into the jack.

The instrument can be operated during the recharge cycle, however this will lengthen the time required to completely recharge the instrument battery.

2.5 Next, turn the funtion switch to the ON position. In this position, the UV light source should be on. To verify, check into the end of the probe to see the purple glow of the lamp. Do not look directly at the lamp itself.

2.6 To zero the instrument, turn the function switch to the STANDBY position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the zero potentiometer produces an upscale deflection while counterclockwise rotation yields a downscale deflection. Note: No zero gas is needed, since this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. Wait 15 or 20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero.

2.7 The instrument is now ready for the calibration procedure. Set the function switch to the 0-200 PPM scale.

2.8 The recommended and most accurate procedure for calibration of the instrument from a pressurized container is to connect one site of a "T" to the pressurized container of mid-range calibration gas, another side of the "T" to a rotameter and the third side of the "T" directly to the 8" extension to the photoionization probe (see Figure 1). Crack the valve of the pressurized container until a slight flow is indicated on the rotameter. The instrument draws in the volume of sample required for detection, and the flow in the rotameter indicates an excess of sample. Now adjust the span pot so that the instrument is reading the exact value of the calibration gas. (After the instrument span setting is changed, the instrument should be turned back to the standby position and the electronic zero should be readadjusted, if necessary, and respan).

2.9 Next, set the function switch to the 0-20 ppm scale. Connect the pressurized container of low range calibration gas to the instrument as described above.

2.10 Do not adjust the span pot. The observed reading on the 0-20 ppm scale should be ± 3 ppm of the acutal concentration of the low range calibration gas. If this is not the case, recalibrate the mid-range scale. If the low range reading consistently falls outside of the recommended tolerances, the probe light source window most likely needs cleaning. When the observed reading is within the required tolerances, the instrument is fully calibrated.

3.0 OPERATION

3.1 With the instrument fully calibrated, it is now ready for use. Any results obtained should be reported as parts per million (ppm) as Isobutylene. Some important performance specifications and power requirements of the PI 101 are listed here.

Performance

- o range 0.1 to 2000 ppm
- o detection limit 0.1 ppm
- o sensitivity (max) 0-2 ppm FSD over 100 division meter scale
- o repeatability ± 1% of FSD
- o linear range 0.1 to 600 ppm
- o useful range 0.1 to 2000 ppm
- o response time < 3 sec to 90% of full scale
- o ambient humidity to 95% RH
- o operating temperature ambient to 40°C*

Power requirements of operating times:

- o continuous use, battery >10 hours
- o continuous use with HNU recorder reduces instrument battery operating time to 1/2 normal time
- o recharge time, max <14 hours, 3 hours to 90% of full charge
- o recharge current, max .4 Amps @ 15 VDC

---

*Instrument is temperature compensated so that a 20°C change in temperature corresponds to a change in reading of < ± 2% full scale at maximum sensitivity.

3.2 The instrument is equipped with an automatic solid state battery protection circuit. When the battery voltage drops below approx. 11 volts, this circuit will automatically turn off the power to the instrument. This prevents deep discharging of the battery and considerably extends the battery life. If the instrument is unintentionally left on overnight, the battery will be unharmed because of the battery protection circuit. If the instrument battery check reads low and the lamp doesn't fire, plug the charger into the instrument. The power to the analyzer should then be returned.

3.3 A small DC operated fan is used to pull air through the photoionization sensor at a flow rate of three to seven hundred centimeters per minutes (0.5 lpm). The fan provides nearly instantaneous response times while consuming little power. With the function switch turned to one of the operating ranges, the fan is turned on automatically. The instrument is now analyzing the surrounding atmosphere.

3.4 To obtain the most accurate reading, the function switch should be set on the lowest possible operating range. An audible alarm can be set at a predetermined concentration if it is so desired.

3.5 A black "magic marker" is kept with the PI 101 at all times to enable the operator to check if the instrument will still provide a given response. With the marker pen held at the end of the probe, an approximate reading of 5 ppm should be obtained.

3.6 If the probe is held close to AC power lines or power transformers, an error may be observed. For management made in close proximity to such items, their effect on measurements can be determined by the following procedure. Zero the instrument in an electrically quiet area, in the standby position, then move the instrument to the questionable area involved. If AC pickup is going to be a problem, the meter (in the standby position) will indicate the magnitude of the error.

3.7 A list of relative photoionization sensitivites is presented in Table 1 for the operators own use. A much more specific list is available from the CDM Boston Laboratory.

4.0 REFERENCE

Instruction Manual for Model PI 1010 Photoionization Analyzer Printed by HNU Systems, Inc., Copyright 1975.

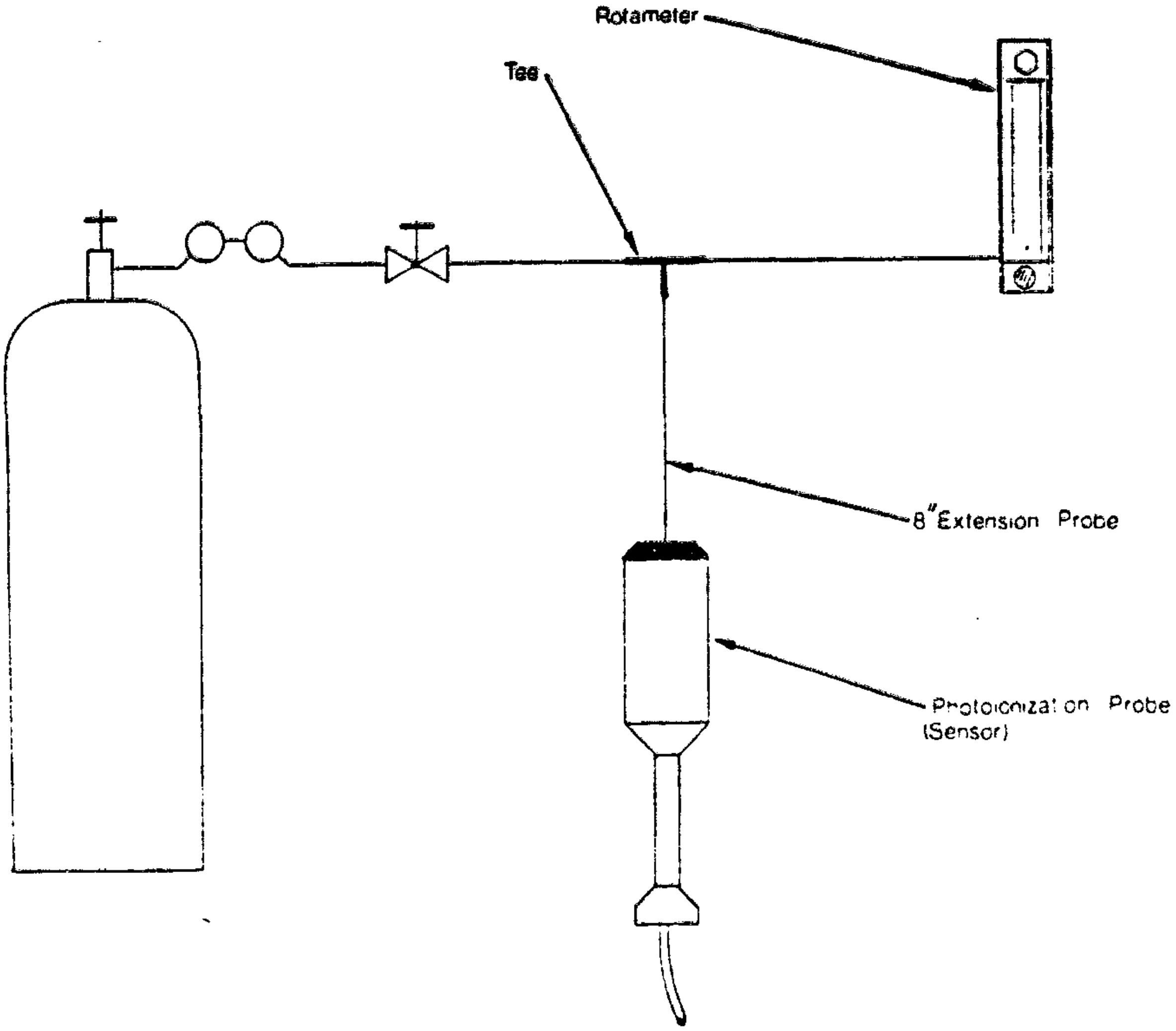
RELATIVE PHOTOIONIZATION SENSITIVITIES FOR VARIOUS GASES

(Sensitivities in ppm)

Chemical Grouping	Relative Sensitivity	Examples
Aromatic	10.0	Benzene, Toluene, Styrene
Aliphatic Amine	10.0	Diethylamine
Chlorinated Unsaturated	5-9	Vinyl Chloride, Vinylidene Chloride, Trichloroethylene
Carbonyl	5-7	MEK, MIBK, Acetone, Cyclohexene,
Unsaturated	3-5	Acrolein, Propylene, Cyclohexene, Allyl Alcohol
Sulfide	3-5	Hydrogen Sulfide, Methyl Mercaptan
Paraffin (C_5-C_7)	1-3	Pentane, Hexane, Heptane
Ammonia	0.3	---
Paraffin (C_1-C_4)	0	Methane, Ethane

FIGURE 1

RECOMMENDED CALIBRATION PROCEDURE FOR PHOTOIONIZATION ANALYZER



No. 3816008
Rev
Page 9 of 9

HNU PI 101 RECALIBRATION FORM

DATE ______________ RECALIBRATED BY ______________
INSTRUMENT SERIAL NO ______________

STANDARD REFERENCE FOR CALIBRATION GAS:
midrange ______ ± ______ ppm ______________
lowrange ______ ± ______ ppm ______________

RECEIVED FROM ______________ PROGRAM ______________

Was instrument recalibrated in field? yes ____ no ____

Battery Check? yes ____ no ____ (if no, recharge)

Intitial Zero (0-20 ppm range) ________ ppm ________ VDC

Challenge with midrange standard.

Initial Reading Designated ________ ppm ________ VDC
Observed ________ ppm ________ VDC

Potentiometer Setting (as found) ____________

Final Reading (after recalibration) ________ ppm ________ VDC

Potentiometer Setting (Final) ____________

Post Calibration Zero (0-20 ppm range) ________ ppm ________ VDC

Challenge with low range standard.

Initial Reading Designated ________ ppm ________ VDC
Observed ________ ppm ________ VDC

Final Zero (0-20 ppm range) Observed ________ ppm ________ VDC
Final ________ ppm ________ VDC

PREVENTIVE MAINTENANCE PERFORMED: Source Window Cleaned? yes ____ no ____
Other: ____

ADDITIONAL NOTES: ____

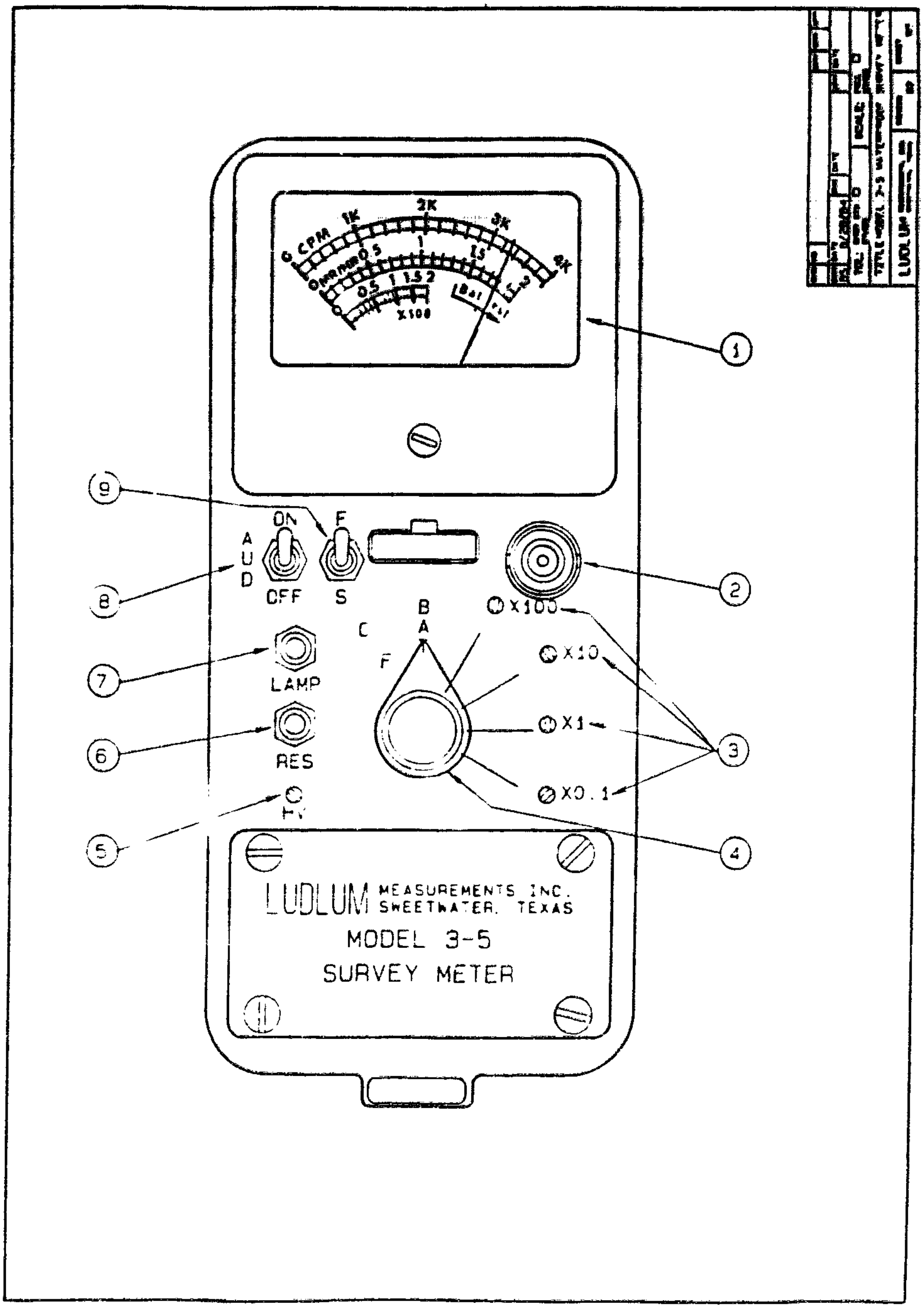
CALIBRATED BY ______________ DATE ______________

Instruction Manual

LUDLUM MODEL 3-5 SURVEY METER

LUDLUM MEASUREMENTS, INC.
501 OAK 915 - 235-5494 P. O. BOX 248
SWEETWATER, TEXAS, U.S.A., 79556

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial
INSTRUMENTS


0 CPM 1K 2K 3K 4K
0 mR/hr 0.5 1 1.5 2
0 0.5 1 1.5 2
X100
Bat
1
9
ON
F
A
U
D
OFF
S
8
2
X100
B
A
C
F
X10
X1
X0.1
3
7
LAMP
6
RES
HV
5
4
LUDLUM MEASUREMENTS INC.
SWEETWATER, TEXAS
MODEL 3-5
SURVEY METER
SCALE
TITLE MODEL 3-5
LUDLUM

LUDLUM MODEL 3-5 SURVEY METER

TABLE OF CONTENTS

AUGUST 1984

LUDLUM MODEL 3-5 SURVEY METER

1. GENERAL

The Model 3-5 is a waterproof, portable survey instrument that operates on two standard "D" cell flashlight batteries. The instrument features a regulated high-voltage, power supply adjustable from 400 to 1500 volts and provides a 4-linear range from 0-200 mR/Hr.

The unit body is made of cast aluminum, including the meter housing. The can is 1/16 aluminum. Other operating features of the instrument include a unimorph speaker mounted to the instrument can with an audio ON-OFF capability, fast-slow meter response, meter reset button, meter light pushbutton and a 6-position switch for selecting battery check or scale multiples of X0.1, X1, X10 and X100. Each range multiplier has its own calibration potentiometer.

Any G-M probe offered by the company will operate on this unit as well as many of the scintillator-type detectors. The instrument is set for 900-volt, G-M tube operation. For special requirements, it may be adjusted for operation with any G-M or scintillator tube between 400 and 1500 volts.

The unit is operated with two flashlight batteries for operation from 150° to approximately 32°F. For temperature operation to 0°F, either very fresh alkaline batteries or rechargeable NiCd batteries may be used. Battery drain averages 30 milliamperes.

2. SPECIFICATIONS

POWER: two standard "D" size batteries

FOUR LINEAR RANGES: from 0 to 200 mR/Hr; meter scale presentation - 0 to 2 mR/Hr with range multiples of X0.1, X1, X10, X100

SENSITIVITY: 40 millivolts, (+20mV, -16mV)

AUDIO: built-in unimorph speaker with an ON-OFF switch

HIGH VOLTAGE: externally adjustable from 400 to 1500 volts

RESPONSE: 5 or 25 seconds for 90% of final meter reading

LINEARITY: plus or minus 5% full scale

LUDLUM MODEL 3-5 SURVEY METER

CALIBRATION STABILITY: less than 15% variance to battery end point

METER: 50 Micro-amp, 2 1/2-inch scale, with pivot-and-jewel suspension

CONNECTOR: Series "C", 706 U/G; BNC or MHV may also be provided

SIZE: 3.4 x 3.5 x 7.0 inches (H x W x L exclusive of handle)

WEIGHT: 3.5 pounds less detector

FINISH: drawn-and-cast aluminum, with computer-beige polyurethane enamel and silk-screened nomenclature.

3. DESCRIPTION OF CONTROLS AND FUNCTIONS

(1) Meter has a readout of 0 to 4K CPM and 0 to 2 mR/hr for an actual count of 0 to 400,000 CPM or 0 to 200 mR/hr. A battery test scale is also provided to check battery-charge status.

(2) A Series "C" connector is provided for connection of the cable and probe.

(3) Range Calibration Adjustments are recessed potentiometers located on line with each multiplier position. These adjustment controls allow individual calibration for each range multiplier.

(4) Range Multiplier Selector Switch is a 6-position switch marked OFF, BAT, X100, X10, X1, X0.1. Turning the range selector switch from OFF to BAT position provides operator a battery check of the instrument. A BAT check scale on the meter provides a visual means of checking the battery status. Moving the range selector switch to one of the range multiplier positions (X0.1, X1, X10, X100) provides the operator with an overall range of 0-200 mR/Hr. Multiply the scale reading by the multiplier for determining the actual reading.

(5) High Voltage Adjustment provides a means to vary the high voltage from 400 to 1500 volts. The high voltage setting may be checked at the connector with an appropriate voltmeter.

(6) RES Button, when depressed, provides a rapid means to drive the meter to zero.

(7) LAMP Pushbutton Switch, when depressed, lights the meter face.

(8) AUDIO ON-OFF Toggle Switch in the ON position operates the unimorph speaker, located on the left side of the instrument. The frequency of the clicks is relative to the rate of the incoming pulses. The higher the rate is, the higher the audio frequency. The audio should be turned OFF when not required to reduce battery drain.

(9) Fast-Slow Toggle Switch provides meter response. Selecting the "F" position of the toggle switch provides 90% of the final meter reading in 5 seconds. In "S" position, 90% of the final meter reading takes 11 seconds. In "F" position there is fast response and large meter deviation. In "S" position there is a slow response and damped meter deviation.

4. OPERATING PROCEDURES

4.1 Remove the battery box lid and install two "D" size batteries. Note (+) (-) marks on the inside of the lid. Match the battery polarity to these marks.

NOTE: Center post of flashlight battery is positive.

Replace the battery box lid.

4.2 Turn the range switch to BAT. The meter should deflect to the battery check portion of the meter scale. If the meter does not respond, recheck that the batteries have proper polarity. Press the LAMP button and check for a light on the meter.

4.3 Connect the cable to the instrument and detector.

4.4 Turn the instrument range switch to X100. Expose the detector to a check source. The speaker should click with the AUDIO ON-OFF switched to ON.

4.5 Move the range switch to the lower scales until a meter reading is indicated. The toggle switch labeled F-S should have fast response in "F"and slow response in "S".

4.6 Depress the RES switch. The meter should zero.

4.7 Proceed to use the instrument.

5. CALIBRATION

5.1 Detector Operating Point: Adjust the HV control for 900 volts at the instrument connector for G-M detectors.

NOTE: If an electrostatic voltmeter is not available, use an ordinary volt-ohm-milliameter with an attenuator to provide at least 100 Meg ohm meter resistance. Select the appropriate scale and then adjust high voltage to read 850 volts.

Do not use a vacuum-tube-type voltmeter for this adjustment unless an external high voltage multiplier probe is used.

Turn the instrument to X100. Expose the instrument to a calibrated gamma field and vary the range calibration adjustment control for proper reading.

5.2 Special Use Calibration: For special G-M detector applications, the power supply may be adjusted for 450--volt and 1200-volt G-M tubes. Follow the above procedure, only set the supply at the new operating voltage.

For scintillation counters, connect the scintillator. Expose the unit to a source and develop an operating voltage versus count-rate plot. Set the operating voltage at the flattest portion of this curve; then proceed to adjust each calibration control for the desired meter reading.

5.3 Calibrating CPM Scale: To calibrate the CPM scale, a precision pulse generator is required. The pulse generator should be capable of providing a 75-millivolt, or greater, negative pulse with a pulse-width of 5 microseconds.

Connect the pulse generator to the instrument and adjust the pulse frequency to provide a 4/5-scale deflection on the X100 range (400,000 CPM). Adjust the X100 range calibration potentiometer as required. Decrease the pulse frequency by decades and adjust each range calibration potentiometer accordingly.

6. MAINTENANCE

NOTE: NEVER STORE THE INSTRUMENT OVER 30 DAYS WITHOUT REMOVING BATTERIES. ALTHOUGH THIS INSTRUMENT WILL OPERATE AT VERY HIGH AMBIENT TEMPERATURES, BATTERY SEAL FAILURE CAN OCCUR AT TEMPERATURES AS LOW AS 100 DEGREES FAHRENHEIT. NEGLECTED BATTERY SEAL FAILURE WILL SURELY CAUSE ONE AWFUL MESS!

Instrument maintenance consists of keeping the instrument clean and periodically checking batteries and calibration. Once initial calibration is performed, recalibration should not be required if batteries are maintained in good condition.

An instrument operational check should be performed prior to each use by exposing detector to a known source and confirming proper reading on each scale.

Under certain conditions, NRC requires instrument recalibration every three months. Check the appropriate regulations to determine recalibration schedule.

Also at three month intervals, the batteries should be removed and the battery contacts cleaned of any corrosion. If the instrument has been exposed to very dusty or corrosive atmosphere, more frequent battery servicing should be used.

Use a spanner wrench to unscrew the battery contact insulators, exposing internal contacts and battery spring. Removing the handle will facilitate access to these contacts.

LUDLUM MODEL 3-5 SURVEY METER

BILL OF MATERIALS

CIRCUIT BOARD, DRAWING 176 X 17

CAPACITORS

C1	100PF, 3KV, C	04-5532
C2	.01MF, 50V, C	04-5523
C3	500PF, 500V, C	04-5555
C4	.0047MF, 100V, P	04-5513
C5	.01MF, 50V, C	04-5523
C6	10MF, 20V, OST	04-5507
C7-C8	100MF, 10V, DST	04-5576
C9	4.7MF, 10V, OST	04-5578
C10	.1MF,10V, C	04-5521
C11	4.7MF, 10V, OST	04-5578
C12	22MF, 20V, T	04-5579
C13	.01MF, 50V, C	04-5523
C14	.1MF, 10V, C	04-5521
C15	100MF, 10V, OST	04-5576
C16	1MF, 35V, OST	04-5575
C17	.1MF, 10V, C	04-5521
C18	100PF, 3KV, OST	04-5532
C19	.005MF, 2KV, C	04-5520
C20	.001MF, 3KV, C	04-5518
C21-C23	.001MF, 1KV, C	04-5519
C24	.01MF, 50V, C	04-5523
C25	500PF, 500V, C	04-5555

TRANSISTORS

Q1-Q2	2N2713	05-5755
Q3	MPSU01	05-5778
Q4	MPS6534	05-5763
Q5-Q6	2N3877	05-5758
Q7	MPS6534	05-5763

INTEGRATED CIRCUITS

U1	CA3096	06-6023
U2	CD4093	06-6030
U3	CD4098	06-6066
U4	CA3096	06-6023
U5-U6	LM358	06-6024

INTRODUCTION & QUICK
REFERENCE GUIDE TO
THE FOXBORO
OVA ORGANIC VAPOR ANALYZER

CDM

REM II

ADVANCED TRAINING COURSE 150.2

QUESTIONS AND ANSWERS ON CENTURY OVA 128 AND OVA 128GC

1. <u>What is the OVA?</u> The OVA (Organic Vapor Analyzer) is a portable flame ionization detector package designed to monitor organic gases and vapors in the ambient air.

2. <u>How does the OVA work?</u> The OVA, as mentioned previously is a flame ionization detector to which can be attached chromatographic columns for qualitative and quanitative analysis of air mixtures. Briefly, the OVA functions as follows:

   A small diaphram pump located integral to the OVA brings in an air sample through a pickup probe (1/4" I.D. tubing) at the rate of 1-2 liters per minute. This air sample is mixed with hydrogen and delivered to the detector chamber where the mixture feeds in a small flame. The flame is part of a very sensitive potentiometer system which can detect the minute ionization due to burning of organic compounds.

   The supply of hydrogen is stored in a 75 cubic centimeters stainless steel tank and fed to the flame through a carefully regulated delivery system.

3. <u>What form does the OVA readout take?</u> The response of the OVA potentiometer is displayed on a meter located on the handle of the pickup probe. The OVA is calibrated to read directly in parts per million as methane. The OVA 128 unit reads out in a linear scale in three ranges 0-10, 0-100 and 0-1000 parts per million.

   The OVA is factory calibrated for methane gas but can be user calibrated for other organic gases and vapors. A key factor to keep in mind is that different organic compounds will have different instrument responses. Example are:

Compound	Relative Responses
Methane	100 (Standard
Acetone	60
Methyl Ethyl Ketone	80
Methyl Isobutyl Ketone	100
Methyl Alcohol	15
Ethyl Alcohol	25
Isopropyl Alcohol	65
Carbon Tetrachloride	10
Chloroform	65
Trichloroethylene	70
Vinyl Chloride	35

4. Is there a general rule with regard to instrument response for the gas or vapor being monitored? Compounds containing oxygen give a lower response than what is observed for pure hydrocarbons. Examples are alcohols, esters, ethers and aldehydes.

   In general, the higher the proportion of carbon to oxygen, the lower the effect of oxygen in lowering instrument response.

   This general rule also applies to nitrogen containing compounds such lower the effect of oxygen in lowering instrument response.

   This general rule also applies to nitrogen containing compounds such as amines and nitriles and halogenated compounds such as freons.

5. What compounds do not give an instrument response? Non-organic compounds and CO_2, CO and high humidity levels.

6. What is the source of power for the OVA? The OVA contains a refillable hydrogen tank and rechargeable batteries (12 volts) sufficient to operate the instrument for a minimum of 8 hours in the field.

7. Is the OVA safe for explosive atmospheres? The OVA 128 have Factory Mutual Approval and are certified intrinsically safe for use in explosive atmospheres.

8. How many people does it take to operate the OVA? The OVA is designed for one man one hand operation. The unit is carried on a shoulder strap and weighs approximately 12 pounds.

9. Does the OVA require the air sample to be filtered? Yes, depending on the particular OVA ordered, the instrument has a porous metal or cotton filter.

10. What is the instrument response time? Less than 2 seconds.

11. What type of chart recorder is supplied with the OVA? The OVA can be equipped with a Rustrak portable chart recorder. This unit is powered from the OVA through the connecting cable. The recorder paper is impact sensitive. The unit is available in an FM approved model certified intrinsically safe.

    In addition, the OVA can be used with a variety of other chart recorders including the linear 5" and 10" recorders. The OVA recorder output is 0-5 volts.

12. What is the chromatographic option offered with the OVA? The chromatographic option consists of a charcoal filter cartridge, a valve system and a chromatographic column.

    The basic principle of operation is that a mixture of organic compounds in the gas phase when swept through the column on a carrier gas are physically separated prior to the exiting to the detector. In other words, the compounds vary in the length of time they require to travel through the column.

Various column packings are utilized to obtain separation. Examples are chromosorb and supelcoport.

In the case of the OVA, the hydrogen supplying the hydrogen flame is used as the carrier gas for the column.

In operation, the user first determines that a given sample is being delivered to the detector by observing a meter response roughly 1/2 of full scale. At this instant, the inject valve is depressed with a sharp motion. This action accomplishes two things. First, a 0.25cc sample of the air mixture is introduced into the hydrogen carrier gas which then proceeds to enter the chromatographic column.

Second, the air sample being brought in to the instrument probe is now directed through a characoal filter cartridge. This insures that "clean" air is being directed to the detector.

A chart recorder is attached to the OVA to obtain instrument responses overtime as the components of the sample exit the column and proceed to the detector.

To return to the "total hydrocarbons" mode of operation, the inject valve is pulled upward to its original position. The backflush is then reversed (to a position opposite of what it was prior to the analysis) to backflush the column and clear it of very slow moving components which will eventually clog the column and reduce the flow of carrier gas.

The chart recorder gives a record of the exit of components called a chromatogram. The time it takes for each compound to exit the column as measured from the instant of injection is called the retention time and serves to identify the compound. The procedure thus gives qualitative information regarding the gas mixture being examined.

The area under the chromatographic peak is proportional to the concentration of the compound which the peak represents. The OVA thereby yields quantitative information about the gas mixture.

13. What is the PIP? The Portable Isothermal Pack (PIP for short) is a device used for keeping the chromatographic columns of the OVA at a constant, preselected temperature during analysis. This control is required particularly for outdoor use of the OVA because the retention for organic compounds on a chromatographic column varies with temperature.

The PIP consist of a metal container roughly 4" in diameter around which is wound the chromatographic column. The column is then foamed in place with polyurethane foam, the whole being contained inside an outer plastic container.

When the cover of the PIP is removed, the inner aluminum container can be filled with a solution at a constant temperature (example: Ice and water) or a metal slug heated to a desired temperature can be used as a heat sink.

The PIP is mounted on a bracket on the side of the OVA.

14. What accessories are available for the OVA? The OVA is equipped with a variety of standard accessories. These are:

a. The instrument carrying and storage case
b. The fuel filling hose assembly
c. The A.C. battery charger
d. The earphone
e. Pickup fixtures

Century OVA's can also be equipped with varies optional accessories. These are:

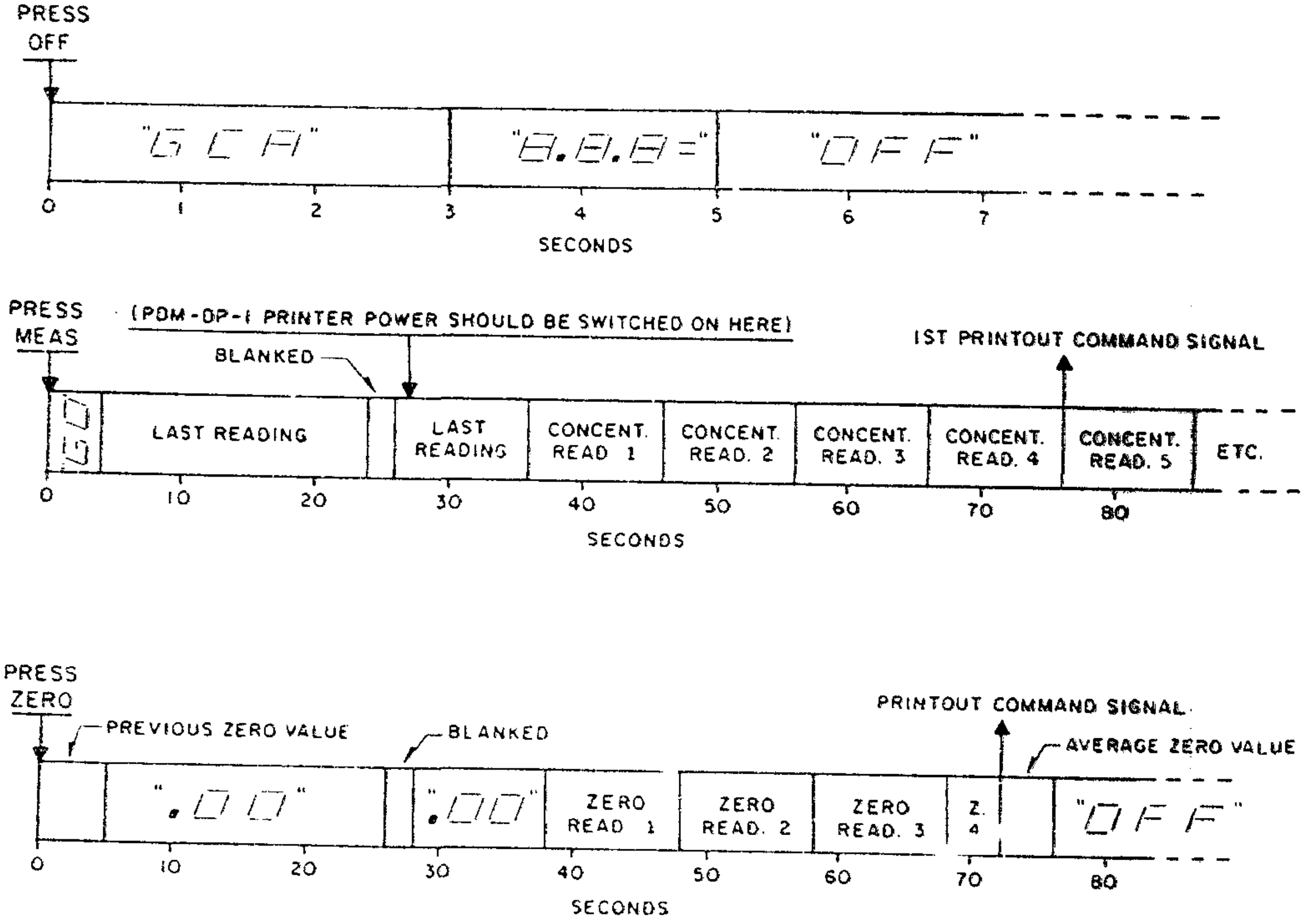
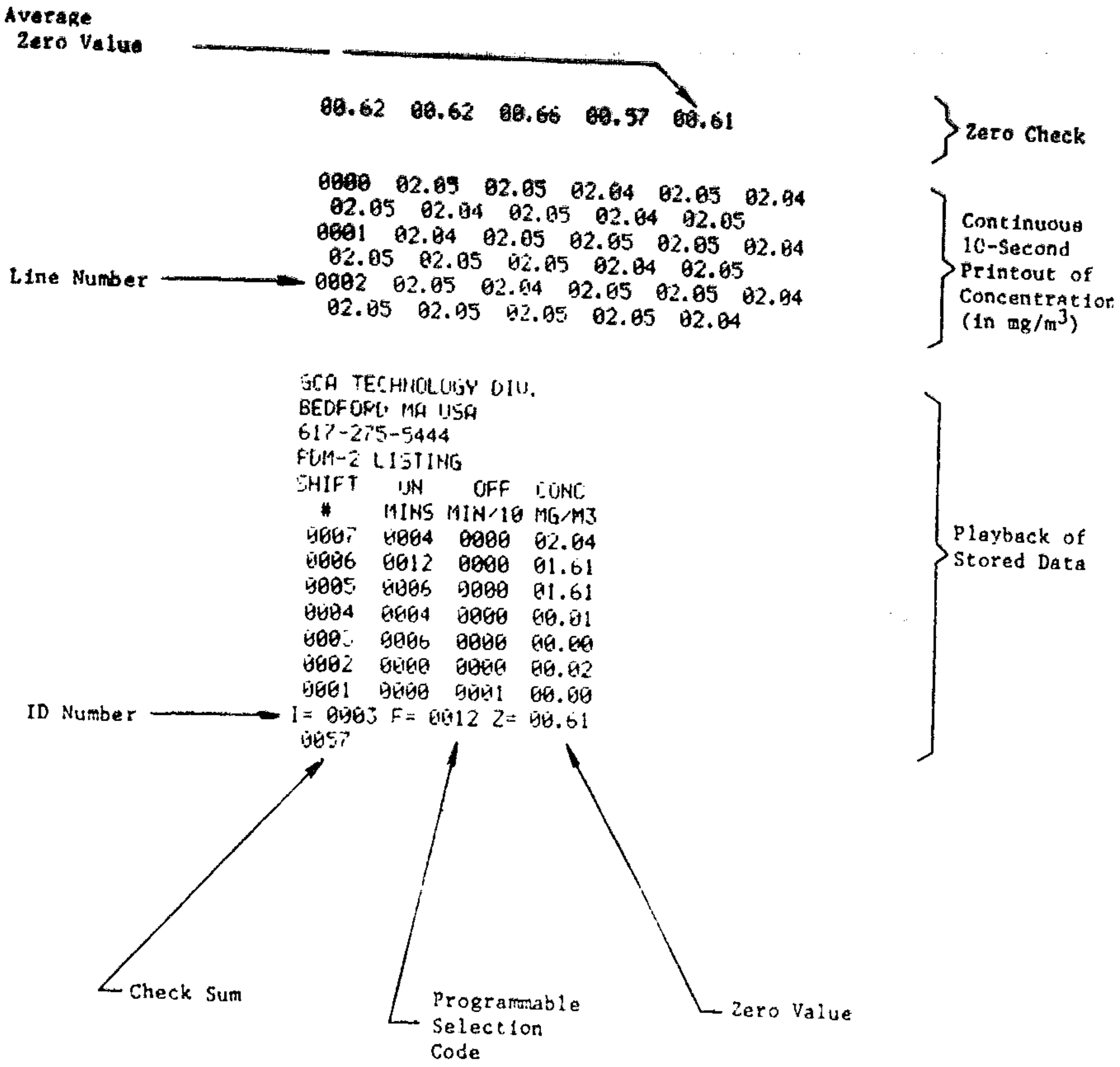


Figure 2. Timing diagram of MINIRAM model PDM-3 when pressing OFF, MEAS. or ZERO (typical times).



```
00.62  00.62  00.66  00.57  00.61

0000  02.05  02.05  02.04  02.05  02.04
 02.05  02.04  02.05  02.04  02.05
0001  02.04  02.05  02.05  02.05  02.04
 02.05  02.05  02.05  02.04  02.05
0002  02.05  02.04  02.05  02.05  02.04
 02.05  02.05  02.05  02.05  02.04

GCA TECHNOLOGY DIV.
BEDFORD MA USA
617-275-5444
PDM-2 LISTING
SHIFT   ON    OFF   CONC
  #    MINS MIN/10 MG/M3
 0007  0004  0000  02.04
 0006  0012  0000  01.61
 0005  0006  0000  01.61
 0004  0004  0000  00.01
 0003  0006  0000  00.00
 0002  0000  0000  00.02
 0001  0000  0001  00.00
I= 0003 F= 0012 Z= 00.61
 0057
```

Figure 3. Typical MINIRAM Model PDM-2 Digital Printout Format

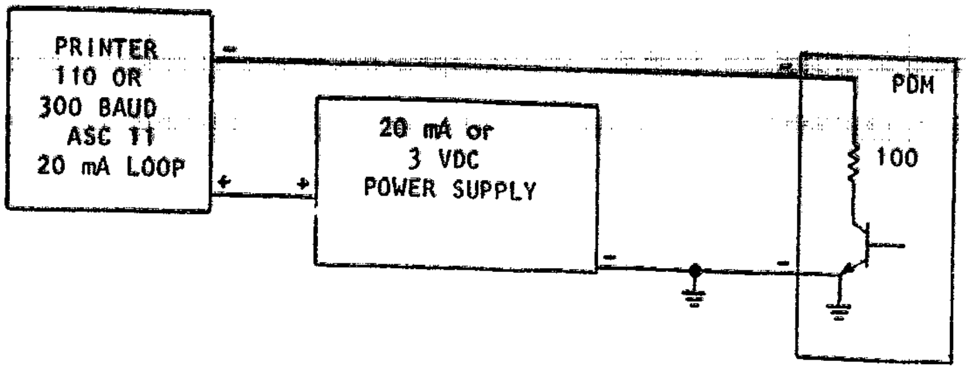


Figure 4. - 20 mA loop connection

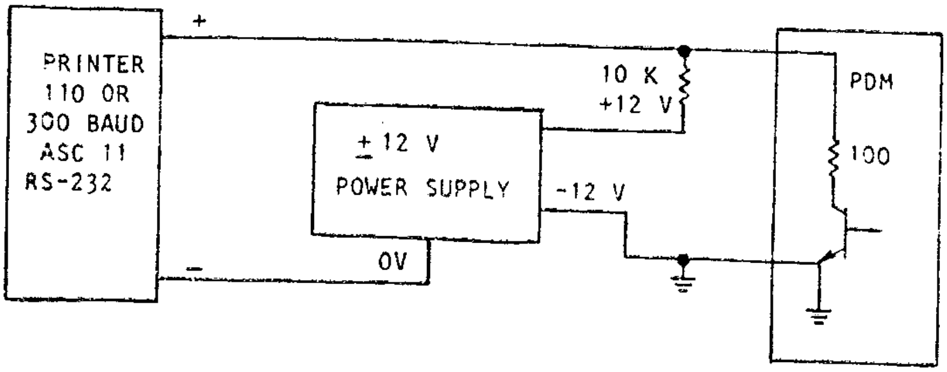


Figure 5. - RS-232 connection

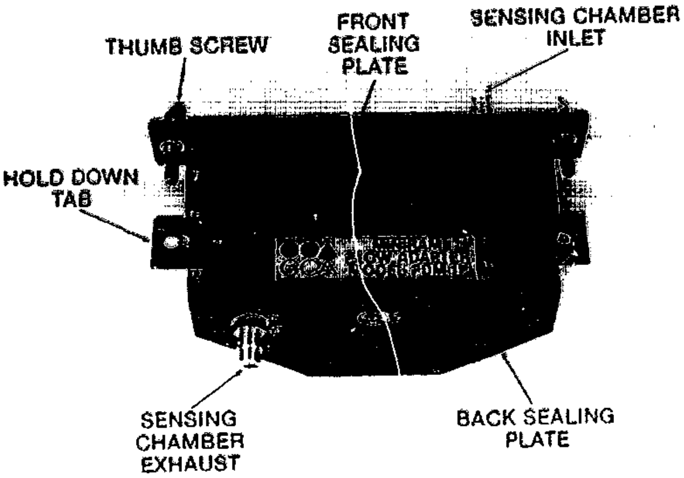


Figure 6a Flow Adapter

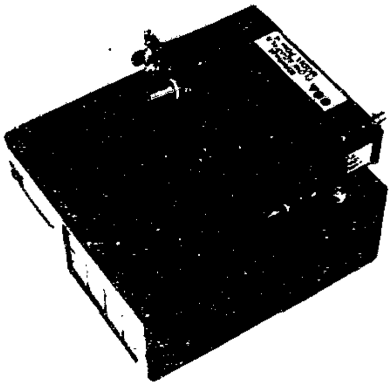


Figure 6b MINIRAM with Flow Adapter Attached

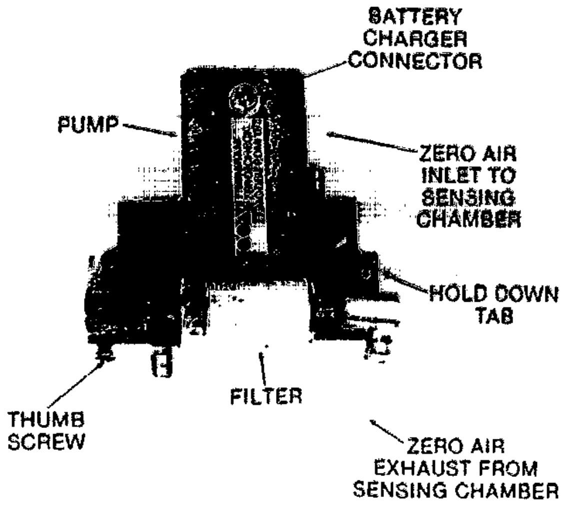


Figure 7a Zero Check Module

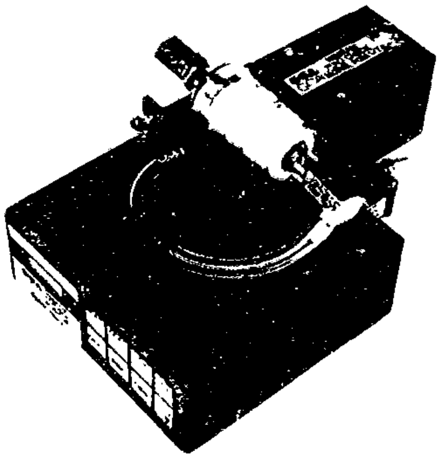


Figure 7b MINIRAM with Zero Check Module Attached

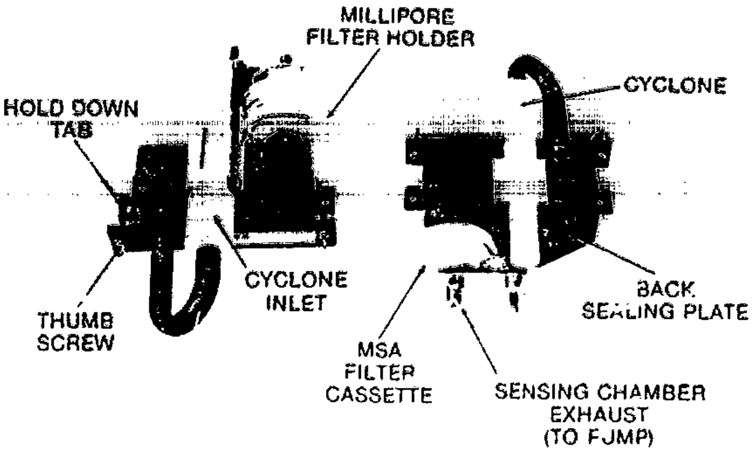


Figure 8a Personal Sampler Adapters

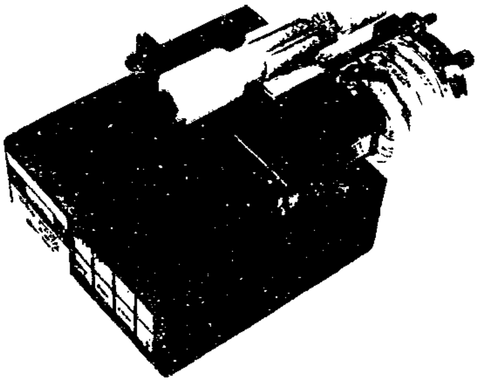


Figure 8b MINIRAM with Personal Sampler Adapter Attached

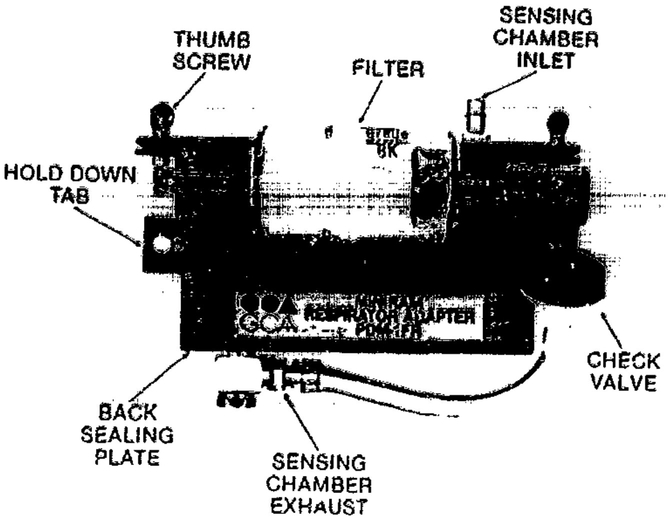


Figure 9a Respirator Adapter

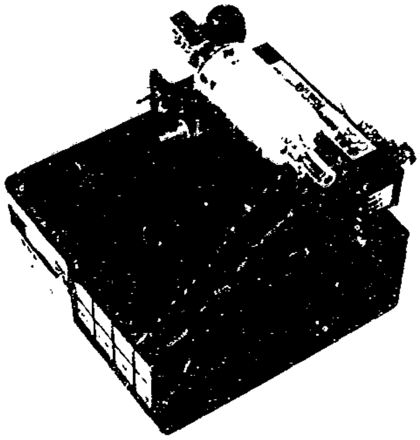


Figure 9b MINIRAM with Respirator Adapter Attached

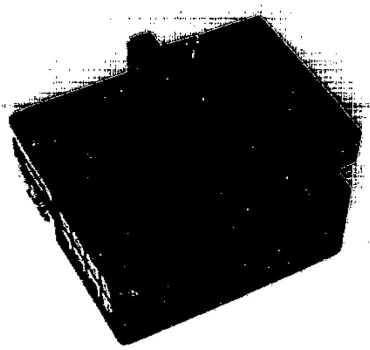


Figure 10. MINIRAM with Sunshield Attached

Figure 11. Model PDM-SS Shoulder Strap

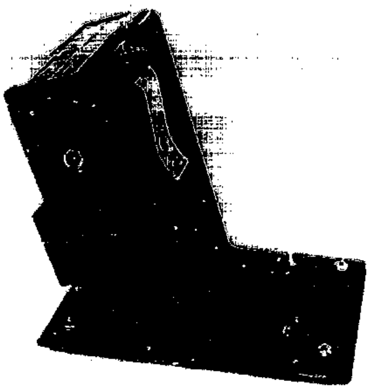


Figure 12. Model PDM-TS Table Stand

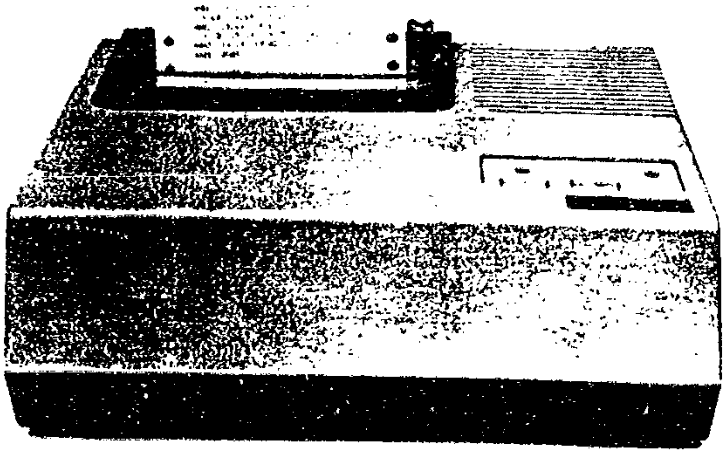


Figure 13. Dot Matrix Digital Printer

APPENDIX V

STANDARD OPERATING PROCEDURES

CONTENTS

APPENDIX V

SUBSURFACE SOIL SAMPLING

1.0 GENERAL

The objective of subsurface sampling is to obtain soil from known depths in order to evaluate site characteristics, detect the presence of any contaminants and to evalutate the potential for pollutant migration. In the following sections, the equipment and techniques used to collect subsurface soil samples are described. General procedures which shall be followed during soil sample collection, including the cleaning of sampling equipment, are presented in method number 3816009.

2.0 BOREHOLE DRILLING

Subsurface soil samples from boreholes can be obtained at specified depths or continuously. Several techniques can be utilized for advancing borings including jetting, wash boring, auger boring, or rotary drilling. These techniques are briefly described in procedure number 3816013. Jetting, is not appropriate where soil samples are of concern.

In some instances borehole advancement, in connection with soil sampling, is accomplished by continuous sampling.

3.0 SOIL SAMPLING

The boring techniques utilized to excavate a borehole result in considerable disturbance of soil and do not allow for accurate determination of the depth from which soil materials have been excavated. Therefore split spoon, thin wall tubes or other sampling techniques must be used in conjunction with boring operations to obtain soil samples.

Subsurface samples may be obtained at predetermined depths, at every change in lithology or continuously. Continuous sampling provides the most accurate record of subsurface conditions for interpretive purposes.

3.1 Split Spoons

Split spoons are devices used to obtain subsurface samples of up to 2.5 feet in length within hollow stem auger flights, cased borings, and mudded holes. The 1.75 to 2.5 in ID split spoon samplers are advanced into the undisturbed material beneath the bottom of the casing or borehole by use of weighted hammer and drill rod. The relationship between hammer weight, drop and blows required to advance the split spoon in 6-inch increments is an indicatoin of density or consistency of subsurface soils. After the split spoon has been driven the prescribed depth, it is removed carefully to avoid loss of soil materials. In non-cohesive or saturated soils a nest shall be used to help retain the sample.

Following removal of the split spoon from the casing, it shall be detached from the drill rod and opened to allow for visual classification of the sample. When less than a 10-inch sample has been obtained, a second cleaned sampler shall be lowered into the hole and a second sample shall be obtained. The first sample collected, if any, shall be retained unless greater sample recovery is obtained during the subsequent sampling attempts. The entire sample (except the top several inches of possibly "disturbed" material) shall be retained.

Samples of cohesive clays or silts shall be wrapped in aluminum foil prior to storage in jars, to preserve as undisturbed a sample as possible.

Once an adequate sample is collected, the sample shall be inspected, described, planed in wide mouth jars, labeled, and stored for transportation to the laboratory.

If volatile organic analyses are to be performed, VOA vials shall be filled immediately from the split spoon before jarring. Subsamples for other specific chemical analyses shall be taken as soon as possible as required.

3.2 Thin Wall Tubes

Thin wall tubes are hollow pipes which are pressed or driven into the soil without rotation to obtain core samples of relatively undisturbed soils.

Thin wall tube samplers are generally 1.875 in ID, 2 in OD and 2 to 3 feet long, but may be of any size convenient for sampling. The thin wall tube has a sharp cutting edge and a positive inside clearance.

Thin wall tube samplers may be pushed or driven into soils inside hollow stem auger flights, wash bore casings or uncased boreholes. The tubes are pushed into the soil without rotation until the desired depth is attained or to refusal. If the sample tubes can not be advanced by pushing, it may be necessary to drive the tube into the soil, without rotation, using hammers and drill rods. The tubes are generally allowed to remain in the boring for 10 to 15 minutes to allow buildup of skin friction prior to removal. The sampler is then rotated to shear the sample from the soil below and carefully removed from the borehole.

Following removal of the tube sampler from the drilling equipment, the sampler is inspected to ensure that an adequate length of sample as been obtained. This sampling procedure shall be repeated until an adequate soil core is obtained provided that the material being sampled is of a nature which would permit retention in the sampler.

Upon successful retrieval of a soil core it shall be described and recorded in the log book and any disturbed soil shall be removed from each end of the tube. Samples for volatile organic analysis must be extracted from the soilds sample as soon after the sampler is withdrawn as possible. During transport to the sampling station, the tube should be capped with a non-reactive material. For other parameter, the shelby tube shall be sealed by pouring three 1/4 inch layers of liquid wax such as Socony Vacuum Product 2300 in each end allowing the wax to solidify between each layer. The remaining space shall be filled to the end of the cylinder with Ottawa sand or other similar sand and allowed to settle and compact. Plastic caps shall be taped over the ends of the cylinder and then sealed by successively dipping the ends into liquid wax. The tube shall then be labeled. Care should be taken in handling to label the top and bottom of the tube.

7777-141-WP1

Project Operations Plan

June 19, 1985 Final

North Cavalcade Site

Nancy B. Johannesmeyer

Robert S. Kier

SUBSURFACE SOIL SAMPLING
ADDENDUM TO METHOD No. 3816031

Procedures

The general procedures provided in Method No. 3816031 of the Site Investigations Procedure Manual (see Appendix IV) will be used to collect the subsurface soil samples. In addition, the following procedures will be utilized for the collection and surrogate analysis of subsurface soil samples.

a. Procedures specified in the subcontractor bid package for subsurface soil investigation contained Appendix IV will be followed:

b. The following on-site and off-site localities will be sampled during the subsurface soils investigation program. These locations have been based on examination of historical aerial photographs and previous data collected in other sampling programs.

- o Northern point of the North Cavalcade Site
- o Known or potential locations of past wood treatment areas
- o Off-site location at Mavry and Woodard streets
- o Random locations throughout drip track area in central part of site.

c. These localities will be investigated first using a portable power auger. The 200 power auger boreholes are to be advanced to a depth of 5 feet.

d. The soil materials brought up from the power auger borings will be qualitatively screened using OVA and HNU instruments and described by the on-site geologist. The instrument readings and soil description will be entered into the field notebook. The approximate depths of each soil type will be noted in the field notebook.

e. All downhole equipment including the power auger will be cleaned prior to sampling and between use using the following method:

1. Rinse with clean distilled water, or steam clean with steam generator as necessary.

2. Rinse with alconox detergent solution, brush deposits if necessday, and allow to dry.

3. Rinse at least once with clean distilled water.

f. All sample locations will be staked and marked with an appropriate label.

g. All soil materials removed from the hole shall be collected, containerized and stored in compliance with RCRA regulations for proper disposal.

h. The power auger borehole will be grouted back to the original surface using a non-shrink bentonite-cement mix.

i. The power auger borings will be used to start determining the limits of the soil contamination and to guide the placement of deeper surface borings. Deeper soil borings will be conducted at 49 on-site locations and 1 off-site location.

j. Each boring will be advanced and sampled continuously to a minimum depth of five feet below the base of the shallow aquifer or until there is no overt contamination that can be detected visually. At a minimum, the borehole will be 25 feet deep.

k. Samples will be collected continuously using a 3-inch diameter split-spoon sampler that will be driven into the ground in consecutive 18-inch intervals. The over-sized split spoon sampler that will be driven into the ground in consecutive 18-inch intervals. The over-size split spoon is needed to provide enough sample for standard laboratory analyses, especially when duplicates are collected.

l. Upon recovery of the sample from the borehole, the split-spoon sampler will be opened after placement on a clean teflon sheet.

m. As the spoon is opened, the soil material will be qualitatively screened using an OVA and/or HNU and described by a geologist using the following techniques.

   1. Verify that the OVA or HNU have been calibrated within the last four hours and that the equipment is functioning properly.

   2. As the split-spoon is opened, pass the air intakes along the sample at a distance of approximately one-half inch, noting the location and magnitude of the readings in the field notebook.

   3. At roughly six-inch intervals, position the intakes close to the sample and then disturb the soil material with a spatula noting the locations and magnitude of the readings in the field notebook.

   4. Record the highest readings on each instrument for each six-inch interval of sample recovered, identifying any interferences and basis of measurement.

   5. Before the borehole is advanced or the next sample is taken, place the air intakes into the borehole, six inches below the ground surface, noting any readings and interferences in the field notebook.

   6. Record the soil descriptions into the field notebook.

n. The disturbed ends of the sample should be trimmed. The soil material will then be divided into three six-inch samples and placed in separate sample containers using clean stainless steel spatulas for further analysis or storage.

o. If less than 18-inches of soil is recovered by the split-spoon, the geologist will use his judgment to assign depth intervals to the recovered material.

p. After the sample has been placed in a bottle for storage or future analysis, a headspace analysis shall be performed in the field using the following techniques.

   1. Each sample will be placed in a sixteen ounce widemouth glass jar with aluminum foil and teflon caps.

   2. Verify that the OVA and/or the HNU have been calibrated within the last four hours and that the equipment in functioning properly.

   3. Leave the sample container at the borehole site. After a minimum period of 15 minutes of equilibrium in the sample jars, place the air intake of the instrument through the aluminum foil and into the headspace of the jar. The length of time prior to conducting the headspace analysis should be approximately the same for each sample.

   4. In sun or shade the "plateau" readings of the headspace in ppm will be recorded in the field notebook along with the ambient temperature. The length of time between placing the sample in the sample container and conducting the headspace analysis will also be recorded.

   5. An average of four soil samples from each continuous soil boring showing a range of CVA and HNU readings from low to high concentrations and/or a range of distinct soil materials will be sent to the on-site warehouse for surrogate analysis by CDM personnel.

q. Approximately four samples per continuous soil boring will be analyzed by CDM personnel using a surrogate analysis. These samples will be screened for zinc, copper, chromium and arsenic using an x-ray fluorescence machine. The procedures to be utilized for conducting this analysis are provided in Appendix IV.

r. From the samples subjected to surrogate analysis 20 samples or 15 percent (whichever is greater) will be sent to the contracted laboratory for the analyses described below.

s. Should highly contaminated samples, containing relatively pure product, be encountered on the site, up to ten samples will be subjected to the analysis for the parameters described below.

t. The boring will be advanced using dry hollow stem augers or other methods approved by the geologist that do not use drilling fluids.

u. The split-spoons, teflon sheets and spatulas will be decontaminated in accordance with the standard protocol presented in Step F prior to each use. the drilling rig and all related equipment and tools used at one boring will be steam-cleaned prior to re-use.

No 3816012
Rev
Page 1 of 7

SURFACE WATER SAMPLING

1.0 OBJECTIVE

The objective of obtaining surface water samples is to determine the surface water quality entering, leaving or affected by the site. Surface water samples are considered environmental samples (containing low concentrations of contaminants) but accurately quantifying the contaminants present is of utmost importance. In order to obtain a representative sample, the hydraulics of the water course must be determined before sampling, so that the most representative sample can be obtained.

Either grab or composite samples may be collected. Grab samples are collected at one particular point and time. Flow- or time-weighted composite samples are composed of more than one aliquot collected at various sampling sites and/or at different points in time. Because of the unknown safety risks, as well as the changes in chemical nature of the sample that may occur through compositing, samples containing hazardous materials at significant concentrations shall not be composited. Environmental samples containing low levels of toxics may be composited however, as described in the site specific sampling and analytical plan.

If it is necessary to wade into the water course to obtain a sample, the team member shall be careful not to disturb bottom sediments and shall enter the water course downstream of the sampling location. While in reality, it is difficult to prevent disturbance of the sediments, it is the responsibility of the team member to minimize the introduction of sediments into the sample. If necessary, the sampling technician shall wait for the sediments to settle before taking the sample.

If the water course is moving, a depth integrated grab sample shall be obtained. A depth integrated sample is collected by lowering an open container (shown in Figure 1) against the flow, to a depth just above bottom. The container is then turned into the flow and raised at a rate that allows it to just fill when it reaches the surface. The sample shall be collected in the middle of the stream.

2.0 EQUIPMENT

The best choice of sampling equipment depends on the particular conditions at the site and the water body being sampled. The tyes of samplers available are:

- o Open tube
- o Pond Sampler
- o Manual Hand Pump
- o Weighted Bottle Sampler
- o Kemmerer Sampler
- o Extended Bottle Sampler.

Of these, the pond sampler and the weighted bottle sampler will be used most often. The criteria for selecting a sample collector are:

- o Disposable and/or easily decontaminated - A collection device may not be used again without sufficient cleaning.
- o Inexpensive - This is a necessity if the item is to be disposed of.
- o Each of operation - Cumbersome safety clothing and the use of protective respiratory equipment dictate the use of simple tools.
- o Nonreactive - The device must not react with the sample in such a manner as to contaminate it.
- o Safe - The unit must not present a safety threat to the user.

3.0 SAMPLING METHODS

3.1 Pond Sampler

The pond or dip sampler (Figure 1) consists of a container attached to the end of a long pole by an adjustable clamp. The pole can be of any non-reactive material such as wood, plastic or metal, as it will not be in contact with the sample itself. The sample shall be collected in a jar or beaker made of stainless steel, glass or non-reactive plastic. Preferably, a disposable beaker which can be replaced, shall be used at each station. Liquid wastes from water courses, ponds, pits, lagoons or open vessels are "ladeled" into a sample container.

3.2 Manual Hand Pumps

Manual pumps are available in various sizes and configurations. Manual hand pumps are commonly operated by peristaltic, bellows or diaphragm, and siphon action. Manual hand pumps which operate by a bellow or diaphragm, and siphon action should not be used to collect samples which will be analyzed fo volatile organics.

The pump is operated according to manufacturer's instructions. The sample inlet hose is inserted into the liquid to be sampled, and a crank or bellows is activated.

To avoid contamination of the pump, a liquid trap consisting of a vacuum flask is inserted at the sample inlet hose to collect the sample (Figure 2). Teflon tubing shall be used for the inlet hose which the liquid sample in order to avoid sample contamination. The hose and trap must be flushed between stations with a minimum of three volumes of liquid, and cleaned or replaced at the end of each day.

3.3 Weighted Bottle Sampler

The sampler (Figure 3) consists of a glass bottle, a weight sinker, a bottle stopper, and a line that is used to open the bottle and to lower and raise the sampler during sampling. There are variations of this sampler, as illustrated in the ASTM methods D 270 and E 300. This sampler can be either fabricated or purchased. Procedure for use:

1. Assemble the weighted bottle sampler as shown in Figure 3.
2. Gently lower the sampler to the desired depth so as not to remove the stopper prematurely.

3. Pull out the stopper with a sharp jerk of the sampler line.
4. Allow the bottle to fill completely, as evidenced by the cessation of air bubbles.
5. Raise the sampler and cap the bottle.
6. Wipe the bottle clean. The bottle can be used as the sample container.

Alternatives to the weighted bottle sampler are the Kemmerer sampler and the extended bottle sampler.

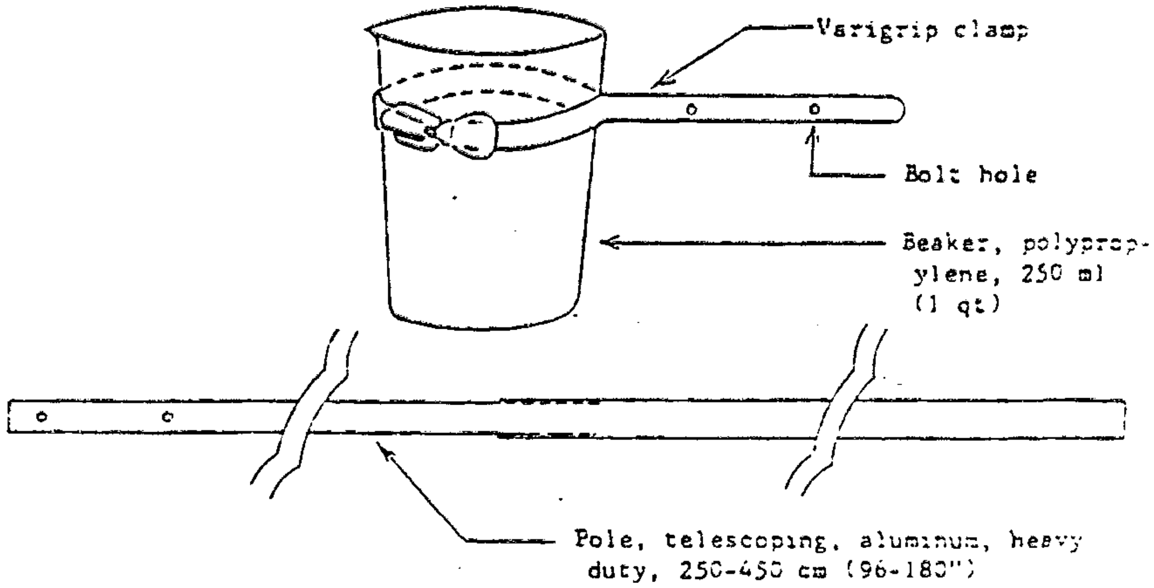
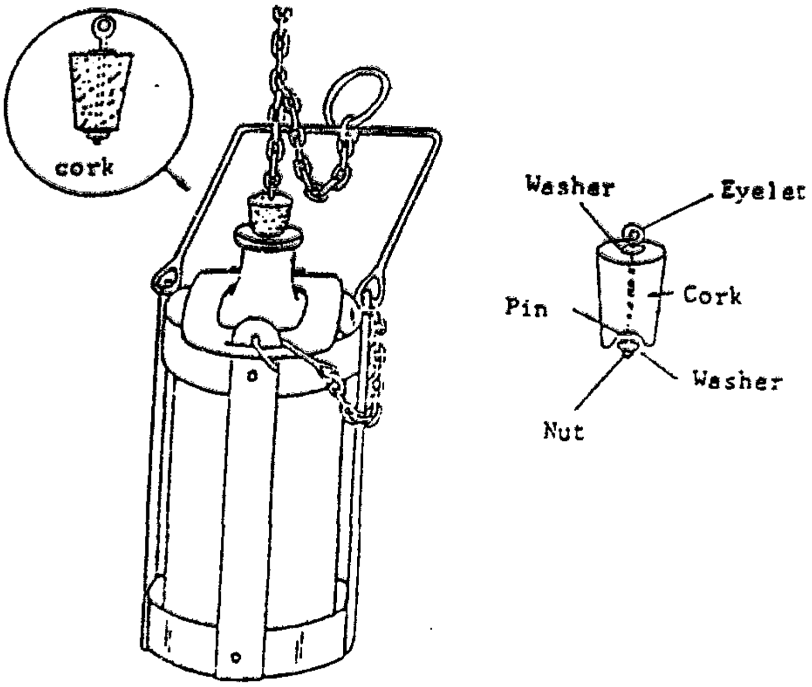


Figure 5.4.1 Pond sampler.



1000 ml (1-quart) weighted
bottle catcher

Figure 5.4.3 Weighted bottle sampler.

SEDIMENT SAMPLING

1.0 GENERAL

Sediment samples are obtained at uncontrolled hazardous waste sites and controlled substances work areas in order to provide information on transport of contaminants. Sediments consist of soil materials which have been transported to ponds or streams due to surface soil erosion or those materials that occur naturally under submerged conditions. Sediments are generally saturated and may be composed of mineral or organic materials or a combination of these.

2.0 SAMPLING EQUIPMENT AND TECHNIQUE

Sediment samples may be obtained using on-shore or off shore-techniques. Sediment sampling equipment and techniques must be designed to minimize the risk of dilution or loss of material as the sample is moved through the water column. For these situations where floatation devices or boats are required for sampling, extra precautionary measures must be employed. At a minimum, life preservers must be provided and two individuals shall undertake the sampling and an additional person shall remain in visual contact on-shore to observe the operations.

In the following sections, sediment samplers and their use are described.

2.1 Dip Sampler

A dip sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

The dip sampler is operated by submerging the jar or scoop and pulling it through the sediments to be sampled. The samples retrieved are then transferred into the appropriate sample container by decanting liquid phase and retaining the sediments.

2.2 Hand Operated Core Samplers

Hand operated sediment core samplers are used to obtain sediment samples in shallow water (<3 ft). These samplers operate in a manner similar to that described for soil core samplers. However because of the saturated conditions of sediments, provisions must be provided so that the sample is retained within the core. Core samplers are generally constructed of an outer rigid metal tube into which a 2 inch ID plastic core sleeve fits with minimal clearance. The cutting edge of the core sampler has a recessed lip on which the plastic sleeve rests and which accomodates a plastic nest. This nest is oriented such that when the sampler is pressed into the sediment, the core is free to move past the nest. Due to construction of the nest, the core will not fall through the nest upon removal of the sampler from the sediment.

When the sampler is removed from the sediment, the plastic sleeve is removed sealed and labeled. Core sleeves should be sealed by packing ends with clean sand and placing plastic caps secured with friction tape over ends. Care should be taken in handling samples and the orientation of the sample core shall be indicated on the sleeve.

Because core sleeves and nests are generally made of plastic, special provisions should be made if samples are to be tested for chlorinated organics.

The land operated core sampler will not be useful for obtaining samples of gravelly, stoney or consolidated sediments.

2.3 Gravity Core Samplers

Gravity core samplers are used to obtain sediment samples in water bodies or lagoons with depths of greater than 3 to 5 feet. These types of samplers can be used for collecting 1 to 2 foot cores with a 2 inch ID, of surface sediments at depths of up to 100 feet beneath the water surface.

As with all core type samplers, they are not suitable for obtaining samples of coarse - gravelly, stoney, or consolidated desposits. They are however, useful for fine grained inorganic and organic sediment sampling.

The gravity core sampler operates in a manner similar to the hand operated core in that a plastic sleeve of 2 inch ID fits within a metal core housing fitted with a cutting edge. Plastic nests are used to retain the core within the plastic sleeve. An opening exists above the core sleeve to allow free flow of water into and through the core as it moves vertically downward to the sediment. The sampler has a messenger-activated valve assembly which seals the opening above the plastic sleeve following sediment penetration. This valve is activated by the messenger creating a partial vacuum to assist in sample retention during retrieval.

Samples are obtained by allowing the sampler which is attached to approximately 100 feet of aircraft cable to drop to the benthic deposits. The weight of the sampler drives to core into the sediment to vary depths depending on the characteristics of the sediments. The messenger is then dropped on the taut aircraft cable to seal the opening above the plastic sleeve. The sampler is then carefully retrieved.

Upon retrieval of the sampler, the plastic core sleeve is removed and void spaces at either end packed with clear sand. The sample is then sealed with plastic caps attached using friction tape. Care should be excerised in labeling in order to properly identify sample orientation.

2.4 Dredges

Dredges are generally used to sample sediments which cannot easily be obtained using coring devices or when large quantities of materials are required. Various dredge designs are available for sampling in deep or turbulent waters and for obtaining samples from gravelly, stoney or dense deposits.

Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger.

Dredges are commonly quite heavy and therefore require use of a winch and crane assembly for sample retrieval.

Upon retrieval of the dredge, the sample can either be sieved or transfered directly to a sample container for labeling and storage.

Dredge types which could be used for sampling include Ponar, Petersen and Ekman dredges.

SAMPLING OF ORGANIC VAPORS AND AIRBORNE PARTICULATES

1.0 INTRODUCTION

This procedure shall be followed to collect organic vapors and particulates present in ambient air. A known volume of air is drawn through a three-stage sampler consisting of a teflon filter followed by a two-stage Tenax-GC sorbent tube to trap the organic vapors/particulates present. The filter is used to collect pollutants in a solid state or adsorbed on particulate matter and is analyzed separately after sampling. The sorbent is used to collect vaporous analytes. The organics are desorbed from the filter and Tenax thermally, and the sample is analyzed using a coupled gas chromatograph/mass spectrometer.

2.0 EQUIPMENT

2.1 Sampling Pump

A calibrated personal sampling pump whose flow can be determined to an accuracy of + 5% at a low rate of 1.0 to 1.5 l/min is required. The pump is calibrated with a representative sampling assembly in line.

2.2 Organic Sampling Filters

The filter assembly consists of a two piece 37 mm filter cassette packed with a teflon coated glass fiber filter (Pallflex Products, Inc. T60A20 or equivalent).

2.3 Organic Sampling Tubes

The sampling tube used to collect the sample consists of a glass tube, 10-cm long with a 6-mm I.D. and a 8-mm O.D. packed with two sections of Tenax-GC^R. The two sections include a front adsorbing section (100 mg) and a backup section (50 mg). The two sections are separated by a portion of silylated glass wool. A plug of silylated glass wool is placed at each end of the sorbent tube. The pressure drop across the tube must be less than one inch of mercury at a flow rate of 1.0 liter per minute. (SKC Inc., CAT #226-35-03 or equivalent).

3.0 PROCEDURE

3.1 A sample size of 150-300 liters is recommended. Sample at a known flow rate of 1.0 liters per minute.

3.2 Immediately before sampling, break open the ends of the tubes.

3.3 The section containing 50 mg of Tenax-GC^R is used as a backup and should be positioned nearest the sampling pump. The tube should be placed in a vertical position during sampling to avoid channeling and subsequent premature breakthrough of the analyte.

3.4 Air sampled should be passed through a teflon coated glass fiber filter before entering the front section of the Tenax-GC^R tube to trap any analyte in particulate form present in the atmosphere.

3.5 Set the flow rate of the pump as accurately as possible using the manufacturer's directions. Record the information necessary to determine flow rate, and also record the initial and final sampling times. Record the temperature and pressure of the atmosphere being sampled.

3.6 The tubes should be firmly sealed with plastic caps immediately after sampling. The filter cassette with the teflon coated glass fiber filter must also be sealed at both ends with caps provided by the manufacturer.

3.7 One Tenax-GC^R tube and teflon filter should be handled in the same manner as the sample tubes except for the taking of an air sample. This sample should be labeled as a blank. Submit one blank for every ten samples, for any batch or partial batch of fewer then ten samples.

3.8 At least one blind duplicate should be prepared for each sampling set taken per day. A blind duplicate is generated by collecting duplicate field samples (other than a blank) simultaneously at one location and labeling each of the two duplicates with a unique field code, consistent with the field sample coding system, as if they were independent samples.

3.9 A minimum of six unused Tenax-GC^R tubes and filters should be available for use in desorption efficiency studies in conjunction with these samples, because desorption efficiency may vary from one batch or sorbent to another. Record the batch number of the Tenax-GC and filters used.

4.0 SPECIAL CONSIDERATIONS

4.1 Where two or more compounds are known or suspected to be present in the air, such information, including their suspected identities, should be transmitted with the sample, if possible.

4.2 Due to the high flow resistance of the sampling assembly, this sampling method places a heavy load on the sampling pump. Therefore, no more than five hours of sampling should be done without first recharging the battery.

5.0 SHIPPING INSTRUCTIONS

Capped sample^2 tubes and filter samples should be packed tightly and padded before they are shipped to minimize breakage or leakage during shipping.

6.0 REFERENCES

Pellizari, E.D., "Analysis of Organic Air Pollutants by Gas Chromatography and Mass Spectrometry", EPA-600/2-77-100; U.S. EPA p. 114.

SAMPLE BOTTLE PREPARATION, SAMPLE PRESERVATION AND MAXIMUM HOLD TIMES

1.0 INTRODUCTION

Depending on the analyses to be performed and the nature of the samples being collected, the sample container must be treated according to specific procedures. For environmental samples, bottles should be washed as described in 'general bottle washing' if: 1) they will be stored for later (not specified) usage 2) they will be used for composite samples for a variety of routine analyses 3) they will be used for routine analyses not requiring special preparation.

Hazardous samples must be placed only in glass containers with teflon-lined screw caps. They must not be fixed with any preservative or preserved with ice or dry ice.

In order that the concentration of chemical constituents in environmental samples are not altered prior to analysis, the samples are preserved by appropriate standard techniques[1], if it is not possible to add preservatives to a sample container prior to sample collection (as is the case of samples that will be composited), samples to be analyzed for more than one parameter should be placed on ice immediately upon sampling.

Listed in Table 1 are accepted[1] container preparation and sample preservation techniques for environmental samples which are described in the pages that follow. Preservation procedures for those parameters not shown in the following table are given in individual analytical methodologies.

---

[1] Bottle type, preservation techniques, and holdtimes (proposed) are defined in the Federal Register 44:69464. December 3, 1979.

a. The gas chromatograph option (OVA 108 and OVA 128)
b. A portable strip chart recorder
c. An activated charcoal filter
d. A dilution assembly
e. A septum adapter for use with the gas chromatograph option.
f. A portable isothermal pack for temperature control of the columns.

PRECAUTIONS FOR BEST PERFORMANCE - ORGANIC VAPOR ANALYZER

Keep battery on charger when not in use
Recharge battery as soon as possible after use
Avoid dropping meter/probe assembly
Avoid intake of high boiling vapors
Backflush column after each chromatogram
Do not overtighten valves
Use hydrogen which contains less than 2 ppm hydrocarbons

REGULAR MAINTENANCE - ORGANIC VAPOR ANALYZER *

PROCEDURE	FREQUENCY
Check particle filters	Daily
Check quad rings (Gas Sampling Valves)	Weekly
Clean burner chamber	Weekly
Check calibration	Daily
Check pumping system	Daily

* If Required, Send Instrument to CDM Boston for Repair.

OVA 128 CALIBRATION PROCEDURES

(REQUIRED FOR REM III)

ROUTINE CALIBRATION

1) Set up instrument calibration log as on page 9.

2) Fill 2-5 liter tedlar gas bag with '100' ppm methane calibration standard.

3) Turn on electronics, H_2 and zero instrument on x-10 scale. Gas select dial to 300.

4) Introduce methane standard.

5) If instrument reads proper concentration, calibration is completed at this stage.

6) If the reading is off, the gas select span can be adjusted from the 300 position to 350-250.

7) If the instrument will still not calibrate refer to trouble shooting guide and check various systems.

8) If all systems checkout and a proper reading is still not obtained an internal calibration may be required as described on the next page.

9) when instrument is fixed, calibrated, and ready to go, complete log and tag instrument with the following information:

Date Calibrated _____
Calibrated w/_____ ppm CH4
@ Gas Select _____
Calibrated By ________
Comments _______________

10) Repeat this entire procedure after every 8 hours of instrument usage (also time to fill H_2 tank), or every time the instrument is being issued for use. Provide field crews with spot calibration gas bags of methane to insure operation in field.

INTERNAL CALIBRATION

1. Remove instrument from case.

2. Turn on electronics and zero instrument on X-10 scale. Gas select dial to 300.

3. Turn on pump and hydrogen. Ignite flame. Go to survey mode.

4. Introduce a methane standard near 100 ppm.

5. Adjust R-32 trimpot on circuit board to make meter read to standard.

6. Turn off hydrogen flame and adjust meter needle to read 4 ppm.

7. Switch to X1 scale and adjust R-31 trimpot to make meter read 4 ppm.

8. Return to X10 scale and adjust meter needle to 40 ppm.

9. Switch to X100 scale and adjust R-33 trimpot to make meter read 4. ppm.

* If instrument is not functioning properly, CDM Boston can aid in trouble shooting and internal repair. Please not not attempt internal repair if you do not feel confident with this procedure or source of problem.

FEM II VNA CALIBRATION LOG

REM II OVA CALIBRATION LOG MODEL 128

INSTRUMENT # EPA I.D.	DATE CALIBRATED	FLOW SETTING	CONC. CAL. GAS	GAS SELECT (300)	INTERNAL ADJUSTMENTS Y/N	NOTED INSTRUMENT PROBLEMS & COMMENTS	SITE CHARGE #	CAL. BY

POSSIBLE INDICATORS OF MALFUNCTION - ORGANIC VAPOR ANALYZER

INDICATIONS	POSSIBLE CAUSES
High background reading (more than 10 ppm)	1. Contaminated hydrogen
	2. Contaminated sample line
Continual flameout	1. Hydrogen leak
	2. Dirty burner chamber
	3. Dirty air filters
Low air flow	1. Dirty air filter
	2. Pump malfunction
	3. Line obstruction
Flame will not light	1. Low battery
	2. Ignitor broken
	3. Hydrogen leak
	4. Dirty burner chamber
	5. Air flow restricted
No power to pump	1. Low battery
	2. Short circuit
Hydorgen leak (instrument not in use)	1. Leak in regulator
	2. Leak in valves

TROUBLE SHOOTING PROCEDURES

TROUBLE	TROUBLE SHOOTING PROCEDURE	REMEDY
1) Low sample flow rate on flow indicator. Nominally 2 units on flow gauge (See also 6 below and refer to paragraph 6 2 4)	a) Check primary filter in sidepack and particle filters in the pickup assembly.	Replace or clean filter if clogged. (See paragraph 6 2 1)
	b) Determine assembly containing restriction by process of elimination, i.e , remove probe, remove Readout Assembly, remove primary filter, etc	Investigate the assembly containing this restriction to determine cause of blockage. Clean or replace as required.
	c) If the restriction is in the Side Pack Assembly, further isolate by disconnecting the sample flow tubing at various points, i. e., pump output, chamber input, etc Note The inherent restrictions due to length of sample line, flame arrestors, etc , must be taken into account when trouble shooting.	If in the detector chamber, remove and clean or replace porous metal flame arrestors If pump is found to be the problem, remove and clean or replace.
2) H2 flame will not light. (See also 6 below)	a) Check sample flow rate (see 1 above).	If sample flow rate is low, follow procedure 1 above
	b) Check igniter by removing the chamber exhaust port and observing the glow when the IGNITE Button is depressed.	If igniter does not light up, replace the plug If igniter still does not light, check the battery and wiring.
	c) Check for rated H2 Supply Pressure. (Listed on calibration plate on pump bracket.)	If low, remove battery pack and adjust to proper level by turning the allen wrench adjustment on the low pressure regulator cap.
	d) Check H2 flow rate by observing the PSI decrease in pressure on the H2 Tank Pressure gauge The flow rate should be about 130 PSI decrease in pressure per hour. (Approximately 12 cc/min. at detector.) On instruments with GC Option, disconnect column and measure H2 flow rate with a bubble meter.	The normal cause for H2 flow restriction would be a blocked or partially blocked capillary tube. If flow rate is marginally low, attempt to compensate by increasing the H2 Supply Pressure by one-half or one PSI. If flow rate cannot be compensated for, replace capillary tubing.
	e) *Check all H2 plumbing joints for leaks using* soap bubble solution. Also, shut off all valves and note pressure decay on H2 tank gauge. It should be less than 350 PSIG per hour.	*Repair leaking joint.*
	f) Check to see if H2 supply system is frozen up by taking unit into a warm area	If there is moisture in the H2 supply system and the unit must be operated in subfreezing temperatures, purge the H2 system with dry N2 and ensure the H2 gas used is dry

	g) Remove exhaust port and check for contamination. (See Figure 6 2.)	If the chamber is dirty, clean with ethyl alcohol and d by running pump for approximately 15 minutes. If t fuel jet is misaligned, ensure the porous metal flame restor is properly seated
	h) Check spacing between collecting electrode and burner tip. Spacing should be 0.1 to 0.15 inches.	Adjust by screwing Mixer/Burner Assembly in or ou This spacing problem should only occur aft reassembling a Mixer/Burner Assembly to a Pream Assembly
3) H2 flame lights but will not stay lighted	a) Follow procedures 2 (a), (c), (d), (e), (g) and (h) above. Also refer to 5 below.	
4) Flame-out alarm will not go on when H2 flame is out	a) Check instrument calibration setting and GAS SELECT control setting. Refer to paragraphs 2.3.1.2 and 2.3.2.	Readjust as required to proper setting. Note that linear OVA's the flame out alarm is actuated when t meter reading goes below zero. On logarithmic OVA the alarm is actuated when the signal level goes belo ppm methane or equivalent.
	b) Remove exhaust port and check for leakage current path in chamber (probably moisture or dirt in chamber)	Clean contamination and/or moisture from the chamb using a swab and alcohol, dry chamber by runni pump for approximately 15 minutes
	c) If above procedures do not resolve the problem, the probable cause is a malfunction in the preamp or power board assemblies	Return preamp chamber or power board assembly the factory for repair.
	d) Check volume control knob is turned up.	Adjust for desired volume
5) False flame-out alarm. (Applies to linear OVA's)	a) Flame-out alarm is actuated on linear instruments when signal goes below electronic zero (eventhough flame is still on). This can be due to inaccurate initial setting, drift or a decrease in ambient concentration. Verify if this is the problem by zeroing meter with flame out and reigniting. (See paragraph 2.3.2)	When using the X1 range, adjust meter to 1 ppm rath than zero. See paragraph 2.3.2. Be sure instrument h been zeroed to "lowest expected ambient backgrou level".
6) Slow response time, T_{90}, time to obtain response after sample is applied to input. (Refer to paragraph 6.2.4)	a) Check to ensure that probe is firmly seated on the rubber seal in the readout assembly	Reseat by holding the probe firmly against the rubb seal and then lock in position with the knurled lock nut
	b) Check sample flow rate per procedure 1 above.	See 1 above.

7) Slow recovery time, i.e., too long a time for the reading to get back to ambient after exposure to a high concentration of organic vapor	a) This problem is normally caused by contamination in the sample input line, requiring pumping for a long period to get the system clean of vapors again. Charcoal in the lines would be the worst type of contamination. Isolate through the process of elimination. (See 1 (b))	Clean or replace contaminated sample line or assembly as required
	b) Check flame chamber for contamination	Clean as required
8) Ambient background reading in clean environment is too high. (Refer to paragraph 6 2 5)	a) An ambient background reading can be caused by hydrocarbons in the H2 fuel supply system. Place finger over sample probe tube restricting sample flow and if meter indication does not go down significantly the contamination is probably in the H2 fuel	Use a higher grade of hydrocarbon free hydrogen. Check for contaminated fittings on filling hose assembly
	b) An ambient background reading can be caused by a residue of sample, building up on the face of the sample inlet filter. If the test in 8 (a) above produces a large drop in reading, this is usually the cause	Remove the exhaust port (it is not necessary to remove instrument from case), use small wire brush from the tool kit or a knife blade and lightly scrub surface of sample inlet filter.
	c) An ambient background reading can also be caused by hydrocarbon contamination in the sample input system. The most likely cause would be a contaminant absorbed or condensed in the sample line. Note. It should be emphasized that running the instrument tends to keep down the buildup of background vapors. Therefore, run the unit whenever possible and store it with the carrying case open in clean air.	Clean and/or replace the sample input lines. Normally the lines will clear up with sufficient running
9) Pump will not run	a) Check 1 AMP Slo Blo fuse on the battery pack cover. NOTE. Certified OVA's do not have fuses	Replace fuse. IMPORTANT. Note that fuse is a Slo Blo type. If fuse continues to blow when igniter switch is closed, check igniter for short circuit. If igniter is not the problem, there is a short in the wiring or pump motor. Return OVA to factory or authorized repair facility
10) No power to electronics but pump runs	a) Check 1/4 AMP fuse on the battery pack cover. NOTE. Certified OVA's do not have fuses	Replace fuse. If fuse continues to blow, there is a short in the electronics assembly. Return OVA to factory or authorized repair facility
11) No power to pump or electronics	a) Place battery on charger and see if power is then available. Recharge in a non hazardous area only	If power is available, battery pack is dead or open. Recharge battery pack. If still defective, replace battery pack. Reference paragraph 2 7

SUGGESTED OVA 128 SPARE PARTS

ITEM	QUANTITY
Ignitor P/N 510461-1	2
Pump Valve P.N 510067-3	1 pkg of 10
Pump Diaphram P/N 510063-1	1
Filter Cup P/N 510318-1	1 pkg of 5
Mixer/Burner Assembly P.N 510513-1	1
Teflon Wafer P/N 510160-1	1 pkg of 10
Brss Washer P/N 510-160-2	1 pkg of 10
Exhaust Port Assembly P/N 510530-1	1
Battery Pack P/N 510542-1	2
Sample Line Assembly P.N 510316-1	1

GAS CHROMATOGRAPH ONLY

Particle Filter P/N 510116-1	1
Quad Rings P/N 510496-1	1 pkg of 10
Teflon Tubing 0.148" ID x .20 Wall P/N 12942	1 ft
Teflon Tubing 0.120" ID x .30 Wall P/N 12941	1 ft
Activated Charcoal GI	1 lb
"O" Ring P/N 2-15	2
Chart Paper Type WA P/N CSC-008	1 pkg of 6 rolls

MINIRAM PERSONAL MONITOR
MODEL PDM-3
OPERATIONS MANUAL

GCA CORPORATION
Technology Division
213 Burlington Road
Bedford, Mass 01730

MINIRAM PERSONAL MONITOR
MODEL PDM-3
OPERATIONS MANUAL

February 1984

GCA CORPORATION
Technology Division

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Cont'd.)

1.0 DESCRIPTION

1.1 Sensing Method

The MINIRAM (for Miniature Real-time Aerosol Monitor) Model PDM-3 is an ultra-compact personal-size airborne particulate monitor whose operating principle is based on the detection of scattered electromagnetic radiation in the near infrared. The MINIRAM uses a pulsed GaAlAs light emitting source, which generates a narrow-band emission (half-power width of 80 nm) centered at 880 nm. This source is operated at an average output power of about 2 mW. The radiation scattered by airborne particles is sensed over an angular range of approximately 45° to 95° from the forward direction by means of a silicon-photovoltaic hybrid detector with internal low-noise preamplifier. An optical interference-type filter is incorporated to screen out any light whose wavelength differs from that of the pulsed source.

The MINIRAM is a light scattering aerosol monitor of the nephelometric type, i.e., the instrument continuously senses the combined scattering from the population of particles present within its sensing volume (approximately 1 cm^3) whose dimensions are large compared with the average separation between the individual airborne particles.

1.2 Open Sensing Chamber Sampling Method

Air surrounding the MINIRAM passes freely through the open aerosol sensing chamber as a result of air transport caused by convection, circulation, ventilation, and personnel motion. The MINIRAM requires no pump for its operation, and the scattering sensing parameters have been designed for preferential response to the particle size range of 0.1 to 10 micrometers, ensuring high correlation with standard gravimetric measurements of both the respirable and thoracic deposition fractions. Optional flow accessories are available for applications requiring specific inertial particle precollection, extractive sampling, concurrent filter collection, etc.

It should be noted that one of the advantages of direct light scattering aerosol sensing is that the rate at which air passes through the sensor does not influence the indicated concentration because the detection is performed directly on every parcel of air traversing the fixed sensing volume. Therefore, flow velocity through a real-time sensor such as the MINIRAM influences only the response time. So, it should not surprise the first-time user when, upon pressing the MEAS key of the MINIRAM, no pump noise is heard, and this silence will be accompanied by a readout message of "GO" on the liquid-crystal display indicating that the MINIRAM has, indeed, been activated.

1.3 MINIRAM Electronics

The GCA MINIRAM is a very advanced aerosol monitor which incorporates a custom-designed single-chip CMOS microprocessor whose functions are to: process the signal from the light scattering detection circuit, control the measurement sequence program, compute concentration averages, keep record of elapsed time, perform automatic zero correction, control auto-ranging, drive the liquid-crystal-display, store average concentration values as well as timing and identification information, sense battery and overload conditions, sequence playback of stored information, and provide alarm signals.

The MINIRAM derives its power from a set of internal rechargeable Ni-Cd batteries which can provide continuous monitoring operation for over 8½ hours, or retain stored information for up to approximately 6 months. The battery set is packaged as a separable module which allows easy field replacement when recharging is not feasible. The MINIRAM can be run without time limit from an A.C. line using the charger provided with the instrument.

The MINIRAM has two output connectors. One provides a continuous, real-time analog signal output proportional to the aerosol concentration. This signal can be used for continuous recording (e.g. on a strip chart recorder), telemetry, or control purposes, etc. The other connector provides, during the measurement mode, either an ASCII digital output which is updated every 10 seconds, or a switched output for alarm purposes (depending on the user-selected function). Stored information playback can be accomplished either by means of the MINIRAM's own display or through the digital output jack. During the normal monitoring operation, the liquid-crystal-display indicates the aerosol concentration in the units of milligrams per cubic meter, and the displayed reading is updated every 10 seconds. When operating in the measurement or monitoring mode, other functions can be displayed momentarily, i.e., as long as a corresponding touch switch is pressed. All external controls are performed by pressing one or more of 8 sealed touch switches on the MINIRAM panel.

1.4 Modes of Use and Application

The MINIRAM measures the concentration of any airborne particles, both solid and liquid, and the display indicates this level in the units of milligrams per cubic meter, based on its factory calibration, against a filter-gravimetric reference, using a standard test dust (Arizona road dust). The MINIRAM can be used to measure the concentration of all forms of aerosol: dusts, fumes, smokes, fogs, etc.

Its small size and weight, and concentration averaging features permit its use as a personal exposure monitor, attached to a belt, shoulder strap, hard hat, etc. Alternatively, it can be used as an area monitor for both indoor and ambient air situations. Test chamber monitoring, visibility measurements, cloud detection (e.g. radio/drop sonde), aerosol dispersion studies, etc. are additional applications of the MINIRAM.

2.0 WHEN YOU RECEIVE THE MINIRAM.......

Follow these steps when first receiving your MINIRAM:

2.1 Remove the instrument from plastic bag.
2.2 Observe display. It should be blank indicating that the MINIRAM is in the minimum power mode.
2.3 Plug charger into A.C. line (standard charger is for 120V, 60 Hz; optional version available for 220V, 50 Hz).
2.4 Connect charger plug into corresponding MINIRAM receptacle.
2.5 Leave charger connected to MINIRAM for a minimum of 12 hours before using instrument without the charger.
2.6 You can operate the MINIRAM immediately after the charger has been connected. Follow operating instructions described in the next section of this manual.

3.0 OPERATING INSTRUCTIONS

Refer to Figure 1 for the location of control switches, display, and connector jacks. Refer to Figure 2 for the display timing sequences.

3.1 Initial Condition

Assuming that the batteries of the MINIRAM have been recharged (see section 2.0), the display may indicate one of the following conditions:

- **Blank display:** means that MINIRAM had not been in the measurement mode for 48 hours or more, and is in the minimum power off mode.
- "OFF" display: MINIRAM has been in the off mode for less than 48 hours.
- **Concentration display that changes or "blinks" once every 10 seconds: the MINIRAM is in the measurement mode.**

3.2 To start Measurement Cycle

- If the MINIRAM shows a blanked display (see above), press OFF and wait until the display reads "OFF" (approximately 5 seconds after pressing OFF), before pressing MEAS to initiate measurement cycle.
- If the MINIRAM shows "OFF" (see above), press MEAS directly to initiate measurement cycle (there is no need to press OFF first, in this case).

The functions performed by pressing each MINIRAM touch switch are as follows:

3.3 MEAS

To start the monitoring operation of the MINIRAM, press MEAS (see automatic timing sequence of Figure 2). The first readout displayed is either "GO" (or "CGO" if TIME is also pressed, see section 3.4), followed by the last concentration reading or ".00". Approximately 36 seconds after pressing MEAS the first new 10-second-averaged concentration reading is displayed. All subsequent readings are concentration values in milligrams per cubic meter, updated every 10 seconds. Figure 3 shows a typical digital printout of a sequence of 10-second measurements (second data block).

The MINIRAM will now run in the measurement mode for 500 minutes (8 hours and 20 minutes), after which it will stop, displaying the last 10-second reading, retaining in storage the concentration average and elapsed time information. Once the MEAS mode has been entered this sequence can only be interrupted by pressing OFF; pressing ZERO, TWA, SA, TIME or ID# only affects the display during the time these keys are pressed, without affecting the measurement cycle. Pressing PBK during this cycle has no effect.

The instrument normally operates in the .00 to 9.99 mg/m^3 range. Whenever a 10-second concentration exceeds 9.99 mg/m^3 the MINIRAM display automatically switches to the .0 to 99.9 mg/m^3 range and remains in that range as long as the measured 10-second concentration exceeds 9.99 mg/m^3, otherwise the MINIRAM reverts to its lower range display.

3.4 MEAS and TIME

If both MEAS and TIME are pressed at the same time (press TIME first and while depressing it actuate MEAS) the MINIRAM will display "CGO" (for Continuous "GO"), and will then operate as above (i.e. pressing MEAS only), except that after the first 8.3 hour run it will restart automatically and continue to measure for an indefinite number of 8.3 hour runs, (with the battery charger) until the OFF key is pressed, or until the batteries are exhausted. Concentration averages and timing information for the last seven 8.3 hour runs will remain in storage at any given time.

3.5 OFF

When this key is pressed the MINIRAM will discontinue whatever mode is underway displaying "GCA" followed by the display segments check ("8.8.8=") and finally "OFF" (see timing diagram of figure 2). The MINIRAM will then remain in this reduced power condition (displaying "OFF") for a minimum of 10 minutes or a maximum of 48 hours or until the MEAS key is pressed to resume the measurement cycle.

If OFF is pressed during a measurement run the display will read "OFF" for 48 hours (unless another key is pressed during that period), after which the display will be blanked. Thereafter, if OFF is pressed the MINIRAM will display the "OFF" reading for only 10 minutes, after which the display will be blanked again unless another key is pressed during that period.

Every time the OFF key is pressed, during a measurement cycle, the MINIRAM will store the concentration average and elapsed monitoring time up to the time of that OFF command. The duration of the off period (up to 48 hours), i.e. between two consecutive measurement cycles, is also stored for each of up to 7 cycles.

If the MINIRAM is not reactivated (i.e. pressing MEAS) within 48 hours of the OFF command, it automatically switches to a minimum power level, with blanked display; however, all data remains stored in memory for up to approximately 6 months without battery recharging (indefinitely, with charger).

OFF must be keyed before any other operating mode can be entered: setting ID#, zero referencing, playing back stored data, or changing the program code. Display functions, however, can be activated during the measurement mode.

3.6 TIME

During the measurement mode, if TIME is pressed the display will show the elapsed time, in minutes, to three significant figures, from the start of the last measurement run. The MINIRAM will automatically return to concentration display after the TIME key is released.

3.7 TWA

This key stands for Time-Weighted-Average. During the measurement mode, if TWA is pressed the display will indicate the average concentration in milligrams/m^3 up to that instant, from the start of the last run. This average is computed by the MINIRAM applying the equation:

$$TWA = \frac{1}{t} \int_0^t C dt$$

where t is the elapsed run time and C is the instantaneous concentration at time t. The value of TWA is updated every 10 seconds. After releasing the TWA key the MINIRAM display returns to the 10-second concentration display.

3.8 SA

This key stands for Shift-Average. During the measurement mode, pressing SA will provide a display of the aerosol concentration, up to that moment, averaged over an 8-hour shift period. This average is computed by the MINIRAM applying the equation:

$$SA = \frac{1}{480 \text{ Min.}} \int_0^t C dt$$

The shift-average value corresponds to the exposure from the start of the measurement cycle. Thus, for example, if the MINIRAM has been measuring for 3 hours, and the time-weighted average over that period has been 6 mg/m^3

(TWA reading), the shift average value at that time, (SA reading) would be 2 mg/m^3, which is equivalent to an 8-hour exposure to an average concentration of 2 mg/m^3.

The value of SA is updated every 10 seconds. When releasing the SA key the MINIRAM display returns to the 10-second concentration display.

3.9 PBK

With the MINIRAM in the off mode (i.e. not in the measurement mode), the stored information can be played back by pressing PBK. If the PBK key is initially pressed the display will indicate "P" for one second. If PBK continues to be pressed for more than 1 second then the stored data is automatically played back through the MINIRAM display: First, the identification number is displayed with the ID indicator bar on; next the shift or run number (7 through 1, i.e. starting with the last run) is shown (with the OVR indicator bar on as identification); followed by the sampling (i.e. measurement) time in minutes, for that run; followed by the off-time between the last and next run (in tens of minutes); finally, the average in mg/m^3.* This sequence is repeated seven times. An average reading of 9.99 indicates that a significant overload condition occurred during that run. The total time required for the complete automatic playback on the MINIRAM display is approximately 70 seconds.

If PBK is pressed for less than one second "PA" will be displayed, and the stored data will be fed out through the digital output jack of the MINIRAM for printout, magnetic storage, telemetry, etc. A printout consists of 8 lines of data. Figure 3 shows a typical stored data printout (see data block labeled "Playback of Stored Data"). The first 7 lines show the data for the last 7 measurement periods, and the last line shows the identification number (I), the programmable selection code (F), and the zero value for that data block (Z). In addition a check sum is printed out on a 9th line for modem/computer data transfer purposes. The first 7 data lines are subdivided into 4 columns. The first column identifies the measurement period (starting with the last or 7th); the next column lists the corresponding duration of each measurement period, in minutes; the third column lists the off time between consecutive measurement periods, in minutes divided by 10; and the last column lists the average concentration values for each period in mg/m^3.*

---

*Either the TWA or the SA values, depending on selected user-programmable code (see section 4.2).

Either time-weighted, or shift average values can be printed, depending on the selected programmable code (see section 4.2). The example shown on Figure 3 (F = 0012) indicates that the TWA values are listed. Although the printout heading will indicate "PDM-2 LISTING" (as shown in Figure 3), this format applies equally to the MINIRAM model PDM-3.

The speed of the digital transfer to a printer or other digital device can be user selected through the programmable selection code (see section 4.2). For a 300 baud rate the transfer time for the stored data block is approximately 45 seconds. See sections 10.0 and 11.0 for instructions on how to connect the MINIRAM to a printer or other digital recording/processing device.

3.10 ZERO

The interior walls of the MINIRAM sampling chamber reflect a small amount of the light from the infrared source into the detector. This background level is referred to as the "zero value", and is automatically subtracted from all aerosol concentration readings during the measurement mode. The result is that the displayed readings depend only on the actual dust concentration present within the sensing chamber.

The zero value varies from instrument to instrument as well as with different sensing chambers. It will increase somewhat as the chamber inner walls and windows become contaminated with dust. A zero update should be performed periodically to correct for this. Also a zero update should be performed after cleaning the sensing chamber (see section 12.0).

Pressing ZERO during a measurement period provides momentary display of the stored zero concentration value used by the MINIRAM to correct all digital concentration readings (the analog output signal is not zero-corrected). To update the ZERO value the MINIRAM must be in its off condition (press OFF in case of doubt). Then, press ZERO and wait until the display again indicates "OFF".

The average of 4 consecutive 10-second zero level measurements will then be stored by the MINIRAM as the new ZERO reference value. (See timing diagram in Figure 2 and digital printout obtained during a typical zero check on Figure 3). When operating the MINIRAM in high particle concentration environments (>5 mg/m^3) the zero value update should be performed approximately every 8 hours. At aerosol concentrations below approximately 1 mg/m^3 this update may only be required once a week, or even less frequently. The zero update should be performed either within a clean-air environment (ideally, a clean room or clean-bench) for dust measurements in the concentration range below 0.5 mg/m^3, approximately, or by flowing clean air through the sensing chamber of the MINIRAM (e.g. by means of an optional clean-air adaptor, GCA model PDM-1FZ Zero Check Module) (see section 17.2) for use at dust concentrations above 0.5 mg/m^3, approximately. Air conditioned offices (without smokers) usually have concentrations below approximately 0.05 mg/m^3 and can thus be used for zeroing purposes. When measurements are performed under essentially clean air conditions, e.g. in the same environment where the zero check was performed, the MINIRAM readings will indicate 0.00 mg/m^3 with small random fluctuations around that value. Positive values (e.g. 0.02) will thus be indicated on the LCD display. Negative values (e.g. -0.02) are suppressed and are also indicated as 0.00. The digital output, however, does include such negative values and these will be printed out by a digital printer (see sections 10.2 and 11.0).

3.11 ID#

Pressing ID# during a measurement period provides momentary display of the identification number stored within the MINIRAM memory.

The ID# key, in combination with other keys, is used for several additional programming functions described in the next section (4.0).

4.0 PROGRAMMABLE FUNCTIONS

4.1 ID# Selection

In order to change the instrument identification number the MINIRAM must first be in the off mode (i.e. press OFF). Then press the ID# key, and the presently stored number (between 1 and 999) will be displayed, as well as the ID indicator bar. To increment the identification number press the ▲ key (same key as TWA), and to decrement the number press the ▼ key (same key as SA). Any number between 1 and 999 can thus be selected and will remain in storage until the batteries are disconnected, or if the MINIRAM is not recharged over a 6-month period.

Pressing the OFF key after the above identification number selection will remove the MINIRAM from the ID# selection routine and lock-in that number until a new number is selected. A complete ID# lock-out (i.e. a routine to preclude panel-control change of that number) can be accomplished by a separate programmable code selection (see section 4.2).

4.2 Programmable Selection Code

The programmable code allows the user to panel-select several alternate functions and operating modes.

The program codes to select specific alternate operating modes are:

1	**selects the alarm instead of ASCII digital output**
2	selects the ID# lock-out
4	selects the TWA instead of the SA to be stored for playback
8	selects a 1-second pause after each printer carriage return (for slow printers)
32	selects 110 baud digital output rate instead of 300 baud
64	selects 600 baud digital output rate instead of 300 baud

These numbers are entered as a sum, e.g. to implement ID# lock out, TWA storage, and 1-second carriage return delay, the code number would be 14 (2+4+8).

To enter the desired code (e.g. 14) follow these steps:

- Press OFF key and wait until "OFF" is displayed
- Press ID# key and set program code to desired number (e.g. 14) by means of the ▲ and ▼ keys
- Press TIME key (this will show previously entered code)
- Press ID# key again to lock in the new program code which will then be displayed.
- The preceding steps will cause the ID# to become equal to the programmable selection code. To restore the desired ID# (without affecting the selected code number which is now locked in), use the ▲ and ▼ keys again to select the ID# for the instrument as described in section 4.1.
- Press OFF to exit the ID# selection routine.
- To look at the programmed code number, at any time, start from the off condition; press ID#, then press TIME ("F" will then be dis-

played momentarily), after which the code number will be displayed. Press OFF to exit the code number routine.

If no specific alternate code is entered the MINIRAM will operate in its standard mode (equivalent to code 12) consisting of the following:

- ASCII digital output
- Panel-selectable ID number (preset to 999)
- Time-Weighted Average (TWA) values in memory storage
- 7-bit ASCII resolution
- 300 baud digital output
- Printer carriage return followed by a 1 second delay

4.3 ID# Lock-out

If the ID# lock-out code has been selected (i.e. a 2 as part of the sum, as described in section 4.2) then both the ID# and the programmable code can only be displayed (and printed out), but neither of the two can then be changed by means of the panel keys. In this case, in order to change the ID# if the lock-out code has been selected, or to alter the programmable code, the battery must be unplugged momentarily. Disconnecting the battery, however, causes the MINIRAM to lose all stored data, and cancels all alternate program codes which may then be restored following the procedure described in section 4.2.

4.4 Alarm Level Adjustment

If the selected program code includes a 1, the MINIRAM will not provide an ASCII digital output but instead a switched output (at the digital output connector) which will close every time the measured 10-second concentration value exceeds a presettable threshold concentration level. If a 1 has been included in the code, then the ID# divided by 10 becomes the alarm level in milligrams/m^3. This level can be adjusted following the ID# selection procedure of section 4.1, that is using the ▲ and ▼ keys to increment or decrement the number. For example, if an alarm level of 12.5 mg/m^3 is desired (and starting from the off mode), press ID#, adjust displayed number to 125 with the ▲ and ▼ keys, and press OFF. This number (e.g. 125) then becomes the ID# as well. It is not possible to enter a separate alarm level and ID# number.

5.0 OVERLOAD AND ERROR CODE INDICATIONS

5.1 Bar Displays

There are three bar indicators on the MINIRAM display, identified as OVR, ID, and BAT. If the OVR bar is displayed at any time during operation in the measurement mode the MINIRAM detection circuit has been overloaded. A momentary overload can be caused by the insertion of an object into the sensing chamber, sudden exposure to sunlight, etc. If the cause of overload is eliminated, the OVR bar will disappear during the next 10-second display period, unless the overload persists for more than a total of 1½ minutes over an 8 1/3 hour measurement cycle.

The ID bar display is activated only for display identification purposes and not for error conditions.

The BAT bar is displayed when the battery voltage becomes insufficient, indicating that the charger should be plugged into the MINIRAM.

5.2 Error Codes

The MINIRAM will display and output (at the digital output jack) error code numbers along with the corresponding overload indicator bars on the LCD readout. These codes will appear only if the problem persists for more than about 30 seconds.

The error code numbers are as follows:

.01 : low battery condition
.02 : RAM (digital processing)
.03 : A/D (signal) overload

If an overload condition persists for more than approximately 1½ minutes the selected concentration average value (SA or TWA) automatically registers 9.99 and that number will be indicated (or digitally transmitted) upon data playback, signifying an invalid measurement cycle. The OVR bar will then remain on for the rest of that run.

6.0 SENSING CHAMBER REMOVAL AND INSERTION

During normal operation of the MINIRAM the removable sensing chamber (see Figure 1) must be properly inserted, i.e. pushed all the way into the

MINIRAM towards the display/control panel end of the instrument. When this chamber is properly positioned the surface on the opposite end from the display/control panel will be approximately flush with the body of the MINIRAM.

To remove the sensing chamber, gently push it away from the display/control panel end, using both thumbs, sliding it out of its channel. This will expose the shouldered metal button with its small spring-loaded plunger, and the two lenses (illumination and detection lenses). Touching of these lenses should be avoided to prevent their soiling. Lens tissue should be used if cleaning of these lenses becomes necessary. Also, the inside surface of the removable sensing chamber is coated with a special anti-reflectant paint and these surfaces should not be touched, if at all possible.

The removable sensing chamber has two small glass windows which should be kept clean (see section 12.0 on routine maintenance).

The sensing chamber is partially closed at one of its open ends. This end is inserted first when sliding the chamber back into the MINIRAM channel. A small shouldered slot is provided on the underside of the removable sensing chamber for the metal button that serves to retain the chamber.

To reinsert the sensing chamber simply slide it back into position making sure that the chamber is moved parallel to the MINIRAM body. Ensure complete insertion, as mentioned above.

7.0 BATTERY PACK REPLACEMENT

The battery pack of the MINIRAM (GCA Part No. PDM-3B) constitutes an intrinsically safe sealed module that can be removed and replaced. To do so, remove the four central screws from the back of the MINIRAM case (not the two corner screws), and gently lift the battery pack up and out, and gently pull apart the battery connector freeing the battery pack. Reverse order of steps when installing another pack.

CAUTION: All stored data will be lost when disconnecting battery.

After reconnecting battery pack, the ID resets to 999 and an automatic zero reference check is performed by the MINIRAM.

Separate battery packs can be used whenever a.c. line power is unavailable to recharge the pack within the MINIRAM. These spare parts can be recharged independently from the MINIRAM by plugging the charger into the charge receptacle which is an integral part of the battery pack (see figure 1).

8.0 CALIBRATION ADJUSTMENT

Although every MINIRAM has been factory-calibrated using a representative dust (see section 1.4), the user may wish to change the calibration constant of the instrument for a specific type of aerosol. Such a calibration should be performed by obtaining a concurrent filter collection (e.g. by means of a personal filter sampler), sampling from the same environment within which the MINIRAM is placed. The average concentration obtained by the MINIRAM (i.e. TWA reading) at the end of the test should be compared with the filter-gravimetric-determined concentration. The ratio of the two concentration values can then be used to correct the MINIRAM calibration. The comparison run should be replicated several times (to minimize errors) to obtain an average ratio.

To change the MINIRAM calibration proceed as follows:

8.1 Place MINIRAM in a clean environment (e.g. air conditioned office).

8.2 Remove battery pack (follow procedure of section 7.0).

8.3 Disconnect battery connector (remember that all stored data will thus be lost/erased from MINIRAM memory).

8.4 While leaving battery pack lying next to MINIRAM, re-connect the two units (i.e. plug in connector).

8.5 Immediately observe MINIRAM display. It will be performing a slow segment-by-segment display checkout. As soon as it displays ".00", press OFF, thus interrupting the initial automatic zero check (see section 7.0). Wait until the display indicates "OFF" and then press MEAS and wait approximately 36 seconds.

8.6 Observe 10-second readings (typically in the range of 1 to 3 mg/m^3) and record manually a few consecutive readings. Calculate the average of these values.

8.7 Identify small potentiometer screw (visible through an opening in the foil shield of the open MINIRAM) opposite the digital output jack. Adjust this potentiometer, using a fine screw driver, until the average MINIRAM reading is increased or decreased (with respect to the average obtained in 8.6) by the desired ratio (e.g. as determined by previous gravimetric comparison runs).

8.8 Shut off MINIRAM, reposition and secure battery pack, and rezero instrument as usual. All subsequent concentration readings are now corrected by the desired ratio.

If an optional Reference Scatterer is available, insert in the MINIRAM instead of the normal sensing chamber and follow the same procedure (i.e., follow steps 8.1 through 8.8).

9.0 ANALOG RECORDER CONNECTION

The analog output of the MINIRAM is a negative voltage of 0 to 1.5 V. A high input impedance recorder (>100KΩ), or other signal processing device can be connected to that output. The 0 to -1.5V range corresponds approximately to 0 to 100 mg/m^3 as displayed by the MINIRAM.

This analog output (as opposed to the digital output and readings) is not zero-corrected, and thus a zero concentration results in a bias level of the order of several millivolts.

It is advisable to connect a capacitor in parallel with (i.e. across) the analog output (e.g. 100 microfarads or larger) in order to obtain a steady output signal. The internal time constant of the analog output of the MINIRAM is only 0.2 seconds which, in the absence of an external capacitor, results in excessive signal fluctuations.

Two miniature plugs are provided with the instrument to connect to the analog and/or digital output jacks (both can be used concurrently).

10.0 USE OF OPTIONAL GCA DIGITAL PRINTER

The MINIRAM can be connected to the GCA model PDM-DP-1 digital printer, an optional accessory designed for direct coupling to the MINIRAM. This printer can be used both to print out the continuous concentration data (updated every

10 seconds) in the normal measurement mode, and to print out the data stored in the MINIRAM memory as described in section 3.9.

An example of the printout formats when using the PDM-DP-1 printer in combination with the MINIRAM is presented in figure 3. The PDM-DP-1, a very compact impact dot matrix printer, is provided with a special interconnection cable to the MINIRAM digital output jack. When using the MINIRAM with this printer, the output data rate should be left at 300 baud (the normal MINIRAM default value), as described in section 4.2.

The following are specific operation procedures for use of the printer in combination with the MINIRAM. Other operating and maintenance information is contained in the instruction manual that accompanies the printer.

10.1 Print Paper Loading

A 20 mA current must flow through the PDM-DP-1 printer for it to operate. Plug its cable into the MINIRAM digital output receptacle and press OFF. Turn on the printer power switch (on its side) and press the ON-LINE switch so that the red light above this switch goes out. The ink ribbon should have been previously loaded. Press the FEED button and insert paper into the paper slot in the rear of the printer until it feeds out the top. Refer to the printer User's Manual for details.

10.2 Printer Test

In order to test whether the PDM-DP-1 printer is operating correctly, turn off its power switch (on side of printer), hold down the FEED switch while turning the power switch on. Release the FEED switch. The printer will then print out all of its characters.

10.3 Printout of Stored Data

Plug printer connector into the MINIRAM digital output receptacle. Turn off printer power switch. Press OFF on MINIRAM and wait until it reads "OFF". Turn on printer power switch. Press PBK on MINIRAM for less than one second (see section 3.9) and the LCD display should then indicate "PA". The printer will then print out the stored data block.

10.4 Printout of Zero or of Measurement Data

Interconnect MINIRAM and printer as indicated before and switch off printer power. Press OFF on the MINIRAM. Press either ZERO or MEAS on MINIRAM (depending on which information should be printed out). Observe MINIRAM display until the 2 second blanking occurs (approximately 22 to 25 seconds after pressing MEAS or ZERO), after which the printer power should be switched on immediately (i.e. as soon as the last reading appears again, see figure 3). Printer will print out zero data approximately 72 seconds after pressing ZERO on MINIRAM (see figure 2). The first line of measurement data will be printed out approximately 76 seconds after pressing MEAS, and thereafter every 50 seconds (each line contains five 10-second measurements).

NOTE: In order to test at any time whether the PDM-DP-1 printer is enabled for printout of MINIRAM data, press the ON LINE switch on the printer; this should extinguish the red light above that switch. Then press ON LINE again to turn on red light again. If the red indicator light remains on whenever the ON LINE switch is actuated, the printer is not enabled, in which case turn printer power switch off and then on again, after which actuation of the ON LINE switch should turn the red light on and off, indicating printer readiness (i.e. with red light on). The printer power can be turned off any time during the measurement cycle, and turned on again during a cycle to resume printing. The data line numbers (see figure 3) will then be the current ones as sequenced by the MINIRAM whose output is independent of the operation of the printer.

11.0 DIGITAL OUTPUT CONNECTIONS

A digital printer (other than GCA model PDM-DP-1), data logger, or modem may be coupled to the MINIRAM. The data output is in the form of 20 mA current loop, 300 baud (110 or 600 baud by alternate programming) asynchronous ASCII characters. The output load should be less than 50 ohms.

Figure 4 is a diagram showing the connections and components required for a 20 mA loop interconnection to a printer. A similar diagram is shown for standard RS232 interfacing with a printer (see Figure 5). These connections do not apply when using the PDM-DP-1 printer.

The MINIRAM does not send parity information, but does provide an ASCII check sum which is the sum of all ASCII characters, to insure data integrity.

To use the check sum the host computer must add the ASCII value of all digits, spaces, carriage returns, and line feeds except for the first two carriage returns and line feeds which are sent immediately after pressing the PMK switch. The last eight bits of this sum should then be expressed as a decimal number (0-255) and should agree with the decimal value of the MINIRAM check sum.

12.0 ROUTINE MAINTENANCE

When the MINIRAM is not being operated it should be placed in its plastic bag which should then be closed. This will minimize the amount of particle contamination of the inner surfaces of the sensing chamber.

After prolonged operation within, and exposure to particulate-laden air, the interior walls and the two glass windows of the sensing chamber may have become contaminated with particles. Although repeated updating of the zero reference following the procedure of section 3.10 will correct errors resulting from such particle accumulations, eventually this contamination could affect the accuracy of the measurements as a result of excessive spurious scattering, and significant attenuation to the radiation passing through the glass windows of the sensing chamber.

An indication of excessive chamber contamination is provided by the zero level reading (section 3.10), which should not exceed 3 mg/m^3, approximately.

In order to clean a soiled sensing chamber remove that chamber as described in section 7.0 and wash it with soap and water, rinsing thoroughly to remove any residues from the glass windows and interior of the chamber. Do not use solvents of any type. Do not rub interior surfaces of the chamber. Allow the sensing chamber to dry completely and re-insert into the MINIRAM as indicated in section 7.0.

13.0 PRECAUTIONS AND OPERATING POSITIONS

The interior of the MINIRAM sensing chamber should not be exposed to fluctuations of intense light; flashes of sunlight or bright daylight especially, are to be avoided. Such excessive variable illumination of the scattering detector can result in significant measurement errors that may persist over several 10-second display cycles. In order to operate the MINIRAM under those conditions it is advisable to use the Sunshield accessory (GCA model PDM-SNS, see section 17.5).

Another potential source of error is the presence of reflecting surfaces in close proximity to the sensing chamber openings. Such objects should be kept at least 2 cm (3/4 inch) from the chamber openings.

The removeable sensing chamber should not be used as a carrying handle, especially not while operating the MINIRAM; holding this chamber may affect the measurements.

When using the MINIRAM for personal monitoring it should be positioned vertically, i.e. with the display/control panel facing upwards, by either clipping the MINIRAM to the belt, shoulder strap, etc.

In general, an approximate vertical position is to be preferred for any long-term monitoring purposes, in that this position minimizes potential particle deposition within the removable sensing chamber.

Other monitoring positions are:

a) horizontal, resting on belt clip
b) hand held (while ensuring that hand and fingers are away from edges of sensing chamber)
c) Using the optional MINIRAM table stand
d) Wall mounted using belt clip, or the four battery pack attachment screws on the back of the MINIRAM.

14.0 INTRINSIC SAFETY

The MINIRAM has been designed to satisfy the requirements for intrinsically safe operation in methane-air mixtures. The sealed battery pack incorporates a current-limiting resistor that limits the battery short circuit current to less than 14A. An MSHA 2G approval has been applied for.*

---

*Approval is expected by March 1984.

15.0 SPECIFICATIONS

- Measurement ranges: 0.01 to 10 mg/m^3 and 0.1 to 100 mg/m^3
- Precision and stability (for 10 sec. readings)*: ± 0.03 mg/m^3 (2-sigma)
- Precision and stability of time-averaged measurements*:
  - ± 0.02 mg/m^3 (for 1 minute averaging)
  - ± 0.006 mg/m^3 (for 10 minute averaging)
  - ± 0.003 mg/m^3 (for 1 hour averaging)
  - ± 0.001 mg/m^3 (for 8 hour averaging)
- Temperature coefficient: 0.005 mg/m^3 per °C (typical)
- Readout resolution: 0.02 mg/m^3 or 0.1 mg/m^3 depending on automatically selected range (3 digit LCD).
- Digital readout updating time: 10 seconds
- Analog output time constant: 0.2 seconds
- Total measurement period: 8 1/3 hours, or indefinite 8 1/3 hour cycles
- Particle size range of maximum response: 0.1 to 10 μm in diameter
- Measurement display: normally 10 second real time measurement; or momentarily: time-weighted average, or 8-hour equivalent shift average, or elapsed sample time (in minutes), or zero value, or identification number, or programmable code.
- Data storage: seven concentration averages, sampling periods in minutes (3 significant figure resolution), off time (10 minute resolution), identification number, zero value, programmable code, and check sum.
- Real time outputs: analog (0 to -1.5V full scale), and digital ASCII.
- Memory playback: either by own LCD display, or by 110, 300 or 600 baud, ASCII digital output (20 mA current loop, or RS232 terminals may be connected with appropriate interface).
- Nominal battery voltage: 7.5V
- Average battery current drain: 40 mA
- Continuous operating time with full battery charge: 10 hours, approximately

---

*At constant temperature (typ. 25°C)

- Operating temperature: 0° to 50°C (32 to 120°F) Storage: -20 to 60°C.
- Outside dimensions: main body: 10 x 10 x 4 cm (4 x 4 x 2 inches); sensing chamber cover: 7.7 x 3.8 x 1.5 cm (3 x 1.5 x 0.6 inches)
- Weight: 0.45 kg. (16 oz.)

16.0 STANDARD ACCESSORIES

Accessories provided with each MINIRAM are detailed in the following subsections.

16.1 Battery Charger

The battery charger (GCA model PDM-1-157-1) serves the following functions: recharge or maintain the charge of the nickel-cadmium batteries within the MINIRAM, permit continuous a.c. power line operation, and provide power for the operation of pump of the optional GCA model model PDM-1FZ Zero Check Module (see section 17.2). The charger can not be used to power the MINIRAM without its batteries, however, it can be used to charge a separate or spare battery pack (GCA model PDM-3B, see section 7.0).

The standard battery charger is designed for a 120V/60 Hz input, however, it can be obtained for 220V/50 Hz if so specified.

16.2 Other Standard Accessories

Other accessories supplied with the MINIRAM are:

- Output connectors (can be used for the analog, and/or the digital output jacks).
- Shipping Case
- Instruction Manual

17.0 OPTIONAL ACCESSORIES

Several optional accessories are available from GCA for the MINIRAM, these are described in the following subsections.*

17.1 Flow Adapter (GCA model PDM-1F)

The Flow Adapter (see figure 6a) when used in conjunction with the MINIRAM and any pump or external flow system, allows a sample to be drawn through the instrument sensing chamber. A personal monitoring pump at flow rates of 2 ℓ/minute or less may be used.

To attach the Flow Adapter to the MINIRAM (see figure 6B) loosen the two thumbscrews and pull the front sealing plate forward. Slide the Adapter over the MINIRAM sensing chamber as illustrated above; secure the Adapter to the MINIRAM by tightening the two allen-head screws through the hold down tabs. Tighten the thumbscrews to seal the two wnd plates to the MINIRAM sensing chamber.

Typically, this accessory would be used when extracting samples from aerosol chambers, detecting leaks from pressurized duct s, or for isokinetic sampling using probes.

17.2 Zero Check Module (GCA model PDM-1FZ)

The Zero Check Module can be used to zero the MINIRAM when a clean air environment is not available. The Zero Check Module should be used when concentrations in the range above 0.5 mg/m^3 are to be measured (see section 3.10).

In addition, this accessory can be used to draw a sample stream through the MINIRAM sensing cahmber (in lieu of a separate pump) by disconnecting the small tube at the sensing chamber inlet fitting (see figure 7a).

This accessory consists of a pump, filter and the necessary tubing to circulate clean filtered air through the MINIRAM. The pump may be powered by the MINIRAM battery charger (or a 5-10 VDC power supply). The battery within the MINIRAM cannot be used to operate the Zero Check Module.

---

*Notes:

When using any of the optional accessories that are attached on and around the sensing chamber (models PDM-1F, -1FZ, -1FS, -1FR, and -SNS) to perform measurements at concentrations below 0.5 mg/m^3, it is advisable to zero check the MINIRAM with the accessory in place, making sure that its mounting and sealing screws are properly tightened.

Use an external pump or pressurized air source (well filtered) to drive clean air through the sensing chamber to zero the MINIRAM with any of those accessories (except in the case of the Zero Check Module). To zero check the MINIRAM when using the Sunshield place instrument with the attached sunshield in a clean room environment (see section 3.10).

To zero the MINIRAM, first attach the Zero Check Module (see figure 7b) following the same procedure described for attaching the basic Flow Adapter (see section 17.1). Connect the battery charger to the Zero Check Module and to an A.C. source. Allow at least one minute of operation to purge the sample chamber with clean air. Press the ZERO button on the MINIRAM and continue operating the Zero Check Module until the final average zero reading is displayed (see section 3.10).

17.3 Personal Sampler Adapter (GCA models PDM-1FS and PDM-2FS)

This accessory, when used with the MINIRAM and a personal monitoring pump, permits active sampling of respirable (cyclone preselected) particles through the instrument sensing chamber and collection on a filter. The aerosol sample is drawn through a 10 mm nylon cyclone (with a 50% cut point at 3.5 μm when operated at 2 ℓ/minute), through the sensing chamber of the MINIRAM, and then collected on a filter located in the cassette/filter holder for subsequent gravimetric or other analysis.

The model PDM-1FS is for use with an MSA 37mm filter cassette no. 457193. The model PDM-2FS is compatible with a Millipore 37mm disk filter holder no. 1-XX11-025-03 (see figure 8a).

To attach the Personal Sampler Adapter to the MINIRAM (see figure 8b), follow the same procedure as described for attaching the basic Flow Adapter (see section 17.1). Connect a length of tubing from the exhaust fitting on the filter holder to a personal sampling pump (not provided with the Adapter).

The use of the Personal Sampler Adapter permits concurrent MINIRAM readings and filter collection to facilitate calibration of the MINIRAM for a specific aerosol, or to determine both concentration and chemical composition of the aerosol.

17.4 Respirator Adapter (GCA model PDM-1FR)

The Respirator Adapter, when used in conjunction with the MINIRAM, provides a means of measuring aerosol concentrations inside a respirator. The external concentration can also be measured with the MINIRAM and thus the values obtained with the MINIRAM after connecting it to the respirator can be used to determine protection factors; consequently, quantitative fit checks are possible under field conditions.

WARNING: DO NOT USE THIS ACCESSORY IN A HAZARDOUS (TOXIC DUSTS, FUMES, GASES, ETC.) ENVIRONMENT, SINCE RESPIRATOR INTEGRITY CANNOT BE GUARANTEED BECAUSE OF THE POSSIBILITY OF LEAKS.

A tube should be attached from a tap on the respirator to the inlet (which is located on the smaller sealing plate) of the Respirator Adapter (see figure 9a). When the respirator wearer exhales, a slight positive pressure develops inside the mask resulting in an air flow to the MINIRAM sample chamber, where the concentration is measured. This air then passes through a check valve as it exits the chamber. When the wearer inhales, the check valve closes to prevent exposure to ambient conditions. A back-up filter is also used after the check valve as an additional safety precaution in the event of check valve failure.

To attach the Respirator Adapter to the MINIRAM, follow the same procedure for attaching the basic Flow Adapter (see section 17.1 and figure 9b).

17.5 Sunshield (GCA model PDM-SNS)

The sunshield accessory serves to protect the MINIRAM sensing elements from excessive ambient light fluctuations (see section 13.0). It should be used whenever the MINIRAM is to be operated outdoors or under fluctuating bright light illumination. It is also advisable to use the sunshield to prevent loose clothing or other objects from touching or entering the open sensing chamber. The use of the sunshield causes only a slight retardation of the air exchange rate between the outside and inside of the sensing chamber, an effect that is negligible except when using the analog output in order to follow rapid fluctuations of particle concentration. The sunshield attaches by its two support tabs to the body of the MINIRAM (see figure 10).

17.6 Shoulder Strap (GCA model PDM-SS)

The PDM-SS is a leather strap, worn over the shoulder and across the chest, which attaches to the wearer's belt in front and back. The MINIRAM mounting loop in the upper chest area allows exposure measurements close to the breathing zone while still permitting comfort and freedom of movement (see figure 11).

17.7 Table Stand (GCA model PDM-TS)

The stable stand accessory provides a convenient mounting support for the MINIRAM when it is used for area monitoring. The MINIRAM is simply clipped onto the table stand which holds it in a position where reflections from the table surface do not interfere with its operation (see figure 12).

17.8 Dot Matrix Digital Printer is a Star DP-8240 unit specially modified for use with the MINIRAM. It is supplied with a special interconnecting cable which is plugged into the digital output jack of the MINIRAM. The PDM-DP-1 is normally provided for 120V/60 Hz operation. Operation with 220V/50 Hz line can be provided upon customer request. The PDM-DP-1 weighs 4 kg (8.8 lbs), and its dimensions are 28W x 20D x 10H cm (11" x 7 7/8" x 4") (see figure 13).

The use of the PDM-DP-1 in combination with the MINIRAM is described in section 10.0. A separate instruction manual for the printer is supplied with that unit.

17.9 Reference Scatterer (GCA model PDM-RS)

The PDM-RS is a specially modified sensing chamber that includes a diffusing optical filter mounted within the sensing region of the MINIRAM. It is designed to scatter a controlled amount of light from the infrared source to the detector, providing a stable and repeatable reading on the MINIRAM display. The reference scatterer is inserted into the MINIRAM instead of the normal sensing chamber, and the readings are obtained operating in the MEAS mode. If the PDM-RS is ordered from GCA concurrently with a MINIRAM the reference scatterer will be factory marked with the calibration reading to be obtained when inserted into that particular MINIRAM whose serial number will also be shown on the PDM-RS tag. The readings displayed by the MINIRAM when inserting the PDM-RS should be within ± 5% of the value marked on that reference scatterer.* The readings obtained with the reference scatterer may show a small warm-up drift (i.e. gradual change) during the initial 5 to 10 minutes after pressing MEAS.

If the reference scatterer is ordered separately from the MINIRAM, the user will then determine the calibration reading obtained on the MINIRAM and mark it (together with the MINIRAM serial number) on the PDM-RS tag.

Because of small differences in the optical configuration of each MINIRAM and of each reference scatterer, the readings obtained with a given reference scatterer are unique to a given MINIRAM. The response to a given population of airborne particles, however, is the same for all factory calibrated MINIRAMs, within approximately ± 5%.

17.10 Carrying Case (GCA model PDM-HC-1)

The PDM-HC-1 is a convenient and compact hard shell carrying case designed to house a MINIRAM and a battery charger. The inside is foam padded for full protection. The outside dimensions of the PDM-HC-1 are: length - 9½ inches, depth - 7 inches, and height - 3½ inches.

---

*Prior to the use of the reference scatterer the MINIRAM should be zeroed with a clean standard sensing chamber as described in section 3.10.

List of Figures

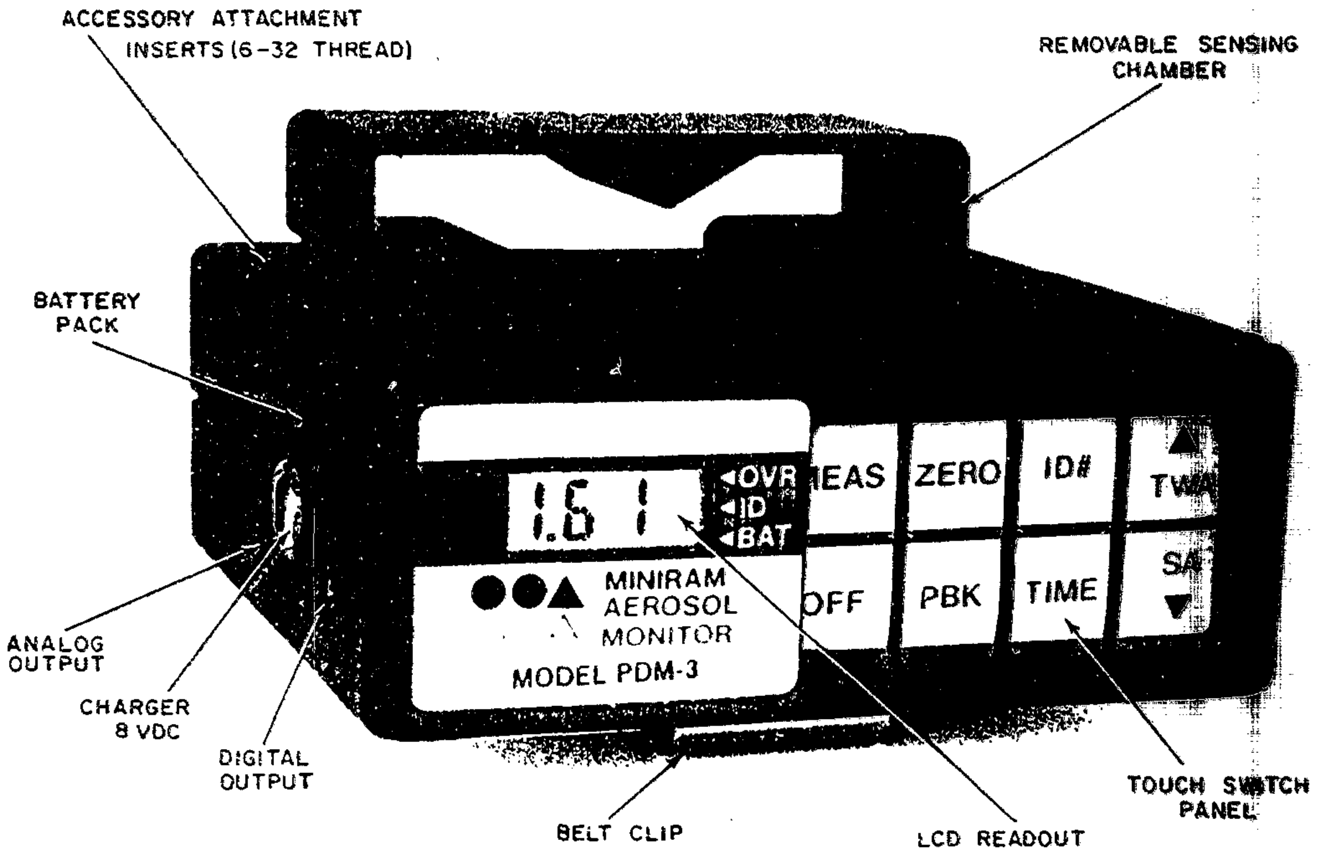


Figure 1. Main view of MINIRAM.

TABLE 1
SAMPLE PRESERVATION AND HOLD TIMES

PARAMETER	BOTTLE	BOTTLE WASHING PROCEDURE	PRESERVATIVE	PERSERVATION PROCEDURE	HOLD TIMES
Acidity	P,G	2.1	Cool, 4°C	-	14 days
Alkalinity	P,G	2.1	Cool, 4°C	-	14 days
Ammonia	P,G	2.1	Cool, 4°C, H_2SO_4 to pH<2	3.5	28 days
BACTERIA					
Coliform, fecal and total	P,G	2.1	Cool, 4°C, 0.008% $Na_2S_2O_3$	-	6 hours
Fecal streptococci	P,G	2.1	Cool, 4°C, 0.008% $Na_2S_2O_3$	-	6 hours
Biochemical oxygen demand	P,G	2.1	Cool, 4°C	-	48 hours
Biochemical oxygen demand carbonaceous	P,G	2.1	Cool, 4°C	-	48 hours
Bromide	P,G	2.1	None required	-	28 days
Chemical oxygen demand	P,G	2.1	Cool, 4°C., H_2SO_4 to pH<2	3.5	28 days
Chloride	P,G	2.1	None required	-	28 days
Chlorinated organic compounds	G, teflon-lined cup	2.4	Cool, 4°C., 0.008% $Na_2S_2O_3$	-	7 days (until extraction) 30 days (after extraction)
Chlorine, total residual	P,G	2.1	Determined on site	-	2 hours
Color	P,G	2.1	Cool, 4°C	-	48 hours
Cyanide, total and amenable to chlorination	P,G P,G	2.1 2.1	Cool, 4°C NaOH to pH>12 0.008% $N_2S_2O_3$	- 3.3	14 days
Dissolved oxygen	-	-	-	-	-
Probe	G, bottle and top	-	Determine on site	-	1 hour
Winkler	G, bottle and top	2.1	Fix on site	-	8 hours
Flouride	P,	2.1	None required	-	28 days
Hardness	P,G	2.1	HNO_2 to pH<2	-	6 months
Hydrogen ion (pH)	P,G	2.1	Determine on site	-	2 hours
Kjeldahl and organic nitrogen	P,G	2.1	Cool, 4°C., H_2SO_4 to pH<2	3.5	28 days
METALS					
Chromium VI	P,G	2.2	Cool, 4°C	-	48 hours
Mercury	P,G	2.2	HNO_3 to pH<2, 0.05% $K_2Cr_2O_7$	3.1	28 days
Metals except above	P,G	2.2	HNO_3 to pH<2	3.1	6 months
Nitrate	P,G	2.1	Cool, 4°C	-	48 hours
Nitrate-Nitrite	P,G	2.1	Cool, 4°C, H_2SO_4 to pH<2	3.5	28 days
Nitrite	P,G	2.1	Cool, 4°C	-	48 hours

Oil and Grease	G	2.3	Cool, 4°C, H_2SO_4 to pH<2	3.2	28 days
Organic Carbon	P,G	2.1	Cool, 4°C, H_2SO_4 to pH<2	-	28 days
ORGANIC COMPOUNDS					
Extractables (including phthalates, nitrosamines organochlorine pesticides, PCB's nitroaromatics, isophorone, polynuclear aromatic hydrocarbons, haloethers, chlorinated hydrocarbons and TCDD).	G, teflon-lined cap	2.4	Cool, 4°C 0.008% $Na_2S_2O_3$	-	7 days (until extraction) 30 days (after extraction)
Extractables (phenols)	G, teflon-lined cap	2.4	Cool, 4°C H_2SO_4 to pH<2 0.008% $Na_2S_2O_3$	- - -	7 days (until extraction) 30 days (after extraction)
Purgeables (halocarbons and aromatics)	G, teflon-lined septum	2.4	Cool, 4°C., 0.008% $Na_2S_2O_3$	-	14 days
Purgeables (acrolein and acrylonitrite)	G, teflon-lined septum	2.4	Cool, 4°C., 0.008% $Na_2S_2O_3$	-	3 days
Orthophosphate	P,G	2.1	Filter on site, cool, 4°C	-	48 hours
Pesticides	G, teflon-lined cap	2.4	Cool, 4°C 0.008% $Na_2S_2O_3$	- -	7 days (until extraction) 30 days (after extraction)
Phenols	G	2.1	Cool, 4°C., $CuSO_4$ & H_2SO_4 to pH<4, H_3PO_4		3.4 28 days
Phosphorus (elemental)	G	2.1	Cool, 4°C	-	48 hours
Phosphorus, total	P,G	2.1	Cool, 4°C., H_2SO_4 to pH<2	3.4	28 days
RADIOLOGICAL					
Alpha, Beta and radium	P,G	-	HNO_3 to pH<2	-	6 months
Residue total	P,G	2.1	Cool, 4°C	-	14 days
Residue, filterable	P,G	2.1	Cool, 4°C	-	14 days
Residue, nonfilterable	P,G	2.1	Cool, 4°C	-	7 days
Residue, settleable	P,G	2.1	Cool, 4°C	-	7 days
Residue, volatile	P,G	2.1	Cool, 4°C	-	7 days
Silica	P	2.1	Cool, 4°C	-	28 days
Specific conductance	P,G	2.1	Cool, 4°C	-	28 days

2.0 BOTTLE CLEANING PROCEDURES

2.1 General Bottle Cleaning

2.1.1 Bottle Material

Usually plastic

2.1.2 Bottle Size

Dependent upon determinations required

2.1.3 Cleaning Reagents

1. Phosphate-free detergent
2. Distilled water

2.1.4 Procedure

1. Rinse bottles with tap water
2. Soak bottles in detergent solution for approximately thirty (30) minutes
3. Scrub bottles with a brush
4. Rinse bottles several times with tap water to remove the detergent
5. Rinse bottles thoroughly, several times, with distilled water

2.2 Bottle Cleaning for Metals Determination

2.2.1 Bottle Material

Usually polypropylene

2.2.2 Bottle Size

Usually 500 ml

2.2.3 Cleaning Reagents

1. Detergents
2. 1:1 Nitric acid
3. Distilled water

2.2.4 Procedure

1. Follow general bottle cleaning procedure
2. Add 1:1 nitric acid to bottles, cap, and shake briefly
3. Allow bottles to stand for approximately 30 minutes, shaking them intermittently
4. Pour acid from bottles and rinse them with tap water
5. Rinse bottles thoroughly, several times, with distilled water

2.3 Bottle Cleaning for Oil & Grease Determinations

2.3.1 Bottle Material

Glass with teflon-lined cap

2.3.2 Bottle Size

One (1) liter

2.3.3 Cleaning Reagents

1. Acid solution of 1+1 nitric acid
2. Detergent
3. Distilled water
4. Freon-113

2.3.4 Procedure

1. Follow general bottle cleaning procedure
2. Rinse bottles (excluding caps) with acid solution
3. Pour acid from bottles and rinse them with tap water
4. Rinse bottles thoroughly, several times, with distilled water
5. Rinse bottles with Freon-113

2.4 Bottle Cleaning for Extractable Organics

2.4.1 Bottle Material

Glass with teflon-lined cap

2.4.2 Bottle Size

One (1) gallon

2.4.2 Cleaning Reagents

1. Detergent
2. Chromic acid cleaning solution
3. Distilled water
4. Pesticide grade hexane

2.4.4 Procedure

1. Follow general bottle cleaning procedure
2. Fill bottles with chromic acid cleaning solution allow to stand for a minimum of 1/2 hour
3. Pour chromic acid cleaning solution from bottles and rinse them thoroughly with tap water
4. Rinse bottles several times with distilled water
5. Rinse bottles and caps two times with pesticide-quality hexane

2.5 Bottle Cleaning for Hazardous Samples

2.5.1 Bottle Material

Glass with teflon-lined cap

2.5.2 Bottle Size

40 ml for tank or high hazard samples, up to 500 ml (wide mouth) for others

2.5.3 Cleaning Reagents

1. Detergent
2. Distilled water
3. Reagent-grade methanol

2.5.4 Procedure

1. Follow general bottle cleaning procedure
2. Rinse bottle with methanol
3. Bake for one hour at 300^0.

3.0 PRESERVATION TECHNIQUES

3.1 Preservation Technique for Total Metals

3.1.1 Chemical Preservative
Ultrex concentrated HNO_3

3.1.2 Procedure

1. Use bottle specifically cleaned for metal determinations
2. Add 5 ml of Ultrex concentrated HNO_3 per liter of sample. This should reduce the pH to less than 2.

3.2 Preservation Technique for Oil and Grease

3.2.1 Chemical Preservative
Conc. H_2SO_4 or HCL

3.2.2 Procedure

1. Use bottled specifically cleaned for oil and grease determinations
2. To avoid corrosion of foil-lined caps, preservative (Conc. H_2SO_4) should not be added to empty bottles prior to sampling, but should be added tc samples as soon as possible after collection.
3. All 5 ml of concentraqted H_2SO_4 or HCL to one (1) liter of liquid sample. This should reduce the pH to less than 2.
4. Add 1 ml concentrated H_2SO_4 per 80 g of solid sample

3.3 Preservation Technique for Cyanide

3.3.1 Chemical Preservative
NaOH

3.3.2 Procedure
Add 2 ml of 10 N NaOH per liter of sample. This should increase the pH to greater than 12.

3.4 Preservation Technique for Phenols

3.4.1 Chemical Preservative

$CuSO_4$, H_2SO_4 and H_3PO_4

3.4.2 Procedure

1. Add 10 ml of a 100 g/l $CuSO_4$ solution per liter of sample in order to attain a concentration of 1 g/l $CuSO_4$, and acidify with H_2SO_4 to a pH less than 4.
2. Add a sufficient volume (usually 5 ml per liter of sample) of 1:9 H_3PO_4 to lower the pH of the sample to less than 4

3.5 H_2SO_4 Preservation Technique for COD and All Forms of Nitrogen and Phosphorus

3.5.1 Chemical Preservative

H_2SO_4

3.5.2 Procedure

Add 2 ml of concentrated H_2SO_4 per liter of sample. This should reduce the pH to less than 2.

4.0 REFERENCES

1. U.S. EPA, 1979. Methods for the chemical analysis of water and wastes. March 1979. EPA-600/4-79-020.

2. A.P.H.A. 1975. Standard methods for the examination of water and wastewater. 14th ed.

pH - Electrometric Method

1.0 SCOPE AND APPLICATION

1.1 This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes.

2.0 SUMMARY OF METHOD

2.1 The pH of a sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode.

3.0 SAMPLE HANDLING AND PRESERVATION

3.1 Samples should be analyzed as soon as possible, preferably in the field at the time of sampling.

3.2 High-purity waters and waters not at equilibrium with the atmosphere are subject to changes when exposed to the atmosphere, therefore the sample containers should be filled completely and kept sealed prior to analysis.

4.0 INTERFERENCES

4.1 The glass electrode, in general, is not subject to solution interferences from color, turbidity, colloidal matter, oxidants, reductants or high salinity.

4.2 Sodium error at pH levels greater than 10 can be reduced or eliminated by using a "low sodium error" electrode.

4.3 Coatings of oily material or particulate matter can impair electrode response. These coatings can usually be removed by gentle wiping or detergent washing, followed by distilled water rinsing. An additional treatment with hydrochloric acid (1 + 9) may be necessary to remove any remaining film.

4.4 Temperature effects on the electrometric measurement of pH arise from two sources. The first is caused by the change in electrode output at various temperatures. This interference can be controlled with instruments having temperature compensation or by calibrating the electrode-instrument system at the temperature of the samples. The second source is the change of pH inherent in the sample at various temperatures. The error is sample dependent and cannot be controlled, it should therefore be noted by reporting both the pH and temerature at the time of analysis.

5.0 APPARATUS

5.1 pH Meter-laboratory or field model.
5.2 Saturated calomel reference electrode, fiber type.
5.3 pH glass electrode, silver/silver chloride, low ionic strength.
5.4 Magnetic Stirrer.
5.5 100 ml Beakers.

6.0 REAGENTS

6.1 pH Reference Buffer Solutions:

pH = 10.00 ±.01
pH = 7.00 ±.01
pH = 4.00 ±.01
pH = 2.00 ±.01

7.0 CALIBRATION

7.1 Reference buffers solutions must be at room temperature. Each instrument/electrode system must be calibrated at a minimum of two points that bracket the expected pH of the samples and are approximately three pH units or more apart.

7.2 Immerse the electrodes in pH 7.00 buffer solution and adjust the meter to the proper reading with the calibration control.

Rinse the electrodes, immerse in a second buffer solution, and adjust to the proper reading with the compensator control.

Repeat adjustments on successive portions of the two buffer solutions as outlined in procedure 8 until readings are within 0.05 pH units of the buffer solution value.

8.0 PROCEDURE

8.1 Transfer approximately 50 ml of sample into a 100 ml beaker. Allow sample to equilibrate to room temperature. With sample stirring on a magnetic stirrer, immerse electrodes and allow three minutes for equilibration. Turn off the stirrer and then record the reading to the nearest 0.05 pH unit.

9.0 CALCULATION

9.1 pH meters read directly in pH units. Report pH to the nearest 0.1 unit and temperature to the nearest °C.

10.0 PRECISION AND ACCURACY

10.1 Forty-four analysts in twenty laboratories analyzed six synthetic water samples containing exact increments of hydrogen-hydroxyl ions, with the following results:

pH Units	Standard Deviation pH Units	Accuracy as Bais, %	Accuracy as Bias pH Units
3.5	0.10	-0.29	-0.01
3.5	0.11	-0.00	
7.1	0.20	+1.01	+0.07
7.2	0.18	-0.03	-0.002
8.0	0.13	-0.12	-0.01
8.0	0.12	+0.16	+0.01

(FWPCA Method Study 1, Mineral and Physical Analyses)

10.2 In a single laboratory (EMSL), using surface water samples an average pH of 7.7, the standard deviation was +0.1.

11.0 REFERENCES

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition, P460, (1975).

2. Annual Book of ASTM Sandards, Part 31, "Water", Standard D1293-65, p178 (1976).

3. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, 1979.

FIELD MEASURMENT OF SPECIFIC CONDUCTANCE

1.0 SCOPE OF APPLICATION

1.1 This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes.

2.0 EQUIPMENT

2.1 The specific conductance of a sample is measured using a YSI Model 33 S-C-T meter, or equivalent.

3.0 MAINTENANCE

3.1 Using bottle brush, scrub the bore of the cell with a water/detergent solution and rinse thoroughly with distilled water. Shake out surplus water and examine to make sure surfaces are evenly wetted.

3.2 If there are more stubborn deposits, soak in a 1% HCl solution and wash out thoroughly with distilled water.

3.3 Switch dial to RED LINE, if the needle cannot be made to remain at RED LINE using the red line adjust knob, replace batteries with two 1.5V (Size D) Duracell batteries.

4.0 CALIBRATION

4.1 Zero check - Switch OFF. with meter screw on face plate, adjust knob to 0 UMHOS if necessary.

4.2 The instrument should be standardized against a known conductivity standard or against the reading of a laboratory conductivity meter once per month, or each time before it is released from the laboratory for field work.

Percentage variance from the known standard should be noted on the instrument face and in the equipment log book.

If the instrument fails to read within 90 percent of the standard, follow manufacturers instructions to recalibrate.

4.3 Check accuracy of temperature readout against an NBS-traceable thermometer. Note variance on instrument face plate and in Equipment log book.

4.4 Record results and date of calibration in Equipment log book.

6.0 OPERATION

6.1 Plug probe into jack.

6.2 Switch to RED LINE with RED LINE control adjust meter to red line.

6.3 Temperature: Switch to temperature and read meter when needle is steady.

6.4 Salinity: Read temperature and set ^{o}C control to indicated temperature, switch to SALINITY and read 5% scale.

6.5 Conductivity: Read temperature and set ^{o}C control to indicate temperature. Switch to appropriate UMHO range for on scale meter readings and multiply reading by range.

7.0 REFERENCE

1. APHA-AWWA-WPCF - 1980 - Standard Methods for the Examination of Water and Wastewater, 15th ed. Method 205.

MONITORING WELL INSTALLATION and GROUNDWATER SAMPLING

1.0 GENERAL

Monitoring wells are installed at or adjacent to hazardous waste sites in order to provide an understanding of the overall groundwater regime, to evaluate flow patterns and hydraulic head fluctuations of the groundwater immediately surrounding the site and for the collection of groundwater samples to determine the extent of contamination in instances where the site in question has affected quality of the groundwater. It is essential that samples be collected from sources in a manner that will accurately assess the concentrations of constituents present. This may include the collection of groundwater samples from existing monitoring wells and large diameter production wells and possibly other sources (under certain circumstances, i.e. springs, etc.), in addition to samples collected from monitoring wells installed for this purpose. Generally, the installation of monitoring wells includes soil sampling--the collection of which is described in procedure number 3816017. In the following sections, techniques are generally described for the installation and sampling of monitoring wells.

In instances where new monitoring wells are necessary, a review of all prior data pertaining to the groundwater regime and the quality of the groundwater in the area is a necessary part of the decision-making progress involved with siting the new wells. Well installations may be accomplished through a contract based on a rigid set of specifications and unit price payments or by a time of materials contract. While the former is normally considered preferrable, the number of unknowns (both in location and subsurface conditions) may dictate that the latter course be followed.

and maintain the borehole. The drill bit is attached to the drill pipe (called the drill stem) and rotated from the ground surface by the drill rig. Water and drilling fluid (usually mud) are circulated down the drill stem, out the bit and up the anular space between the borehole and drill stem. Generally, a mud pit or tank at ground surface receives the drilling fluid and allows the subsurface drill cutting to settle out.

Well casing is generally not employed during drilling except to maintain an open borehole above the water table or where especially loose formation materials are encountered. Below the water table, in most normal circumstances, the thick drilling muds "pack" open the borehole, permitting placement of well screens and casing after the drill bit and stem are removed from the borehole.

Two common variations of hydraulic rotary drilling are air rotary and reverse circulation rotary. Air rotary is commonly employed in consolidated rock drilling where compressed air of high volume and pressure removes drill cuttings and the borehole remains open due to its consolidated nature. Reverse circulation rotary is a method which uses water along as the drilling fluid with the water flow up the drill stem and down the anular space between the borehole and drill stem (in the opposite direction from hydraulic or straight rotary drilling). In reverse circulation drilling, the hydrostatic pressure of continuous water circulation maintains the borehole prior to screen and casing placement.

Rotary drilling is most similar to another drilling method known as jet drilling or jetting.

2.2.4 Jetting

Jetting involves the use of water or drilling muds under pressure to advance the casing. Cuttings are removed in advance of the borehole by the return flow of the drilling fluid. The borehole may be stabilized by the drilling fluid on casing.

Accurate and precise groundwater quality monitoring requires sophisticated well installations. Several basic design criteria must be followed to insure quality installations in the highly variable geologic conditions encountered.

Well drilling methods and equipment are highly specialized, and therefore, well drilling crew qualifications, equipment and experience are important to the successful completion of the work. However, well drillers typically only provide operational capabilities; they require the guidance and assistance of the certified geologist or engineer to interpret the application of of the basic criteria to the changing geologic at a given site. In addition, onsite observation of the well driller's operations by an independent party provides a check of specific product details, which are most important to the interpretation of the water quality results obtained. The certified geologist or engineer would provide services including, but not limited to the following:

- All matters pertianing to pay estimates, contractor claims, progress of work, deficiencies.

- Reviewing the contractor's proposed plans, schedule, program, and other data to be submitted in compliance with requirements of a purchase order or specifications, such as any plans for special testing work, soils sampling, developing, grouting, and locking cap devices.

- Reviewing and approving all equipment and methods the contractor proposes to use.

- Records of operation, such as: procurement, storage and installation of all materials and equipment; all well logs, special testing reports, progress reports, equipment reports, safety reports.

- Observing, measuring, and recording all operational tests such as soil or core sampling, special testing, logging and water sampling.

- Satisfying that information on screen settings and other decisions dependent upon field conditions encountered during the progress of the work are handled expeditiously and promptly and properly transmitted to the Contractor.

3.0 PERMANENT SAMPLING DEVICES

In addition to monitoring wells, permanent sampling devices such as "Barcads" or suction lysimeters may be installed in order to obtain groundwater samples. Installation techniques for these devices will be developed recognizing the special requirements of these devices. In general, however, permanent sampling devices will be installed in boreholes excavated using wash bore or augering techniques as discussed previously. Such devices may also be installed in boreholes that have been drilled with other equipment and in boreholes drilled in bedrock where conditions require.

The sampler shall be positioned in the borehole at the desired depth for sampling and packed with clean mono-mineralic filter sand. The method by which sand is added to the borehole and tamped shall be such as not to damage the sampling device.

Normally such devices are utilized where multiple levels groundwater levels are to be monitored and bentonite pellets shall be used to isolate samplers and prevent cross contamination of aquifers. The interval to be sealed will be determined by subsurface strata encountered during the boring and the thickness of the seal and method by which it is installed will be determined based upon the type of boring equipment utilized and the geologic dormation into which it is placed. Groundwater samples should be obtained in accordance with procedures outlined by the manufacturer.

Following the placement of a sampling device and bentonite seal, the borehole shall be backfilled with cement grout or material of sufficiently low permeability and of such quality that the potential for contamination from overlying zones is minimized. Similar material shall be placed in the intervals between devices where multiple zones are to be monitored.

4.0 SAMPLING FROM A MONITORING WELL

When sampling a monitoring well, the following procedure should be followed:

- o Check the well for above ground damage.
- o Remove the well cap (a wrench may be needed).
- o Measure and record the depth to water and the time of measurement.
- o Measure the total depth of the well.
- o Remeasure and record the depth of water after a lapse of 4 to 8 minutes following initial measurement and record the depth to water and time of measurement.
- o If successive measurements show essentially no difference, continue the sampling procedure. Where the level change is greater than 1/100th ft, delay the remaining procedures until the change observed and recorded is less than that figure.
- o Determine the amount of water in the well (depth of water x cross sectional area).
- o Purge the well by either removing all the water from the well and allowing it to recover three to ten times, or by removing the equivalent of three to ten well volumes of water. The procedure to be used will be determined by the on-site coordinator on the basis of geologic and/or hydrogeologic conditions and on well construction details. Well purging can be accomplished with centrifugal pumps, peristaltic pumps or

bailers. The well purging equipment shall be cleaned as described for samplers in Section 4.1 following.

- Clean the sampler as described in the following Section (4.1) immediately prior to inserting it into a well.
- Collect samples using a bailer, pump, or positive pressure sampler dependent upon the general nature of the contaminants of concern. Sampler materials of construction shall be specifically selected for each contaminant.

4.1 Sampler Cleaning

Sampler cleaning is to be performed immediately prior to sampling from any well. Any portion of the sampling device which contacts contaminated water shall be cleaned or disposed of between wells. For example, the cable used for bailing shall be subjected to the same cleaning requirement for a length at least equal to twice the depth to the water surface. Where pumps are used, short sections of sample tubing may be disposed of rather than cleaning. The following procedure is followed for cleaning samplers and equipment:

- Rinse with clean tap water.
- Rinse with reagent grade methanol and allow to air dry.
- Rinse at east once with clean tap water.

If appropriate the above procedure can be preceded with a wash with soap (Alconox or Liqinox). Line and cables used to lower samplers into monitoring wells will be disposed of in an appropriate manner dictated by the On-site Coordinator or cleaned and rinsed using the procedures outlined above for cleaning sampling devices. Persons obtaining groundwater samples will wear chemically inert protective gloves to prevent skin contact with sampling devices, lines and cables and potentially contaminated groundwater.

4.2 Bailing

A bailer made of PVC, Teflon, or stainless steel can be used to remove the stagnant water in monitoring wells and obtain samples. The problems with this method are: a) cross-contamination between wells can occur; b) the method is time-consuming; and c) contaminants can easily enter the water with many trips up and down the well. Properly used, a bottom filling bailer should not significantly alter the water quality. It is a cost-effective method if the wells are shallow have adequate size for the sampler and only need to be sampled infrequently.

4.3.1 Equipment

Bottom Filling Bailer - Stainless steel bailers with inert fittings (such as teflon) shall be used to collect samples. Water enters the bailer through a hole drilled through the bottom end plug and is prevented from draining out by an inert ball check valve. The plug fits tightly inside the bailer and requires no adhesives, which might contaminate the water. A cable made of nickel (or some other noninterfering material) wire is used to raise and lower the bailer.

4.3.2 Sampling Procedure

The cable supporting the sampler should be prevented from coming in contact with the water in the well. The bailer should not come in contact with any materials outside of the well casing. When emptying the bailer, a new pair of disposable gloves are to be worn for each individual well sampling.

Samples are carefully poured from the bailer into clean serum bottles or screw-cap vials of appropriate size (usually 40-125 ml), avoiding turbulence, which might result in loss of volatile organics and/or excessive oxygenation of the samples. Care shall also be exercised to eliminate the entry of or contact with any substance and the interior surface of the vials or caps other than the water sample being collected. The containers are topped-off to avoid gas space and tightly closed with teflon-lined septums held in place by open-top screw caps. The sample bottles should be prepared with appropriate preservatives prior to sampling. The bailer must be cleaned as described in the previous section before reuse.

4.4 Pumping (for suction lifts up to 25 feet)

The peristaltic pump is the preferred type of pump for sampling groundwater (except when samples for volatile organic analyses are obtained). The pump will not significantly affect the quality of the sampled water, except possibly strip volatile fractions. The water is pumped through chemically tubing (i.e. teflon), therefore, it does not come in contact with the air, nor is a strong vaccum applied to it. The major drawback of this pump is that it cannot be used to pump water from a depth greater than about 25 ft and that it pumps at a relatively low rate (100 ml/minute).

4.4.1 Equipment

- Peristaltic pump
- 1 liter erlenmeyer flask
- 6 mm I.D. teflon tubing
- 6 mm O.D. glass tubing
- 6 mm I.D. tygon tubing

4.4.2 Sampling Procedure

Figure 1 depicts the sampling system which shall be used to obtain samples by pumping.

Groundwater withdrawn through a precleaned 6 mm O.D. teflon tube and discharged into a clean, calibrated one-liter heavy-wall erlenmeyer flask with a peristalic pump on the outlet side of the sampling flask.

The sampled water contacts only teflon and precleaned glass is then carefully transferred to appropriate glass sample containers for shipment to the laboratory. This system shall not be used for samples to be analyzed for volatile organics, because of possible stripping of highly volatile constituents from the sample under the reduced occurring in these systems. It may, however, be used for non-volatile constituents such as metals or other organics.

4.5 Positive Pressure Sampling (for greater than 25 feet sampling depth)

A gas-lift sampler can be used in wells where the ground water surface may be greater than 25 ft. below ground surface. The sample pump should be made of glass, PVC, Teflon, or stainless steel, depending on the constituents of interest. For the toxic pollutants, PVC or Teflon is best due to their inertness and ruggedness. Care should be excercised in selecting the pressurizing gas so the water quality is not significantly affected due to the gas-water contact. Note that sample times are typically installed for each sample station.

4.5.1 Equipment

- o Gas-lift sample pump utilizing tubing and materials lined with glass, PVC, Teflon, or stainless steel.
- o Ultra high purity compressed nitrogen (99.999% pure) (New England Cyrogenics, Newton, MA).
- o Reagent grade methanol.

4.5.2 Sampling Procedure

Compressed nitrogen is regulated into an approximate 1/2-inch diameter nylon tube connected to the sampler in the well. Groundwater that has permeated the sampler is forced up through an approximate 1/4-inch concentric nylon tube and sampled. The pressure and flow of nitrogen will be controlled with the regulator in order that the groundwater sample exists slowly and with a minimum of "spurting" at the end. One volume of groundwater will be flushed out and discarded to clean the tubes and obtain newly permeated groundwater. All sample bottles will be filled directly from the 1/4-inch tubing except in the case of VOA vials where less than 47 ml is released with each sampling. In this situation, a clean transfer bottle is filled first and then transferred to the VOA vial, filling carefully and capping tightly so that no air bubbles remain inside. This avoids the introduction of bubbles that would occur from filling directly from a "spurting" groundwater flow.

APPENDIX VI

SUBCONTRACTOR BID SPECIFICATIONS

CONTENTS

APPENDIX VI

- GEOPHYSICAL SURVEY SERVICES
- LABORATORY SERVICES
- SITE SURVEY SERVICES
- DRILLING SERVICES

WORK SPECIFICATIONS
GEOPHYSICAL SURVEYING
NORTH CAVALCADE SITE

PART 1: GENERAL

1.01 SCOPE

A. The work to be performed under this section includes the furnishing of all labor, equipment, materials and other facilities and incidentals necessary to perform geophysical surveying near the North Cavalcade Site in Houston, Texas.

B. The site surveying will consist of using a combination of resistivity, electromagnetics, and ground penetrating radar to determine which method, or combination of methods, if any, that will produce the best resolution. In general, the initial profiles should be widely spaced, with infilling traverses-established based on the results obtained, the ability to traverse the site with the particular geophysical tool being used and other factors, as identified in the field. Onsite data processing capability will facilitate obtaining maximum benefit from the geophysical tools.

1.02 INSURANCE

A. Subcontractor agrees and shall submit evidence to the Engineers before beginning work on the Project that he has procured and will maintain such insurance as is described in the Engineers Standard Subcontractor Agreement.

1.03 QUALIFICATIONS

A. The Subcontractor responsible for this work shall be a reputable geophysicist employing only competent workmen for the execution of this Project.

B. The Engineer may make any other investigations deemed necessary to determine the ability of the Subontractor to perform the work, and the Subcontractor shall furnish to the Engineer all such information and data for this purpose.

C. The Subcontractor shall furnish satisfactory evidence upon request that all equipment is in good working order.

D. The Subcontractor shall complete the work in accordance with applicable portions of the Federal, State, and Local laws and regulations.

1.04 SITE PROTECTION

A. Upon completion of the work, the Subcontractor shall restore the site as nearly as possible to the original condition, including the replacement, at the Subcontractor's sole expense, of any facility or landscaping which has been damaged beyond restoration to its original condition, or destroyed.

1.05 ADDITIONAL WORK

A. At the option of the Engineer additional work may be authorized. Additional work shall be completed at the unit prices bid.

1.06 MEASUREMENT AND PAYMENT

A. Payment of work performed shall be on a basis of unit and lump sum prices bid and actual work performed.

PART 2: DELIVERABLES

2.01 PROFILES

A. If a suitable method is determined, the Subcontractor shall submit contour and isopach maps indicating the stratigraphic profiles of the soils materials of the shallow aquifer (at about 20 feet), the aquitard (20-80 feet), and the overlying materials.

2.02 REPORT

A. The Subcontractor shall submit a report detailing all work performed including all maps noted above.

PART 3: EXECUTION

3.01 SITE PROTECTION

A. At all times during the progress of the work the Subcontractor shall use all reasonable precautions to prevent any destruction to the site property.

3.02 SITE ACCESS

A. The Subcontractor shall be responsible for all means of access to the site area, including the need for crossing ditches, etc., with any vehicles.

3.03 GEOPHYSICAL SURVEY

A. The area to be surveyed will be near North Cavalcade Street in Houston, Texas.

B. The method to be used shall be determined as follows:

1. The electrical resistivity method shall be employed first, using a Wenner electrode array;
2. The electromagnetic conductivity technique shall then be used, using a Geonics EM-34 or similar instrument capable of onsite data analysis;

3. If deemed necessary, the ground penetrating radar method shall be employed:

4. Once the best method or combination of methods has been determined; the remainder of the survey shall be carried out using the appropriate techniques.

C. Exact areas to be surveyed will be determined in the field as needed.

D. If no method provides results satisfactory to the Contractor, the survey shall be terminated and the payment to the Subcontractor shall be prorated as described in the submitted cost proposal.

PART 4: HEALTH AND SAFETY PROTOCOL

4.01 GENERAL

A. The work to be carried out under these specifications is within a hazardous waste site that is listed on EPA's National Priority List (NPL). Hazardous materials are known to be present in the soils and groundwater of the area.

B. It is anticipated that Level D protection equipment shall be utilized by the Subcontractor's personnel with contingency to upgrade as outlined in Section 4.03.

4.02 SUBCONTRACTOR'S RESPONSIBILITIES

A. The Subcontractor is solely responsible for it's personnel's health and safety. At a minimum, the Subcontractor will be responsible for adhering to the Contractor's health and safety guidelines.

B. The Subcontractor must provide his personnel with all the required health and safety equipment.

Note that the items to be furnished by the Subcontractor for his work crew under different levels of protection are as described below:

- All Levels - hard hats
  - ~~rubber gloves (butyl, nitrile or neoprene)~~
  - rubber boots (butyl, nitrile or neoprene) with steel toe and shank
  - coveralls

- Level D

  - chemical resistant coveralls (i.e., Saranex) optional
  - disposable outer boots (i.e., PVC or equal) optional

- Level C - Protective clothing and equipment
  - full face, air purifying cannister equipped respirator
  - chemical resistant coveralls (i.e., Saranex)
  - disposable outer boots (i.e., PVC or equal) optional
- Level B - protective clothing and equipment
  - pressure demand self-contained breathing apparatus (SCBA)
  - chemical resistant coveralls (i.e., PVC, rubber or Saranex)
  - disposable outer boots (PVC or equal)

C. The Subcontractor must submit a letter stating that all it's site personnel have been trained and fit tested for the use of air purifying respirators (APR).

4.03 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor will maintain air monitoring stations on a daily basis when any personnel are onsite.

B. Any changes to the level of personal protection will be as defined below:

1. Site Personnel will upgrade to Level C respiratory protection when HNu readings observed in the ambient atmosphere are 5 ppm above background for a 15 minute time weighted average period.
2. When HNu readings observed in the ambient atmosphere are below 5 ppm above background for a 15 minute time weighted average then a downgrading to Level D protection can occur.
3. Site Personnel will: a) upgrade from Level C to Level B respiratory protection; or b) vacate the site, when HNu readings observed in the ambient atmosphere are 10 ppm above background for a 15 minute time weighted average.
4. When the HNu readings in the ambient atmosphere exceed 50 ppm above background all work will cease, the site will be vacated and the Regional Health and Safety Supervisor and the Site Manager will be notified.
5. When respirable dust monitor reading of 0.1 mg/m^3 or greater are observed:,

   a) Level B protection will be worn; or

   b) the site will be vacated.

4.04 ONSITE HEALTH AND SAFETY COORDINATOR

Should, for any reason, it be determined that the working conditions are unsafe, the Onsite Health and Safety Coordinator at his/her discretion can terminate the work. The H & S Coordinator is charged with overseeing site health and safety, instrument monitoring, personnel decontamination, control of contaminated material and emergency response measures.

END OF SECTION

TECHNICAL SPECIFICATIONS
FOR LABORATORY SERVICES

PART 1: GENERAL

1.01 INTRODUCTION

The work to be performed under this section includes furnishing all sample bottles, preservatives and shipping containers necessary for the sampling of soil, sediment, and water samples and the analysis of these samples. The samples will be obtained at a United States Environmental Protection Agency (USEPA) Superfund site in Harris County, Texas. The site to be investigated is the North Cavalcade Street Site in Houston, Texas (see Figure 1). The samples may be heavily contaminated with compounds injurious to human health and the environment and should be handled only by personnel trained and equipped for dealing with high hazard chemicals. The work may include the analysis of other matrices such as waste depending upon the results of preliminary investigations.

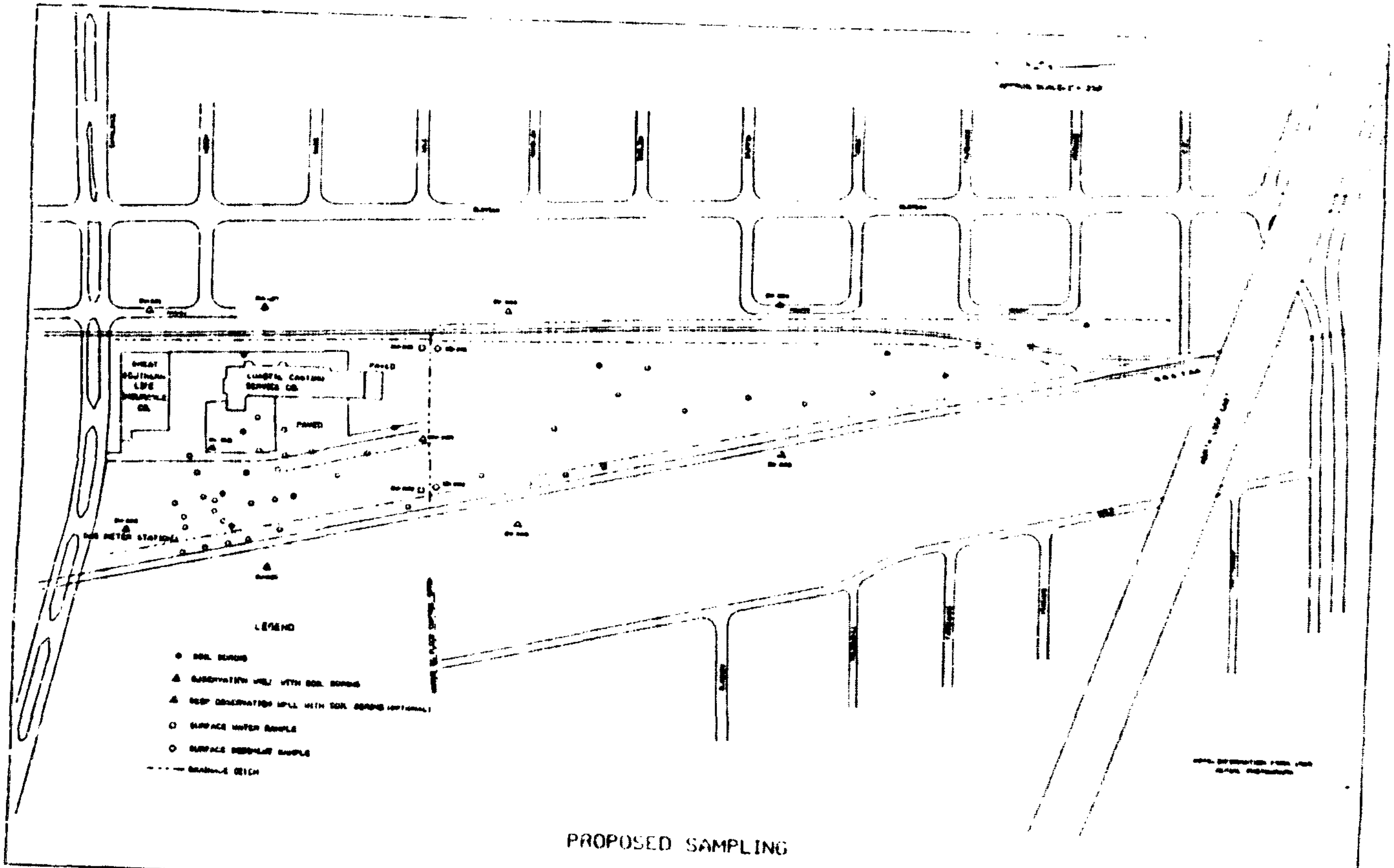
The following Scope of Work fully describes the requirements of the project.

1.02 SCOPE OF WORK - GENERAL DESCRIPTION

A. The laboratory chosen for this work should be thoroughly familiar and equipped for the analysis of high hazard waste samples. The materials to be analyzed include soil, sediment, water, and acid, base/neutral air catchment tubes. The proposed sample types and volumes are given in Table 1.

The laboratory is requested to respond in proposal form to each of the following criteria, at a minimum, and present price bids on the enclosed form. It is requested that the technical proposal be no more than fifteen (15) pages in length including cover letter. A company representative should be designated that is qualified to negotiate and sign contractual agreements with CDM. It is anticipated that a visit to the laboratory to inspect the facilities, interview personnel, and confirm adherence to quality assurance documentation will be scheduled prior to contract signing.

FIGURE 1



PROPOSED SAMPLING

Table I

Proposed Laboratory Sample[a] Specifications

PARAMETER	SAMPLE MATRIX	REFERENCE EPA METHOD	CONTAINER TYPE	VOLUME	QUANTITY SURROGATE[b]	QUANTITY FINAL ANALYSIS[b]
Acid - Base/Neutral	Air	TO-Z	filter	N/A	N/A	15
Acid - Base/Neutral	Soil	8250/8270	Glass Widemouth	16 oz.	N/A	70
Pesticides & PCB's	Soil	8080	Jars with	16 oz.	N/A	70
Cyanide	Soil	9010	Teflon or Foil	16 oz.	N/A	70
Priority Pollutant Metals	Soil	6010	Cap Liners	16 oz.	N/A	70
Iron	Soil	236.1	Glass Widemouth	16 oz.	N/A	70
Total Petroleum Hydrocarbons	Soil	413.2[b]	Jars with	16 oz.	N/A	70
Volatile Organics	Soil	8240	Teflon or Foil	16 oz.	N/A	70
Arsenic	Soil	7061	Cap Liners	16 oz.	N/A	70
Volatile Organics	Water	624	septum cap vial	40 ml.	N/A	42
Acid - Base/Neutrals	Water	625	amber glass	1 gal.	N/A	42
Priority Pollutant Metals	Water	200.7	glass	1 liter	N/A	42
Total Cyanide	Water	335.1	glass	1 liter	N/A	42
Nitrates	Water	353.3	amber glass	1 gal.	N/A	32
Iron	Water	236.1	glass	1 liter	N/A	42
Pesticides & PCB's	Water	608	amber glass	1 gal.	N/A	42
Total Petroleum Hydrocarbons	Water	413.2[b]	glass	1 liter	N/A	42
GC/FID Screening for creosote compounds and pentachlorophenol	Soil	N/A	amber glass Wide mouth jar	1 gal.	600	

---

[a] All bottles cleaned and prepped as per USEPA requirements

[b] Maximum estimated - actual quantities may vary

Address proposals to:

Camp Dresser & McKee Inc.
National Program Management Office (REM II)
7630 Little River Turnpike, Suite 500
Annandale, Virginia 22003
Attention: Mr. Daniel L. Hutton
Subcontracts Manager
(703) 642-5500

1.03 SCOPE OF WORK - DETAILED SUMMARY

The following Scope of Work is a description of the minimum CDM requirements for successful completion of this project. The analytical parameters, matrix types, and estimated volume of samples are given in Table 1. the following sections are presented as minimum requirements but are not limited to the information presented in the bid proposal presented to CDM by the laboratory.

A. INSTRUMENTATION

Instrumentation to be used for the analyses of these samples shall be modern and well maintained. The types of instrumentation used for each analysis shall be specified. Maintenance and calibration procedures and intervals shall be explained and may not be less than manufacturers' or U.S. EPA specifications. Methods for determining instruments that are out of specification or calibration and their isolation and repair procedures shall be listed in the proposal.

B. PERSONNEL

Personnel performing test procedures shall be experienced and qualified to run specific analyses. Any training or certification methods used shall be noted in addition to the individual analysts' resumes. Procedures to ensure that analysts maintain proficiency and do not perform tests they are unqualified for shall be given in the proposal.

C. QUALITY ASSURANCE

1. The Quality Assurance (QA) program of the laboratory shall be structured to provide precise, accurate data of a known and documented quality. A clearly written QA program shall be presented at the Client's request. Data packages should be reported containing all pertinent QA operations to allow a qualified individual to determine the quality of the data and its applicability to the investigation.

2. The methods for storage of chemicals and analytical reference materials for standardization shall be presented. A consistent plan for replacement of standards and their ability to be traced to a reference material such as an NBS standard shall be given. The procedures used for obtaining laboratory and field grade

blanks and their isolation from sample flow or preparation areas are requested.

3. Documentation of the percentage of blanks, standards, duplicates, and matrix spikes shall be given in the proposal as well as the method of introduction into normal sample flow. Duplicate samples will also be presented to the laboratory without prior notification.

4. Methods of non-conformance or corrective action control such as charts and supplemental data shall be presented in the proposal as well as documentation procedures noting: in control, out of control. and return to control periods.

5. Specific organics analysis procedures such as a quality control summary containing surrogate, system blank, reagent blank, duplicate matrix spike analysis recovery, instrument tuning and performance information shall be presented. Also note any % blank or % spike analysis performed in addition to laboratory QA program minimum requirements.

6. Certifications, audits, or other inter-laboratory/round robin quality assurance procedures are an example of a commitment to quality and should be noted in the proposal.

D. METHODS

1. The laboratory should use published analytical methods with data available to determine precision, accuracy, and detection limit for each type of matrix encountered. The methods shall be available to each analyst in written form and used on the bench top or place of analysis.

2. The procedure used to specify applicable methods for each analysis shall be noted in the proposal as well as how to determine if the method is not working due to interference, or other causes.

3. Sample preparation methods shall be documented separately from analytical methods. Procedures for determination of the correct preparation method shall be explained in the proposal.

4. If no applicable method is available, the steps taken during method development shall be explained to determine the reliability of the new method. Documentation of the development procedures and verification of precision, accuracy, and detection limit for applicable materials is requested in the proposal.

5. Exact methods proposed for each type of analysis requested shall be presented in the bid price sheets.

E. HAZARDOUS MATERIAL HANDLING CAPABILITY

1. The samples that will be submitted by the Client may be heavily contaminated with materials hazardous to human health and the environment. The laboratory shall be equipped and personnel trained to handle these materials in accordance with current OSHA, NIOSH, or other local, state, and federal regulations. Special procedures or facilities used for this type work shall be explained in the proposal.

F. SAMPLE MANAGEMENT

1. Procedures for preparing the correct type of sample container according to U.S. EPA specifications and the provisions for the correct preservative type shall be explained.

2. Insulated sample shipping or storage chests shall be provided to the client to maintain correct storage temperatures and chain of custody integrity.

3. The laboratory is requested to pick up the samples at the North Cavalcade job site or provide for delivery services.

4. Procedures shall be explained in the proposal for the provision and maintenance of field blanks and field duplicates and the introduction of control samples inconspicuously into the flow of work.

5. If the client needs assistance in correctly labeling, marking, or otherwise meeting DOT Title 49 regulations for shipping, the laboratory may be called upon to provide it.

G. DATA MANAGEMENT

1. A step by step procedure shall be provided for sample logging and identification. The method used to track samples and workload in the lab shall be explained using flowcharts or other means in the proposal.

2. Error found procedures and data validity checking are key elements in the data reporting procedures to the client. The ability of the client to inspect lab notebooks, logsheets, or computer files is necessary if litigation results from the investigation. Corporate policy on this information and file integrity shall be provided.

3. Laboratory procedures for re-analyzing samples that may have questionable data shall be provided.

H. TURNAROUND PROJECTIONS AND RUSH SAMPLE ANALYSIS

1. It may be necessary for the Client to submit samples at night, on the weekend, or on a priority rush basis. Proposal price sheets should list any surcharges for these services.

2. It is required that all samples be analyzed within U.S. EPA specified holding times. The schedule listed below is requested in addition:

   a. Organics - Sample Extraction within 5 days
   VOA Analysis within 7 days
   Data Delivery within 30 days

   b. Inorganics - Data Delivery within 30 days.

I. SAFETY AND SAMPLE DISPOSAL

1. In addition to the requirements set forth in Section 1.03-H the laboratory shall have a documented safety plan that provides for the employees in accordance with OSHA and NIOSH guidelines.

2. The samples submitted may be hazardous under RCRA. The laboratory shall dispose of these samples in compliance with local, state, and federal laws and provide proof of proper disposal to the client. Samples shall be retained for a period of 90 days prior to disposal.

J. PROBLEM RESOLUTION

1. Problems concerning sample receipt and analysis should be resolved quickly. The key to this type of problem resolution is timeliness, since delays impact sample holding times, contractual time requirements for sample extraction and analysis, and if extreme, could invalidate analyses. The laboratory shall designate in the proposal a knowledgeable staff member as the contact person to settle disputes or answer questions quickly.

2. Problems concerning analytical data shall be resolved through discussions between the Client Project Manager and the Laboratory Supervisor. It may be necessary to examine any and all documentation concerning the problem sample or question laboratory personnel. The laboratory shall propose a problem resolution method in the proposal.

K. LABORATORY INSPECTION

1. The laboratory shall make its facilities and personnel available for a notified inspection prior to contract negotiation to allow the Client to inspect these facilities and personnel and to confirm adherence to quality assurance documentation.

2. Periodic inspections may be necessary during the course of the project to confirm adherence to quality assurance documentation.

3. If litigation occurs as a result of the Client's investigation of the North Cavalcade site, the laboratory shall provide all lab notebooks, logsheets, computer files or other data as necessary to the Client.

1.04 QUALIFICATIONS

A. The laboratory providing analytical services to the Client shall be experienced and equipped in the analysis of soil, air and water samples by U.S. EPA methods or equivalent.

B. The laboratory shall be capable of handling and analyzing samples containing compounds hazardous to human health and the environment in a safe and legal manner.

C. The laboratory shall provide a list of past clients for whom this type of work has been provided, and CDM may contact any or all of these to satisfy it's needs.

1.05 ADDITIONAL WORK

A. At the option of CDM, additional work may be authorized during the course of the project. Additional work shall be completed at the prices bid.

1.06 SURFEIT OF SAMPLES

A. Due to circumstances beyond its control, CDM may not be able to provide the contracted number of samples. In this case, the work will be completed and CDM will be charged for the actual work done on a unit price basis.

1.07 NEGOTIATION OF CONTRACT

A. The laboratory shall designate a person qualified to negotiate and sign contractual agreements with CDM.

1.08 MEASUREMENT AND PAYMENT

A. Payment of work performed shall be on a basis of unit and lump sum prices bid and actual work performed.

END OF SECTION

STATEMENT OF WORK/SPECIFICATIONS
SITE SURVEYING SERVICES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The work to be performed under this section includes the furnishing of all labor, equipment, materials and other facilities and incidentals necessary to perform site surveying operations described herein, at the North Cavalcade Site in Houston, Texas.

B. This work shall be conducted by ground survey or, if deemed necessary and sufficient, by the Contractor, aerial survey. The Subcontractor shall be responsible for setting survey targets.

1.02 MONITORING WELL SURVEY

The horizontal (to the nearest 0.01 foot) and vertical (to the nearest 0.1 foot) positions of 9 monitoring wells are to be determined. Locations are shown in Figure 1.

A permanent reference marker will be affixed to the well casing. Subsequent location descriptions will be in reference to this marker.

1.03 BORING SURVEY

The horizontal (to the nearest 0.01 foot) positions of approximately 250 power auger/boring sites are to be determined. Locations will be determined during the Contractors initial investigations. A reference marker for each location will be inserted at each completed site. Subsequent location descriptions will be in reference to this marker.

1.04 BUILDING SURVEY

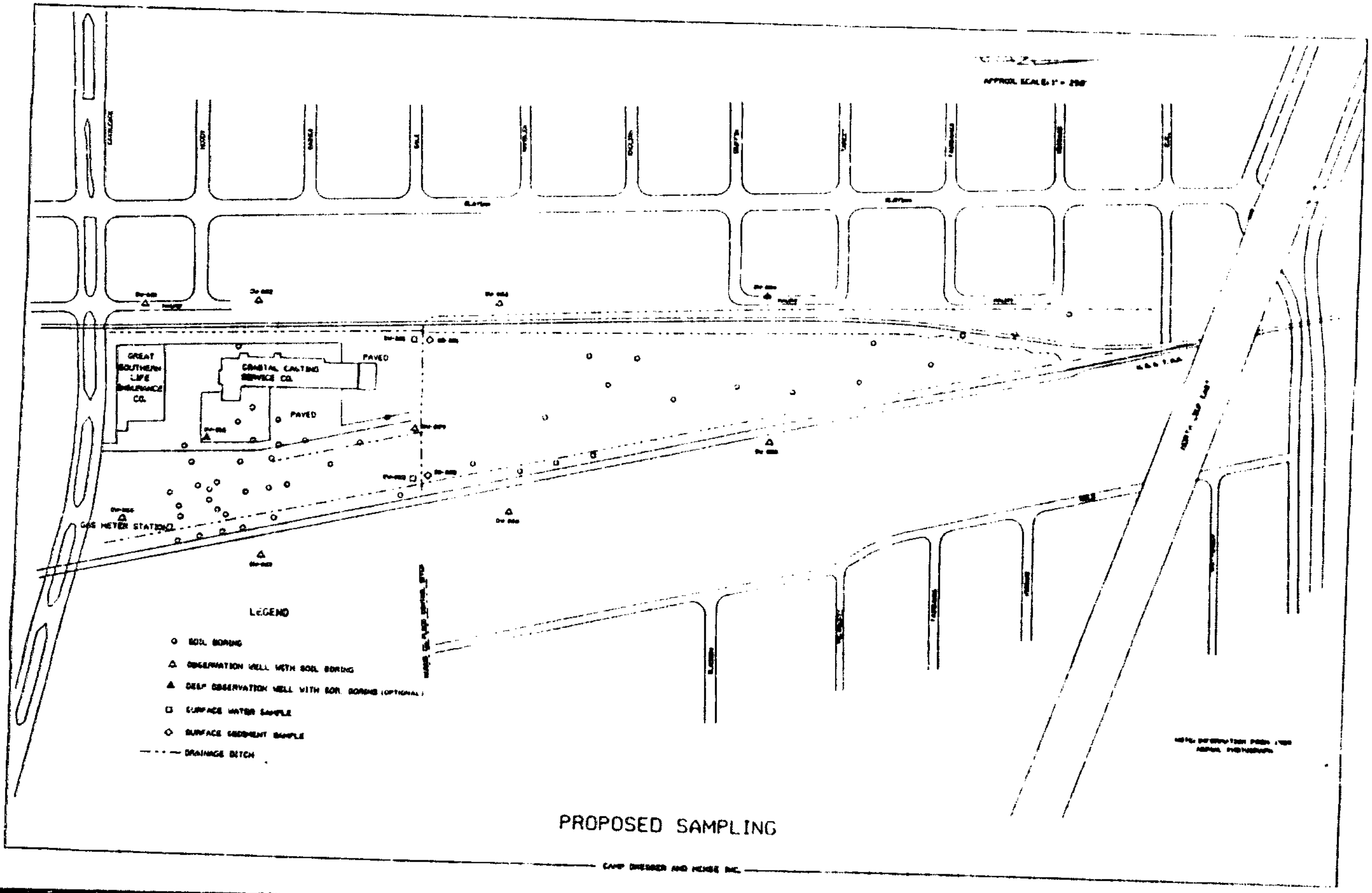
The horizontal (to the nearest 0.01 foot) and vertical (to the nearest 0.1 foot) positions of all existing features such as building and paved areas shall be surveyed.

1.05 DELIVERABLES

A. The Subcontractor will prepare a brief report outlining the field methods and procedures used, the appropriate traverse data, and the locations and elevations of each of the survey points. The locations of the survey points will be plotted on a base map, which will have been issued by the Contractor.

B. The Subcontractor shall submit a topographic map of the area with a one-foot contour interval and a scale of one-inch equals 100-feet. This map shall include all features surveyed such as wells and buildings.

FIGURE 1



PROPOSED SAMPLING

CAMP DRESSER AND MCKEE INC.

1.06 GENERAL REQUIREMENTS

A. Horizontal Control

All monitoring wells will be located and tied to the nearest state road right-of-way. State plane coordinates will be used if available. Control will meet or exceed the minimum technical standards for Land Surveyors in the State of Texas, as specified in the Texas Statutes.

B. Vertical Control

Vertical control will be based on a United States Geological Survey datum. The vertical datum shall be mean sea level, NGVD 1929 general adjustment, as established by the NOS and NOAA. The statutes stated above will be met or exceeded.

C. Proposed location of horizontal and vertical control points shall be submitted to the Site Manager, Robert S. Kier, for review and comments.

1.06 PERMITS

A. The Subcontractor shall be responsible for obtaining any federal, state, or local permits required for work or access.

B. The Subcontractor shall not perform any work until these permits are obtained.

C. The Subcontractor shall furnish separate copies of all permits to the Contractor as the permits are received. Copies of all permits shall be furnished to the Contractor prior to mobilization.

1.07 UNDERGROUND AND OVERHEAD UTILITIES

Damage to underground and overhead utilities resulting from the actions of the Subcontractor are the sole responsibility of the Subcontractor.

1.08 QUALIFICATIONS

The Subcontractor responsible for surveying the site shall be licensed by the State of Texas as a Registered Public Surveyor employing only competent workers for the execution of this work. All such work shall be performed under the direct supervision of an experienced and as specified licensed surveyor.

1.09 SUBMITTALS

The Subcontractor shall furnish satisfactory evidence upon request that all materials to be furnished in performing the work are in good working order.

1.10 AREA INGRESS AND EGRESS

Rights of ingress and egress will be provided by the U. S. Environmental Protection Agency. The Subcontractor shall be responsible for construction of any physical access that is required in order to move equipment onto the work area and restoration of any and all areas used for this purpose.

1.11 AREA RESTORATION

The Subcontractor shall be responsible for preserving, protecting, and preventing damage to all public and private property. Any damage to private or public priority resulting directly or indirectly from any of the Subcontractor's operations, shall be restored, at his expense, to a condition similar or equal to that existing before the damage was done in a manner acceptable to the Contractor.

PART 2: PRODUCTS (NOT APPLICABLE)

PART 3: EXECUTION

3.01 PROTECTION AND SITE CLEANUP

A. At all times during the progress of the work, the Subcontractor shall use all reasonable precautions to prevent either tampering with the existing area conditions or the entrance of foreign material.

B. Immediately upon completion of the work, the Subcontractor shall remove all of his equipment, materials, and supplies from the site of the work. The area shall be thoroughly cleaned by the Subcontractor to the approval of the Contractor. Failure to comply with these requirements shall give authority to other subcontractors or workers, directed by the Contractor, to enter the area and complete the cleanup, etc. The cost of this work shall be deducted from money due or become due to the Subcontractor for site surveying.

PART 4: HEALTH AND SAFETY PROTOCOL

4.01 GENERAL

A. The work to be carried out under these specifications is within a hazardous waste site that is listed on EPA's National Priority List (NPL). Hazardous materials are known to be present in the soils and groundwater of the area.

B. It is anticipated that Level D protection equipment shall be utilized by the Subcontractor's personnel with contingency to upgrade as outlined in Section 4.03.

4.02 SUBCONTRACTOR'S RESPONSIBILITIES

A. The Subcontractor is solely responsible for it's personnel's health and safety. At a minimum, the Subcontractor will be responsible for adherence to the Contractor's health and safety guidelines.

B. The Subcontractor must provide his personnel with all the required health and safety equipment.

Note that the items to be furnished by the Subcontractor for his work crew under different levels of protection are as described below:

- o All Levels - hard hats
  - rubber gloves (butyl, nitrile or neoprene)
  - rubber boots (butyl, nitrile or neoprene) with steel toe and shank
  - coveralls
- o Level D
  - chemical resistant coveralls (i.e., Saranex) <u>optional</u>
  - disposable outer boots (i.e., PVC or equal) <u>optional</u>
- o Level C - Protective clothing and equipment
  - full face, air purifying cannister equipped respirator
  - chemical resistant coveralls (i.e., Saranex)
  - disposable outer boots (i.e., PVC or equal) <u>optional</u>
- o Level B - protective clothing and equipment
  - pressure demand self-contained breathing apparatus SCBA)
  - chemical resistant coveralls (i.e., PVC, rubber or Saranex)
  - disposable outer boots (PVC or equal)

C. The Subcontractor must submit a letter stating that all it's site personnel have been trained and fit tested for the use of air purifying respirators (APR).

4.03 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor will maintain air monitoring stations on a daily basis when any personnel are onsite.

B. Any changes to the level of personal protection will be as defined below:

1. Site Personnel will upgrade to Level C respiratory protection when HNu readings observed in the ambient atmosphere are 5 ppm above background for a 15 minute time weighted average period.

2. When HNu readings observed in the ambient atmosphere are below 5 ppm above background for a 15 minute time weighted average then a downgrading to Level D protection can occur.

3. Site Personnel will: a) upgrade from Level C to Level B respiratory protection: or b) vacate the site when HNu readings observed in the ambient atmosphere are 10 ppm above background for a 15 minute time weighted average.

4. When the HNu readings in the ambient atmosphere exceed 50 ppm above background all work will cease, the site will be vacated and the Regional Health and Safety Supervisor and the Site Manager will be notified.

5. When respirable dust monitor reading of 0.1 mg/m^3 or greater are observed, Level B protection will be worn.

4.04 ONSITE HEALTH AND SAFETY COORDINATOR

Should, for any reason, it be determined that the working conditions are unsafe, the Onsite Health and Safety Coordinator at his/her discretion can terminate the work. The H & S Coordinator is charged with overseeing site health and safety, instrument monitoring, personnel decontamination, control of contaminated material and emergency response measures.

WORK SPECIFICATIONS
NORTH CAVALCADE
WELL INSTALLATION

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The work to be performed under this section includes the furnishing of all labor, equipment, materials, and other facilities and incidentals necessary to perform split spoon sampling and to install monitoring wells at the North Cavalcade Site in Houston, Texas.

B. In general, the overall well construction procedures shall be as follows:

1. site preparation;
2. drilling, sampling, and logging boreholes;
3. well construction including setting the well casing and screen, packing, sealing, and grouting;
4. affixing a permanent well number and well depth with water proof marking substance to the exposed portion of the well casing;
5. developing and completing the well;
6. site cleanup.

C. Approximately 50 additional shallow boreholes shall be sampled continuously using a combination of split spoon or Shelby tube sampling and dry hollow-stem augering technique.

1.02 SCOPE OF WORK - SUMMARY DESCRIPTION

A. The well installation program is to be carried out as follows:

1. All wells drilled will be identified by one of two categories, shallow or deep. The actual depth of each well will be determined by the Engineer.

   A total of nine (9) shallow wells and one (1) deep well is to be completed. The following well depths are only rough estimates and meant for comparison only.

Well Type	Depth (feet)
Shallow	20
Deep	250

The installation of the deep well is optional and contingent upon the results of the shallow well sampling. The deep well installation costs should be bid as a separate item.

2. The wells shall be drilled plumb and free of obstruction to the designated depth. The boreholes shall be of sufficient nominal diameter to provide a minimum annular space of 1 1/2 inches around the casing.

3. Shallow wells shall be drilled using a combination of split spoon or Shelby tube sampling and dry hollow-stem augering technique. Continuous soil samples shall be taken to a depth of five feet below the base of the shallow aquifer.

4. The deep well shall be drilled using a telescoping procedure so that the possibility of contamination by the uppermost aquifer is minimized. Soil samples shall be collected at five-foot intervals to 50 feet, at ten-foot intervals thereafter, and at each change in materials. Samples shall be collected immediately above and below the target horizon.

5. All drilling mud and cuttings shall be collected, containerized, and stored in compliance with RCRA (no permit required) for disposal onsite or an approved facility. Drums for waste disposal are to be provided by the drilling Subcontractor.

6. Accurately log each well and visually describe the materials encountered using the Unified Soil Classification method. Retain samples as directed by the Engineer.

7. All wells shall be PVC with manufactured PVC screens of 0.010 inch openings. All joints shall be screw threaded or riveted; no cement welded joints are permitted. All well screens and casings shall be thoroughly steam cleaned prior to installation.

   a. Shallow wells may be either 2-inch or 1 1/2-inch, flush-joint, Schedule 40 PVC.

   b. The deep well shall have a minimum nominal diameter of four inches and be constructed of Schedule 80 PVC.

8. The shallow well screens shall be of sufficient length to screen the entire thickness of the shallow aquifer plus two feet above the indicated water table. A blank section of casing may be installed below the screen to act as a sediment trap.

9. The deep well screen shall be of sufficient length to screen the entire interval of the deeper aquifer.

10. The entire length of the well screen to two feet above the top of the well screen (if possible) shall be packed with an

appropriate sized material (gravel) to facilitate hydraulic communication between the well and the formation and to prevent clogging of the well screen with fine particles.

11. The annular space immediately above the pack material shall be filled with a high sodium bentonite of thicknesses two and five feet, respectively, for the shallow and deep wells.

12. Each well shall be grouted to the surface with a non-shrink bentonite-cement grout.

13. Each well shall be protected with a lockable steel casing, concrete pad, and cement-filled steel barriers.

14. The proper identification code of each well shall be permanently affixed to the protective casing.

15. Upon completion, and after the grout has been allowed to cure for a minimum of 24 hours, the wells shall be developed using air lift or other appropriate techniques to a sediment-free condition defined as less than 0.01 ml of sand collected in a 1000 ml Imhoff cone when sampled 1 to 2 minutes after start of pumping. Total maximum development time shall be two hours for the shallow wells and ten hours for the deep well (excluding any non-pumping periods of more than 15 minutes).

16. Once free of apparent sediment the shallow wells shall continue to be pumped for a minimum of 30 minutes or five casing volumes, whichever takes longer. The deep well shall continue to be pumped for a minimum of eight hours at ten gallons per minute, or the equivalent volume of water. All water produced by completion or purging must be collected, containerized, and stored in compliance with RCRA (no permit required) for proper disposal. Drums for disposal of produced water are to be provided by the drilling Subcontractor.

B. Approximately 50 additional shallow boreholes shall be drilled using the sampling methods stated in Section 1.02, Part A. Locations shall be determined by the Field Engineer. Each borehole will be grouted to the surface with a non-shrink bentonite-cement grout.

C. Clean up site, remove all residual drilling equipment and trash and make any necessary repairs to property.

1.03 INSURANCE

A. Subcontractor agrees and shall submit evidence to the Engineers before beginning work on the Project that he has procured and will maintain such insurance as is described in the Engineers Standard Subcontractor Agreement.

1.04 SITE DESCRIPTION

A. Each site will be visited and staked prior to mobilization of the drilling Subcontractor and access assured.

B. The drilling Subcontractor shall be responsible for clearing brush and other minor obstructions if necessary. However, the onsite representative shall be notified prior to any site clearing work.

1.05 QUALIFICATIONS

A. The Subcontractor responsible for constructing the wells shall be a reputable well contractor employing only competent workmen for the execution of this work. All such work shall be performed under the direct supervision of an experienced well driller satisfactory to the Owner's representative.

B. The well driller shall be capable of identifying geologic formations, maintaining complete and current well logs and daily notes for the well completion report, and developing and testing the wells.

C. The Engineer may make any other investigations deemed necessary to determine the ability of the Subcontractor to perform the work, and the Subcontractor shall furnish to the Engineer all such information and data for this purpose as the Engineer may request.

D. The Subcontractor shall furnish satisfactory evidence upon request that all materials to be furnished in performing the work are new and all equipment to be used is in good working order.

E. The Subcontractor shall complete the work described in this Section in accordance with applicable portions of all federal, state, and local laws and regulations.

1.06 SUBMITTALS

A. Copies of all materials required to establish compliance with the specifications shall be submitted to the Engineer.

B. During drilling, the Subcontractor shall maintain at the well site a complete log setting forth the following:

1. The reference point for all depth measurements.
2. The depth at which each change of formation occurs.
3. The identification of the material of which each stratum is composed (Unified Soil Classification, at minimum).
4. The depth interval from which formation samples were taken.
5. Other pertinent data requested by the Engineer.

C. During drilling, a daily detailed driller's report shall be maintained and submitted if requested by Engineer. The report shall give a complete description of all formations encountered, number of feet drilled, number of hours on the job, shutdown due to breakdown, feet of casing set, and other pertinent data requested by the Engineer.

D. During drilling of each well, formation samples shall be collected and preserved immediately after retrieval in a manner approved by the Engineer. Samples shall be clearly and indelibly labeled with the following information:

1. Location of the well.
2. Name or number of the well.
3. Depth interval represented by the sample.
4. Sampling method.
5. Date taken.

E. Upon completion of each well, the Subcontractor shall also submit to the Engineer a report to include the following:

1. The total depth of the completed well.
2. The depth of location of any lost drilling fluid, drilling materials or tools.
3. Record of the top and bottom depth of each stratum encountered and driller's description of material.
4. The grout intervals. The gravel pack intervals.
5. The complete description (including length, diameter, slot sizes, etc.) of well casings and screens.
6. Other pertinent data requested by the Engineer.

F. Sample containers shall be as approved by the Engineer.

G. Field copies of the logs shall be evaluated by the Onsite Coordinator or Geologist prior to setting the casing and well screen.

1.07 HANDLING OF MATERIALS

A. All equipment parts and materials shall be properly protected so that no damage or deterioration will occur during a prolonged delay from time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment, parts, and materials shall be properly protected against damage at the site. Any equipment, parts and materials damaged, or deemed unacceptable by the Engineer, shall be removed from the site and replaced with new like equipment, parts, or materials by the Subcontractor is at his expense.

1.08 WELL ACCEPTANCE CRITERIA

A. Wells will be accepted by the Engineer when the well is developed to the point that it is producing water free of drilling fluid and is sand- and sediment-free, or a good hydraulic connection between the well and aquifer can be demonstrated.

1.09 SITE PROTECTION

A. Upon completion of the work, the Subcontractor shall restore the site as nearly as possible to the original condition, including the replacement, at the Subcontractor's sole expense, of any facility or landscaping which has been damaged beyond restoration to its original condition, or destroyed.

1.10 ADDITIONAL WORK

A. At the option of the Engineer, additional work may be authorized. Additional work shall be completed at the unit prices bid.

1.11 MEASUREMENT AND PAYMENT

A. Payment of work performed shall be on a basis of unit and lump sum prices bid and actual work performed.

PART 2: PRODUCTS

2.01 CASING

A. Shallow well casings shall be 1 1/2 inch or 2 inch Schedule 40 PVC, threaded or riveted flush-joint. Deep well casing shall be a minimum four inch diameter Schedule 80 PVC, threaded or riveted joints. The surface casing for the deep well should be a large diameter (six inches or larger) steel casing. Factory markings should clearly identify the materials as that which is specified.

2.02 SCREEN

A. Well screen shall be slotted PVC with openings of 0.010 inches and diameter equivalent to the casing.

B. Screens shall be fitted with a plug on one end.

2.03 GRAVEL PACK

A. An approved, commercially available gravel shall be employed as a gravel pack material.

B. The gravel shall be well rounded, washed and properly sized for compatibility with the well screen slot size.

2.04 GROUT

A. A non-shrink bentonite cement grout shall be used in all wells.

2.05 BENTONITE SEALS

A. Bentonite used to form a seal between the gravel pack and grout shall be a high sodium bentonite.

2.06 PROTECTIVE CAPS

A. Each well shall be fitted with a threaded or slip-on cap to prevent the entry of foreign materials into the well.

2.07 STEEL BARRIERS

A. Four-inch diameter steel barrier posts shall be sunk 36-inches into the ground and extend 48-inches above the ground surface. Three posts shall be used for each well, filled with concrete, and equally spaced around the well.

2.08 CONCRETE PAD

A. A 2 ft. x 2 ft. x 4 in. concrete pad shall be poured around the surface casing to prevent surface water from entering the well or well annulus.

2.09 SAFETY EQUIPMENT

A. The Subcontractor shall provide for his employees, and any subcontractors, all equipment necessary to provide adequate safety at the drill sites.

PART 3: EXECUTION

3.01 SITE PROTECTION

A. At all times during the progress of the work the Subcontractor shall use all reasonable precautions to prevent tampering with the wells, or contaminated water, gasoline, etc., and other foreign materials from entering the wells.

3.02 BOREHOLE CONSTRUCTION

A. The diameter of the boreholes shall be of sufficient diameter to provide a minimum annular space of 1 1/2 inches around the casing.

1. Shallow wells shall be bored to a depth of five feet below the base of the shallow aquifer.

2. The deep well shall initially be bored completely through the shallow aquifer, sealed with a steel casing, and then bored though the deep aquifer.

3.03 BOREHOLE SAMPLING

A. Borehole sampling shall be conducted at those intervals stated in Section 1.02 as well as all pronounced changes in stratum and at the termination of the borehole. These samples shall be labeled, packed and given to the Onsite Coordinator.

3.04 CASING AND SCREEN INSTALLATION

A. Every effort shall be made by the Subcontractor to assure casing plumbness and centralization within the borehole.

B. Centralizers may be used to assure casing centralization within the borehole for the deep well.

C. The shallow well casing shall be installed through the hollow stem of the auger as auger is removed from the borehole.

D. The shallow well casing shall be installed through the hollow stem of the auger. In drilling the deep well the well bore should be initially advanced through the shallow aquifer using mud rotary techniques until "clean" materials are encountered in the underlying formation. The underlying formation may be assured to be clean if no indications of the contamination are detected through visual examination of the soils, with the olfactory sense, or with field instruments. A sample from the terminus of this initial boring shall be collected. The well bore should then be sealed off with a large diameter (six inches or more) steel casing cemented into place with non-shrink, bentonite cement grout. Once the grout has set (24 hour minimum) and the well bore inside the surface casing has been thoroughly cleaned, the well bore should be advanced further employing a pure, high sodium bentonite mud of sufficient consistency and weights to insure that its density is greater than the density of any known contaminants of the site (approximately 120 percent the density of water).

E. The casing and screen column shall be secured approximately 1 foot above the bottom of the borehole to allow the gravel pack to form beneath the screen.

F. Casing and screen shall be cleaned as necessary and as directed by the Engineer.

3.05 GRAVEL PACK

A. All wells shall have a gravel pack placed around the well screen up to two feet above the screen, if possible.

B. The gravel pack shall be placed in the well by means of a tremie pipe or other means to insure that no bridging of the hole occurs.

C. The gravel pack shall not extend into any stratum in contact with the stratum that is being cased off.

3.06 BENTONITE SEAL

A. The top of all gravel packs shall be sealed with bentonite prior to grouting. The bentonite pellets shall be placed in a manner similar to the gravel pack, such that any bridging of the hole does not occur.

B. The bentonite seal be a minimum of two (2) feet thick in the shallow wells and five (5) feet thick in the deep well.

C. The bentonite seal shall not extend into any stratum in contact with the stratum that is being screened.

3.07 GROUT

A. All cement grout shall be placed using a tremie pipe or other method as approved by the Engineer.

B. The annular space shall be grouted to the surface and completed with a pad.

C. No additional work shall be carried out on any well for a minimum of 24 hours after grouting, to provide a proper cure.

3.08 WELL DEVELOPMENT

A. Each well shall be developed sufficiently to ensure a good hydraulic connection with the aquifer for the well to be acceptable.

B. Each well shall be developed by pumping, surging, or air lifting until groundwater produced is clear of all turbidity and sedimentary particles from the drilling mud and surrounding formation and continue to be pumped for a period of time stated in Section 1.02.

3.09 WELL COMPLETION

A. The casing shall be cut off at a point 24 inches to 36 inches above the ground surface and fitted with a threaded or slip-on type cap.

B. Each well shall be adequately protected with a lockable steel casing, concrete pad, and cement-filled barriers. In the case of the deep well, the surface casing may be used as the protective casing.

C. Each well shall be permanently marked with its depth, measuring point and identification number.

3.10 WELL ABANDONMENT

A. In the event that the Subcontractor shall fail to sink the well to the depth specified or to such other depths as directed by the

Engineer, or should abandon the well because of loss of tools or for any other cause, he shall, as requested and directed by the Engineer, plug the well with non-shrink cement/bentonite grout from the bottom of the hole upwards to ground level in one operation at no additional cost.

PART 4: HEALTH AND SAFETY PROTOCOL

4.01 GENERAL

A. The work to be carried out under these specifications is within a hazardous waste site that is listed on EPA's National Priority List (NPL). Hazardous materials are known to be present in the soils and groundwater of the area.

B. It is anticipated that Level D protection equipment shall be utilized by the Subcontractor's personnel with contingency to upgrade as outlined in Section 4.03.

4.02 SUBCONTRACTOR'S RESPONSIBILITIES

A. The Subcontractor is solely responsible for it's personnel's health and safety. At a minimum, the Subcontractor will be responsible for adhering to the Contractor's health and safety guidelines.

B. The Subcontractor must provide his personnel with all the required health and safety equipment.

Note that the items to be furnished by the Subcontractor for his work crew under different levels of protection are as described below:

o All Levels - hard hats
  - rubber gloves (butyl, nitrile or neoprene)
  - rubber boots (butyl, nitrile or neoprene) with steel toe and shank
  - coveralls

o Level D

  - chemical resistant coveralls (i.e., Saranex) optional
  - disposable outer boots (i.e., PVC or equal) optional

o Level C - Protective clothing and equipment

  - full face, air purifying cannister equipped respirator
  - chemical resistant coveralls (i.e., Saranex)
  - disposable outer boots (i.e., PVC or equal) optional

o Level B - protective clothing and equipment

  - pressure demand self-contained breathing apparatus (SCBA)
  - chemical resistant coveralls (i.e., PVC, rubber or Saranex)
  - disposable outer boots (PVC or equal)

C. The Subcontractor must submit a letter stating that all it's site personnel have been trained and fit tested for the use of air purifying respirators (APR).

4.03 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor will maintain air monitoring stations on a daily basis when any personnel are onsite.

B. Any changes to the level of personal protection will be as defined below:

1. Site Personnel will upgrade to Level C respiratory protection when HNu readings observed in the ambient atmosphere are 5 ppm above background for a 15 minute time weighted average period.

2. When HNu readings observed in the ambient atmosphere are below 5 ppm above background for a 15 minute time weighted average then a downgrading to Level D protection can occur.

3. Site Personnel will upgrade from Level C to Level B respiratory protection when HNu readings observed in the ambient atmosphere are 10 ppm above background for a 15 minute time weighted average.

4. When the HNu readings in the ambient atmosphere exceed 50 ppm above background all work will cease, the site ~~will be vacated and~~ the ~~Regional Health and Safety~~ Supervisor and the Site Manager will be notified.

5. When respirable dust monitor reading of 0.1 mg/m^3 or greater are observed, Level ~~B~~ protection will be worn.

4.04 ONSITE HEALTH AND SAFETY COORDINATOR

Should, for any reason, it be determined that the working conditions are unsafe, the Onsite Health and Safety Coordinator at his/her discretion can terminate the work. The H & S Coordinator is charged with overseeing site health and safety, instrument monitoring, personnel decontamination, control of contaminated material and emergency response measures.

END OF SECTION

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
1201 ELM STREET
DALLAS, TEXAS 75270

June 7, .985

Dr. Robert S. Kier
Camp, Dresser and McKee
3445 Executive Center Drive
Suite 220
Austin TX 78731

Re: North Cavalcade Street site

Dear Dr. Kier:

Per our conversation of May 22, 1985 I am writing to define EPA's position concerning surface water/sediment sampling and placement of a deep monitoring well at the North Cavalcade site.

(1) Surface Water/Sediment Sampling - The Harris County flood control ditch that divides the site is the discharge path for the sites surface water runoff. A normal and high flow sample from the point where the ditch enters the site and from where the ditch leaves the site will be adequate to determine if the surface water/sediment is conveying contaminants from the site. If, based on EPA's review of the lab results, significant quantities of contaminants are leaving the site, the sampling program will be expanded to determine the source of the contamination.

(2) Deep Monitoring Well - The placement of a monitoring well to sample the "200 foot" aquifer is to be optional. Only if, based on EPA's review of the soil samples and/or other facts, contamination of the "200 foot" aquifer appears to be possible, then the deep monitoring well will be installed. Camp, Dresser and McKee will include the cost of this monitoring well in costing the Remedial Investigation/Feasibility Study.

If you have any questions please feel free to call me at (214)-767-9763.

Sincerely yours,

John Cochran

John Cochran
Regional Site Project Officer