Section III: Appendix

1.	Agreement Statement	Appendix A
2.	Site Safety Plan Agreement	Appendix B
3.	Hazard Waiver	Appendix C
4.	Hazard Evaluation Guidelines	Appendix D
5.	Accident/Incident/Near Miss	Appendix E
6.	Project Personnel	Appendix F

Section IV: Material Safety Data Sheets

1. Benzene
2. Ethylbenzene
3. Gasolines: Automotive
4. Kerosene
5. Oils, Fuel 1-D
6. Oils, Fuel 2-D
7. Polychlorinated Biphenyl
8. Toluene
9. m-Xylene
10. o-Xylene
11. p-Xylene

Section V: Site Description and History - _____ Engineers

1. Introduction

The Harrison Garage Project will be divided into five phases as follows:

1. Phase I: Removal of two subsurface gasoline tanks and associated piping and pumps.

2. Phase II: Removal of hydraulic lifts in the service area garage (Harrison Street).

3. Phase III: Removal of two waste oil tanks, an asbestos lagged pipe and possibly the removal of an additional hydraulic lift in the basement (Alice Street).

4. Phase IV: Scoping of subsurface contamination.

5. Phase V: Remediation of contamination.

This Site Safety Plan is applicable to all phases. The starting and sequence of each phase will depend on the arrangement among the interested parties.

1.1 Background

Alvin Bacharach and Barbara Jean Borsuk have retained _____ to assess site conditions and provide a Site Safety Plan at 1432-1434 Harrison Street and 1435 Alice Street Garages, Oakland, California (Section 5). The purpose of the Site Safety Plan (SSP) is to provide _____ Engineers, _____ field personnel and subcontractors with an understanding of the potential chemical and physical hazards that exist or may arise while the tasks of this project are performed.

This SSP describes the procedures to be followed to reduce employee exposure to potential health hazards that may be present on the project site. The emergency response procedures necessary to respond to such hazards are also described within this SSP. The SSP is primarily designed to guide project personnel on how to respond to normal or extreme conditions that may arise during the project execution. Some of the site characterizations contained in the SSP are based on the site assessment reports of Subsurface Consultant, _____ Engineers, and _____. Data from Chromolab laboratory analyses and results of samples from the subject site were also considered. See Appendix G for detailed site assessment reports.

Normal conditions are when the petroleum hydrocarbon vapors in the ambient air are below 50 ppm as monitored with an OVA. Conditions are extreme when the petroleum hydrocarbon vapors in the ambient air are above 50 ppm as monitored with an OVA.

1.2 Objective

The primary objective is to ensure the well being of observers, field personnel and the community surrounding the subject property. To do this, project staff, client personnel and approved subcontractors shall acknowledge and adhere to the policies and procedures established herein. Accordingly, all personnel assigned to this project shall read this SSP and sign the Agreements and Acknowledgement Statement (Appendix A)

ambient air with an O_2/LEL meter. If the LEL reading exceeds 20%, leave the site immediately and contact the fire department.

- Contamination: Contact with contaminated surface or surfaces suspected of being contaminated should be avoided. This includes working through, kneeling or placing equipment in puddles, mud, discolored surfaces or on drums and other containers. Eating, smoking, drinking and/or the application of cosmetics is prohibited on this site in the immediate work area. This reduces the likelihood of contamination by ingestion.

- Falling Objects: Hard hats must be worn by all project staff and observers whenever construction activity is taking place (i.e., drilling, excavation, etc.).

- Vehicle Traffic: All project staff and observers will be required to wear a fluorescent safety vest at all times while on site. In addition, use flags, tapes, barricades and cones to designate restricted areas.

- Explosion Protection: Explosion-proof lighting will be used in the basement area during all work. Explosion-proof ventilation equipment will be used to control airborne contaminant levels during all work within the garage area. See Table II for the location of ventilation equipment and other precautions needed.

2.3.2 Well Installation, Development, Gauging, Baling, Sampling

Skin and eye contact with contaminated groundwater and/or soil may occur during these tasks. Butyl nitrile rubber or neoprene gloves and approved safety goggles should be worn when contact with contaminated substance and/or splash is possible.

2.3.3 Samples Preservation

When hydrochloric acid (HCL) is used, skin and eye contact can occur. This hazard can be reduced with the use of butyl nitrile rubber or neoprene gloves and the use of safety goggles.

2.3.4 Cleaning Equipment

Skin and eye contact with trisodium phosphate methanol or other cleaning substances can occur while cleaning equipment. This hazard can be reduced with the use of butyl nitrile rubber or neoprene gloves and the use of safety goggles.

3. Personnel Protective Equipment

3.1 Acceptable Levels

Level D is the minimum acceptable level for this site in non-confined areas. Level C is acceptable for this site in confined areas.

Modified Level D/Sidewalk:

- Cover-alls work uniform
- Steel toe and shank boots
- Butyl nitrile rubber or neoprene gloves (optional)
- Splash goggles/safety glasses if potential for splash
- Hard hat
- Fluorescent vest
- Tyvek suit (optional)
- Hearing protection (as appropriate)

Level C/Inside Building (Confined Areas):

- full face respirator, NIOSH approved, with organic vapor cartridges
- Tyvek suits (if splash hazard is possible, a coated suit must be worn)
- Butyl nitrile rubber or neoprene gloves
- Steel toe and shank boots
- Outer Boots/chemical resistant
- inner disposable gloves (two pair recommended)
- hard hat
- fluorescent vest
- hearing protection (as appropriate)

Level B:

- air supplied respirator
- coated Tyvek suit, such as Saranex
- Butyl nitrile rubber or neoprene gloves
- Inner latex or vinyl gloves
- Steel toe and shank boots
- Outer boots/chemical resistant
- Hard hat
- Fluorescent vest
- Hearing protection (as appropriate)

Level A: This is the highest level of skin and respiratory protection. It includes all of Level B.

4. Decontamination Procedures

4.1 Procedures

All operations conducted at this site have the potential to contaminate monitoring equipment and personnel protective equipment (PPE). To prevent the transfer of contamination to vehicles, administrative areas and personnel, the following procedures must be followed:

the Material Safety Data Sheets located in Section 4. The following is a health analysis of these chemicals:

Gasoline constituents can be divided into five major groups: alkanes, alkenes, cycloalkanes, aromatics and additives. The aromatics are the constituents generally regarded to be of the greatest toxic concern. The major aromatics in gasoline are benzene, toluene, ethyl benzene and xylene. Of these, benzene is considered the most toxic. One characteristic effect of gasoline and its aromatic constituents is their ability to irritate the skin when repeated or prolonged exposure occurs.

Benzene

Benzene can enter the body through inhalation, ingestion and skin contact. Studies have noted that chronic exposure to benzene vapor can produce neurotoxic and hemotopoietic (blood system) effects. Other effects can include headache, dizziness, nausea, convulsions, coma and possible death if exposure is not reversed. One significant effect from chronic benzene exposure is bone marrow toxicity. There is also an association between chronic exposures to benzene and the development of certain types of leukemia.

Toluene

Inhalation exposure to toluene vapor can produce effects such as central nervous system depression. Depending on exposure factors signs and symptoms can include headache, dizziness, fatigue, muscular weakness, incoordination, drowsiness, collapse and possible coma. Toluene can be a skin and mucous membrane irritant and studies have shown that high levels of toluene exposure can cause liver and kidney damage.

Ethylbenzene

Exposure to ethyl benzene at high vapor concentrations may produce irritation to the skin, eyes and upper respiratory tract. Overexposure to ethyl benzene vapors can produce central nervous system depression with symptoms of headache, nausea, dizziness, shortness of breath and unsteadiness. Prolonged skin exposure to ethyl benzene may result in drying and cracking of the skin (dermatitis). Solvent resistant gloves should be worn during sampling to prevent exposure to the skin.

Xylenes

Depending on exposure factors, inhalation exposure to xylene vapor may produce central nervous system excitation followed by depression. Exposure to xylene vapor can produce dizziness, staggering, drowsiness and unconsciousness. At very high concentrations, xylene vapor may produce lung irritation, nausea, vomiting and abdominal pain. Xylene is not known to possess the chronic bone marrow toxicity of benzene, but liver enlargement and nerve-cell damage have been noted from chronic overexposure.

Diesel/Kerosene

Diesel and kerosene fuel components are less volatile than gasoline. Alphatic hydrocarbons may be saturated or unsaturated open chain, branched or unbranched molecule. Health precautions include ventilation for confined spaces. Symptoms of over exposure include nausea, vomiting, lung irritation and headache.

Tasks Performed Within a Confined Space

- The scope of work for this project does not include confined space entry such as tanks, but will entail work within a building which, for the purposes of this plan, is considered a confined area. All work within confined areas requires the use of Level C protective equipment (see Section 3.0).

  All monitoring equipment must be calibrated and maintained in accordance with manufacturer's recommendations.

7. Health and Safety Requirements

7.1 Medical Monitoring Program

All _____ and _____ field personnel must have annual medical evaluations in accordance with the company's Health and Safety Program policy. Additional reevaluation will be considered in the event of chemical over-exposure while working on this project.

The petrochemicals typical of petroleum hydrocarbons can affect specific organ systems producing characteristic health effects. The medical evaluation will, therefore, focus on the liver, kidney, nervous system, blood systems, and skin and lung function. Laboratory testing will include complete blood count, and applicable kidney and liver-function tests. Other tests include skin examinations.

7.2 Training

All personnel working on tank removal at this site should have received a minimum of 40 hours of initial hazardous waste activity instruction and a minimum of three days of field experience under the direct supervision of a trained, experienced person. Personnel assigned to the site are also required to have eight hours refresher training per year. On-site managers and supervisors directly responsible for employees engaged in hazardous waste operations are required to have had an additional eight hours of supervisory training. These training requirements comply with the OSHA Hazardous Waste Operations and Emergency Response regulation, 29 CFR 1910.120.

The initial 40-hour training and the 8 hour annual refresher training includes specific details on the following:

- Regulatory Requirements
- First Aid/CPR
- Confined Space Entry
- Respiratory Protection
- Air Monitoring
- Decontamination Procedures
- Hazard Communication
- Toxicology

These specifics are then complimented with actual hands-on experience with use of personal protective equipment and air monitoring equipment.

hand). The GFCI does provide protection against the most common form of electrical shock hazard, the ground fault. It also provides protection against fires, overheating, and destruction of insulation on wiring.

GFCIs can be used successfully to reduce electrical hazards on construction sites. Tripping of GFCIs - interruption of current flow - can be caused by wet connectors and tools. It is good practice to limit exposure of connectors and tools to excessive moisture by using watertight or sealable connectors. Providing more GFCIs or shorter circuits can prevent tripping caused by the cumulative leakage from several tools or by leakages from extremely long circuits. (Adapted from OSHA 3007; Ground-Fault Protection on Construction Sites, 1987).

7.7 Fire Prevention

During equipment operation, periodic vapor concentration measurements should be taken with an explosimeter or combustimeter. If at any time the vapor concentrations exceed 20% of LEL, then the Site Safety Officer or designated field worker should immediately shut down all operations.

Only Factory Mutual (FM) approved fire safety cans will be used to transport and store flammable liquids.

All gasoline and diesel-driven engines requiring refueling must be shut down and allowed to cool before filling.

Smoking is not allowed during any operations within the work area in which petroleum products or solvents in free-floating, dissolved or vapor forms, or other flammable liquids may be present.

No open flame or spark is allowed in any area containing petroleum products or other flammable liquids.

7.8 General Health

Medicine and alcohol can increase the effects of exposure to toxic chemicals. Unless specifically approved by a qualified physician, prescription drugs should not be taken by personnel assigned to operations where the potential for absorption, inhalation, or ingestion of toxic substances exists.

Drinking alcoholic beverages is prohibited. Drinking alcoholic beverages and driving is prohibited at any time. Driving at excessive speeds is always prohibited.

Skin abrasions must be thoroughly protected to prevent chemicals from penetrating the abrasion.

It is recommended that contact lenses not be worn by persons working on the site.

7.9 MSDS Information

Material Safety Data Sheets (MSDS) on chemical substances encountered at the site shall be made available to all persons (including subcontractors) working at the site. The MSDSs shall be enclosed within this Site Safety Plan in Section 4).

9. Emergency Response

9.1 Emergency Response Procedure

In the event of an accident or emergency, immediate action must be taken by the first person to recognize the event. First aid equipment is located on site inside the vehicle. Notify (1) the Site Safety Officer and (2) the Project Manager and Health and Safety Manager about the situation immediately after emergency procedures are implemented.

9.2 Emergency Telephone Numbers:

Emergency:	Phone
Local Police	911
Fire	911
State Police	911
Ambulance	911
Underground Service Alert (USA)	(800) 642-2444
Gas Company	834-1234
Electric Company	834-1234
Telephone Company	811-9000

Primary Hospital:

Peralta Hospital
450 30th Street
Oakland, CA
(510) 451-4900

Directions: From the site, go west on 14th Street to Martin Luther King, Jr. Way. Go north on Martin Luther King, Jr. Way to 20th Street. Go east on 20th Street to Telegraph Avenue, from here go north to the intersection of Telegraph Avenue and 30th Street. The hospital is the right side of the street.

Back-up Hospital:

Merrit Hospital
Hawthorne & Webster Street
Oakland, CA
(510) 655-4000

Directions: From the site, go west on 14th Street to Broadway. Turn right on Broadway. Turn left (west) on 34th Street. Proceed for about one and one half blocks. The hospital is on the left side of the street.

2. Send/take this SSP with the attached MSDSs to the medical facility with injured person.

3. If the injury is minor, proceed to administer first aid.

4. Notify the Site Safety Officer, Project Manager, and the Health & Safety Hygienists of all accidents, incidents and near-miss situations.

5. Complete Accident/Incident/Near-Miss Form found in Appendix F.

9.5 Emergency Treatment

When transporting an injured person to a hospital, bring this Site Safety Plan to assist medical personnel with diagnosis and treatment. In all cases of chemical overexposure, follow standard procedures as outlined below for poison management, first aid, and, if applicable, cardiopulmonary resuscitation. Four different routes of exposure and their respective first aid/poison management procedures are outlined below:

9.5.1 Ingestion:

DO NOT INDUCE VOMITING. Transport person to nearest hospital immediately.

9.5.2 Inhalation/Confined Space:

DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME UNLESS PROPERLY EQUIPPED WITH A SELF-CONTAINED BREATHING APPARATUS AND HAVE A STANDBY PERSON.

9.5.3 Inhalation/Other:

Remove the person from the contaminated environment. Initiate CPR if necessary. Call or have someone call for medical assistance. Refer to MSDS for additional specific information. If necessary, transport the victim to the nearest hospital as soon as possible.

9.5.4 Skin Contact/Non-Caustic Contaminant (Petroleum, Gasoline, etc.)/PCBs:

Wash off skin with a large amount of water immediately. Remove any contaminated clothing and rewash skin using soap, if available. Transport person to a medical facility if necessary.

9.5.5 Skin contact/Corrosive Contaminant (Acids, Hydrogen Peroxide):

Wash off skin with a large amount of water immediately. Remove any contaminated clothing and rewash skin with water. Transport person to a medical facility if necessary.

9.5.6 Eyes:

Hold eyelids open and rinse the eyes immediately with large amounts of water for 15 minutes. If possible, have the person remove his/her contact lenses (if worn). Never permit the eyes to be rubbed. Transport person to a medical facility as soon as possible.

be used. The frequency of use may be at the discretion of the site safety manager. The use of a mobile laboratory here will have the same advantage as mentioned above.

12. Removal of Tanks on Harrison Street

12.1 Tank Removal Procedure

The removal of tanks on the Harrison street sidewalk includes the gasoline dispensers and associated pipings. Activities here are not considered to be in a confined space. Due to traffic and pedestrians, work area must be sealed with caution tapes and reflective cones. Items needed in this area will include OVA, vapor suppressing foam, trench plates, shoring and dewatering equipment. Conditions that will necessitate the use of shoring and dewatering equipment have been mentioned above. Trench plates will be needed when the tank excavation, cleaning and removal are not accomplished in a day's operation. In such a situation, trench plates will be used to cover the excavated pit. This will prevent accidents happening at any time when the pit is unattended. The OVA will be used to monitor the ambient air. The reading from the OVA will indicate the frequency at which the vapor suppressing foam will be used. The cut-off point will be 50 ppm, or at the discretion of the site safety manager. It is advisable that a vacuum truck be on standby should a pool of free product be encountered. The advantages of using a mobile laboratory here is the same as above.

13. Asbestos Removal in the Basement

13.1 Basement Asbestos Removal Procedure

Abatement of asbestos materials will be completed within the basement prior to any tank removal. Abatement will be completed via glove bag techniques.

APPENDIX B

Site Safety Plan Amendment Sheet

Project Name:

Project Number:

Location:

Changes in field activities or hazards:

Proposed Amendment:

Proposed By:
Date:

Approved By (Project Manager):
Date:

Approved By (Health & Safety Manager):
Date:

Declined By:
Date:

Amendment Number:
Amendment Effective Date:

APPENDIX D

Definition of Hazard Evaluation Guidelines

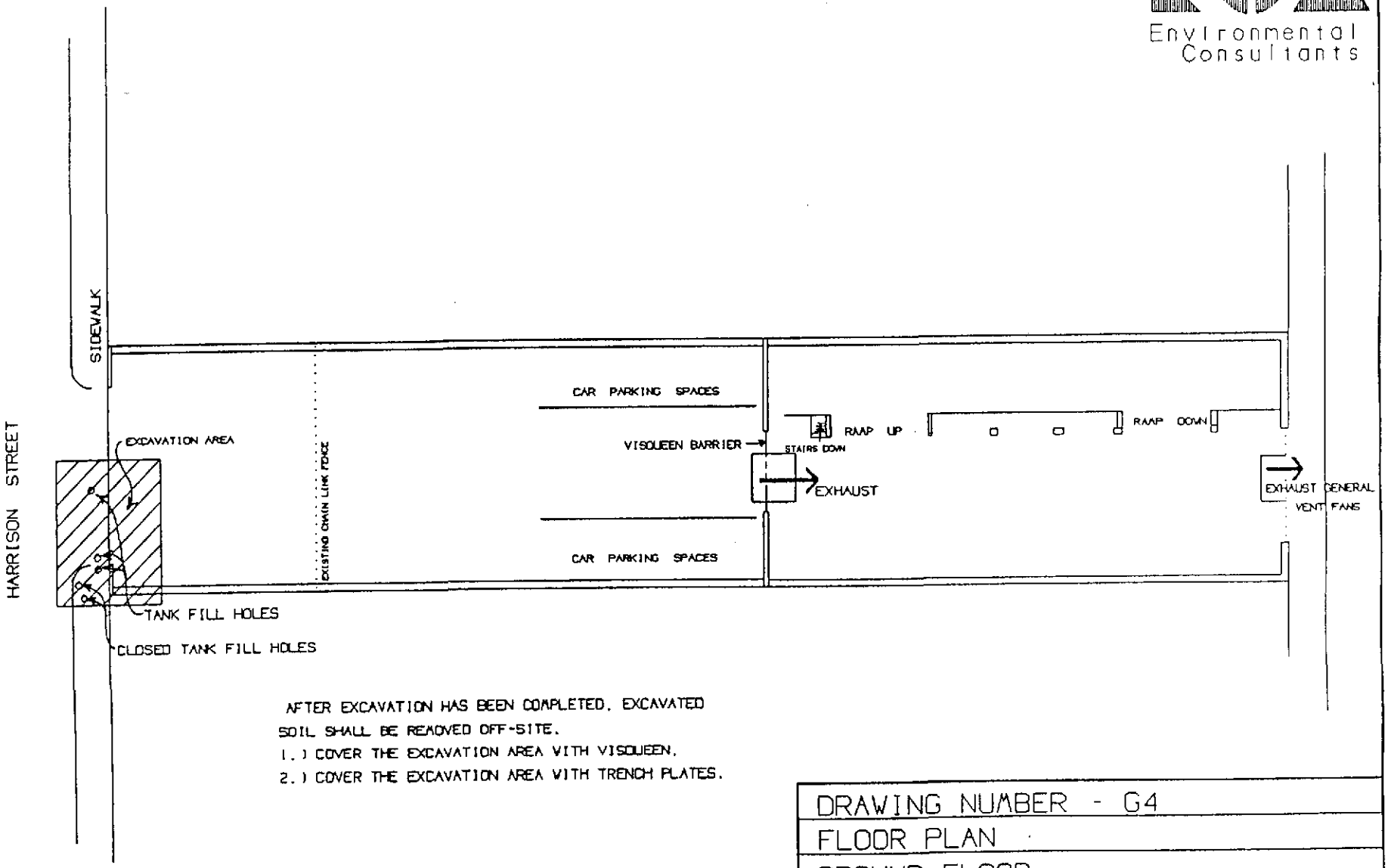
Hazard: Airborne Contaminants

Guideline	Explanation
Threshold Limit Value Time-Weighted Average (TLV-TWA)	The time weighted average concentration for a normal eight hour work day and a forty hour work week, to which nearly all workers may be repeatedly exposed without adverse effect.
Permissible Exposure Limit (PEL)	Time weighted average concentrations similar to (and in many cases derived from) the Threshold Limit Values.
Immediately Dangerous to Life and Health (IDLH)	"IDLH" or "Immediately dangerous to life or health" means any atmospheric condition that poses an immediate threat to life, or that is likely to result in acute or immediate severe health effects. This includes oxygen deficiency conditions.

Hazard: Explosion

Guideline	Explanation
Lower Explosive Limit (LEL)	The minimum concentration of vapor in air below which propagation of a flame will not occur in the presence of an ignition source.
Upper Explosive Limit (UEL)	The maximum concentration of vapor in air above which propagation of a flame will not occur in the presence of an ignition source.

RGA
Environmental
Consultants



AFTER EXCAVATION HAS BEEN COMPLETED, EXCAVATED SOIL SHALL BE REMOVED OFF-SITE.

1.) COVER THE EXCAVATION AREA WITH VISQUEEN.

2.) COVER THE EXCAVATION AREA WITH TRENCH PLATES.

DRAWING IS SCHEMATIC

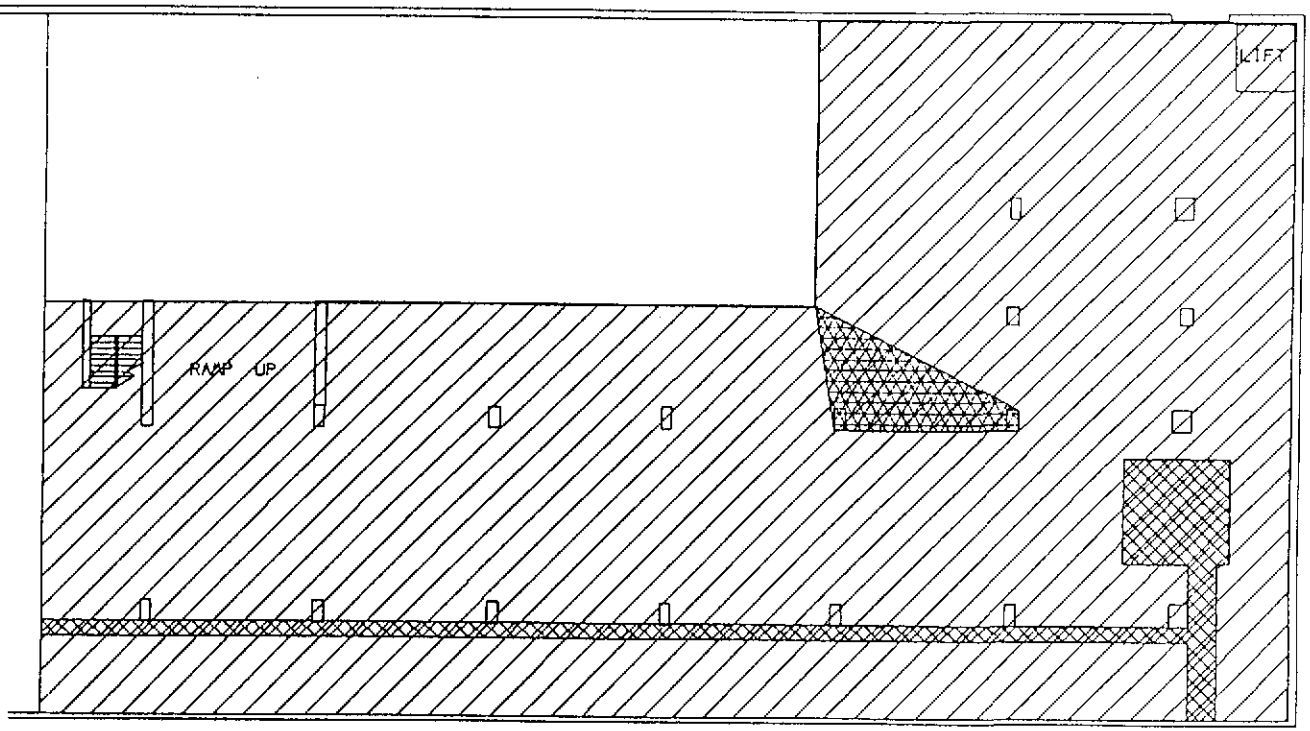
SCALE IS APPROXIMATE

LOCATIONS ARE APPROXIMATE

DRAWING NUMBER - G4
FLOOR PLAN
GROUND FLOOR
HARRISON STREET GARAGE
VENTILATION PLAN - TANK REMOVAL
APPROXIMATE SCALE: 1" = 40'

Environmental Consultants

CONTRACTOR SHALL SECURE AREA PRIOR TO EXCAVATION.



- AREA WHERE CONCRETE HAS BEEN CUT FROM SLAB

- AREA OF CONCRETE RUBBLE

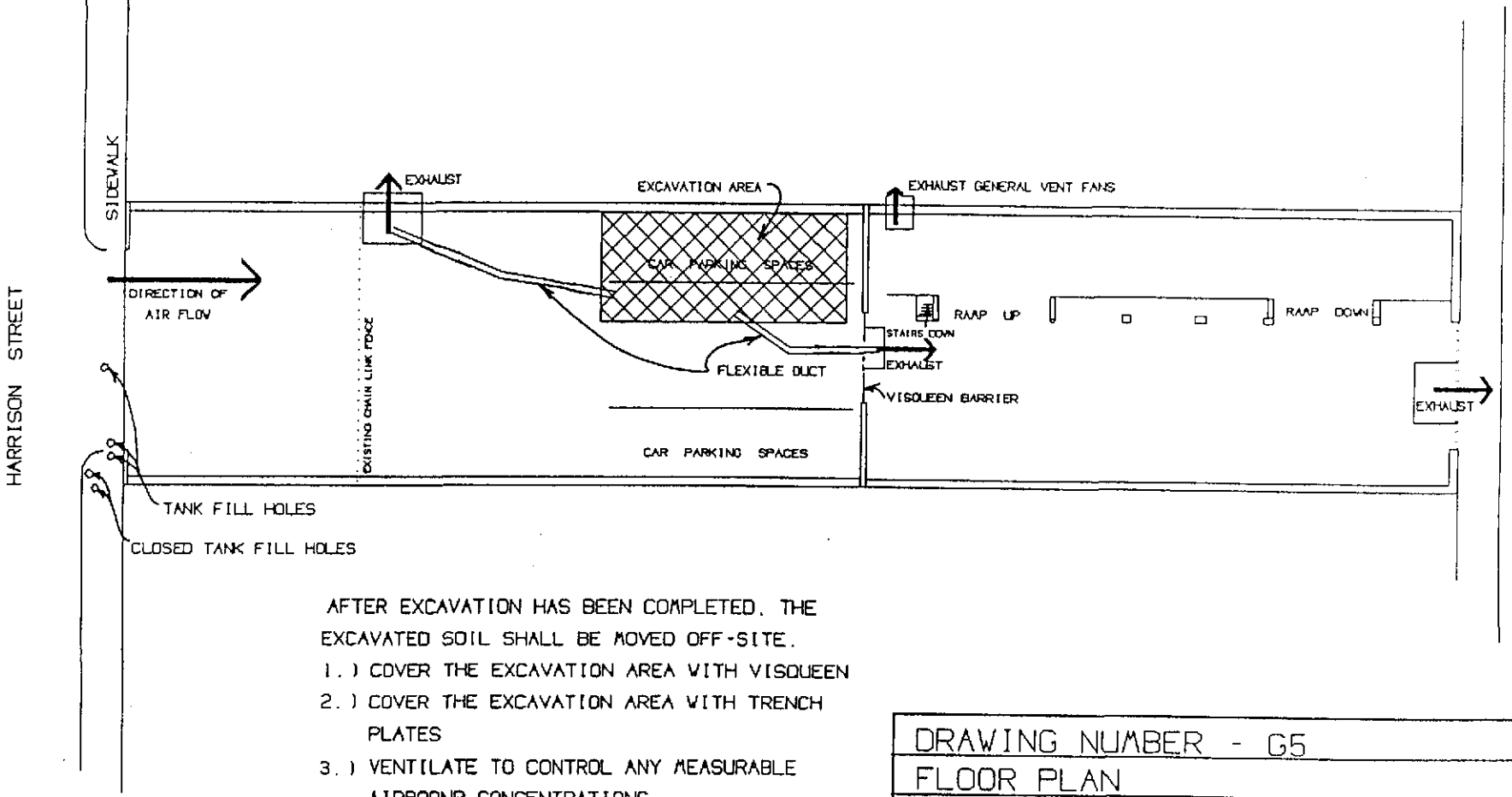
- CONFINED SPACE

DRAWING IS SCHEMATIC
SCALE IS APPROXIMATE
LOCATIONS ARE APPROXIMATE

DRAWING NUMBER - G2
FLOOR PLAN
BASEMENT LEVEL
HARRISON STREET GARAGE
CONFINED SPACE
APPROXIMATE SCALE: 1" = 25'

Environmental Consultants

1. CONTRACTOR SHALL SECURE AREA PRIOR TO EXCAVATION.



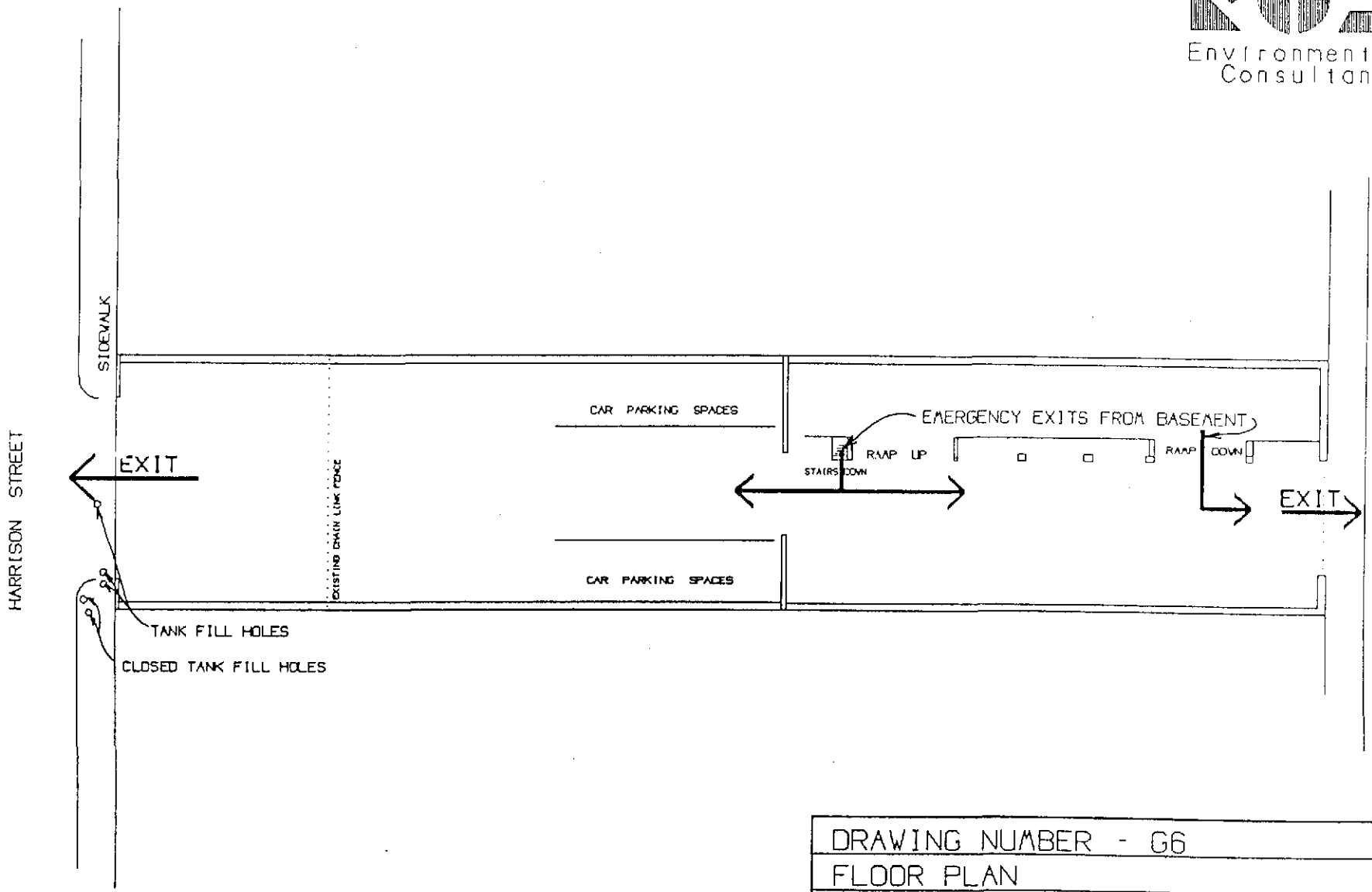
AFTER EXCAVATION HAS BEEN COMPLETED, THE EXCAVATED SOIL SHALL BE MOVED OFF-SITE.

1.) COVER THE EXCAVATION AREA WITH VISQUEEN
2.) COVER THE EXCAVATION AREA WITH TRENCH PLATES
3.) VENTILATE TO CONTROL ANY MEASURABLE AIRBORNR CONCENTRATIONS.

DRAWING IS SCHEMATIC
SCALE IS APPROXIMATE
LOCATIONS ARE APPROXIMATE

DRAWING NUMBER - G5
FLOOR PLAN
GROUND FLOOR
HARRISON STREET GARAGE
VENTILATION PLAN
APPROXIMATE SCALE: 1" = 40'

RGA
Environmental
Consultants



DRAWING IS SCHEMATIC
SCALE IS APPROXIMATE
LOCATIONS ARE APPROXIMATE

DRAWING NUMBER - G6
FLOOR PLAN
GROUND FLOOR
HARRISON STREET GARAGE
EMERGENCY EXITS
APPROXIMATE SCALE: 1" = 40'

BENZENE

BNZ

Common Synonyms	Watery liquid	Colorless	Gasoline-like odor
Benzol Benzole	Floats on water. Flammable, irritating vapor is produced. Freezing point is 42°F.		

Avoid contact with liquid and vapor. Keep people away.
Wear goggles and self-contained breathing apparatus.
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Ignite and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.

Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.
VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.

Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.
LIQUID
Irritating to 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.

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)

Issue warning-high flammability
Restrict access

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: C_6H_6
3.3 IMO/UN Designation: 3.2/1114
3.4 DOT ID No.: 1114
3.5 CAS Registry No.: 71-43-2

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Aromatic; rather pleasant aromatic odor; characteristic odor

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Hydrocarbon vapor canister, supplied air or a hose mask; hydrocarbon-insoluble rubber or plastic gloves, chemical goggles or face splash shield; hydrocarbon-insoluble apron such as neoprene.
5.2 Symptoms Following Exposure: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death.
5.3 Treatment of Exposure: SKIN: flush with water followed by soap and water; remove contaminated clothing and wash skin. EYES: flush with plenty of water until irritation subsides. INHALATION: remove from exposure immediately. Call a physician. IF breathing is irregular or stopped, start resuscitation, administer oxygen.
5.4 Threshold Limit Value: 10 ppm
5.5 Short Term Inhalation Limits: 75 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 Late Toxicity: Leukemia
5.8 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors may cause irritation of eyes or respiratory system. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 4.68 ppm
5.11 IDLH Value: 2,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 12°F C.C.
6.2 Flammable Limits in Air: 1.3%-7.9%
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 1097°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 6.6 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity:
5 ppm/8 hr/minnow/lethal/distilled water
20 ppm/24 hr/sunfish/TL_m/tap water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 1.2 lb/lb, 10 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity:
Industrial pure .....99+ %
Thiophene-free .....99+ %
Nitration .....99+ %
Industrial 90% .....85+ %
Reagent .....99+ %
9.2 Storage Temperature: Open
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U-V-W

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	3
Water Pollution	
Human Toxicity	3
Aquatic Toxicity	1
Aesthetic Effect	3
Reactivity	
Other Chemicals	2
Water	1
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 78.11
12.3 Boiling Point at 1 atm: 176°F = 80.1°C = 353.3°K
12.4 Freezing Point: 42.0°F = 5.5°C = 278.7°K
12.5 Critical Temperature: 552.0°F = 288.9°C = 562.1°K
12.6 Critical Pressure: 710 psa = 48.3 atm = 4.89 MN/m²
12.7 Specific Gravity: 0.879 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.9 dynes/cm = 0.0289 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 35.0 dynes/cm = 0.035 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 2.7
12.11 Ratio of Specific Heats of Vapor (Gas): 1.061
12.12 Latent Heat of Vaporization: 169 Btu/lb = 94.1 cal/g = 3.94 X 10^5 J/kg
12.13 Heat of Combustion: −17,480 Btu/lb = −9698 cal/g = −406.0 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 30.45 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 3.22 psia

NOTES

ETHYLBENZENE

ETB

Common Synonyms	Liquid	Colorless	Sweet, gasoline-like odor
Phenylethane EB	Floats on water. Flammable, irritating vapor is produced.		

Avoid contact with liquid and vapor. Keep people away.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Shut off ignition sources and call fire department.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

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.
Fouling to shoreline.
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)

Mechanical containment
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic hydrocarbon
3.2 Formula: $C_6H_5CH_2CH_3$
3.3 IMO/UN Designation: 3.3/1175
3.4 DOT ID No.: 1175
3.5 CAS Registry No.: 100-41-4

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Self-contained breathing apparatus, safety goggles.
5.2 Symptoms Following Exposure: Inhalation may cause irritation of nose, dizziness, depression. Moderate irritation of eye with corneal injury possible. Irritates skin and may cause blisters.
5.3 Treatment of Exposure: INHALATION: If ill effects occur, remove victim to fresh air, keep him warm and quiet, and get medical help promptly. If breathing stops, give artificial respiration. INGESTION: Induce vomiting only upon physician's approval, material in lung may cause chemical pneumonitis. SKIN AND EYES: promptly flush with plenty of water (15 min. for eyes) and get medical attention; remove and wash contaminated clothing before reuse.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 200 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg (rat)
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: Causes smarting of the skin and first-degree burns on short exposure; may cause secondary burns on long exposure.
5.10 Odor Threshold: 140 ppm
5.11 IDLH Value: 2,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 80°F O.C.; 59°F C.C.
6.2 Flammable Limits in Air: 1.0%-6.7%
6.3 Fire Extinguishing Agents: Foam (most effective); water fog, carbon dioxide or dry chemical
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Irritating vapors are generated when heated.
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to the source of ignition and flash back.
6.7 Ignition Temperature: 860°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 5.8 mm/min
6.10 Adiabatic Flame Temperature: Data Not Available

(Continued)

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
7.7 Molar Ratio (Reactant to Product): Data Not Available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: 29 ppm/96 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 2.8% (theor.), 5 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research grade: 99.98%, pure grade: 99.5%; technical grade: 99.0%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	2
Liquid or Solid Irritant	2
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.17
12.3 Boiling Point at 1 atm: 277.2°F = 136.2°C = 409.4°K
12.4 Freezing Point: −139°F = −95°C = 178°K
12.5 Critical Temperature: 651.0°F = 343.9°C = 617.1°K
12.6 Critical Pressure: 523 psia = 35.6 atm = 3.61 MN/m²
12.7 Specific Gravity: 0.867 at 20°C (liquid)
12.8 Liquid Surface Tension: 29.2 dynes/cm = 0.0292 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 35.46 dynes/cm = 0.03548 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats at Vapor (Gas): 1.071
12.12 Latent Heat of Vaporization: 144 Btu/lb = 80.1 cal/g = 3.35 X 10^4 J/kg
12.13 Heat of Combustion: −17,790 Btu/lb = −9877 cal/g = −413.5 X 10^4 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data Not Available
12.26 Limiting Value: Data Not Available
12.27 Reid Vapor Pressure: 0.4 psia

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data Not Available
6.13 Flame Temperature: Data Not Available

GASOLINES: AUTOMOTIVE (<4.23g lead/gal)

GAT

Common Synonyms	Watery liquid	Colorless to pale brown or pink	Gasoline odor
Motor spirit Petrol	Floats on water. Flammable, irritating vapor is produced		

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
[illegible]
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness, headache, difficult breathing or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea or vomiting.
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.
Fouling to shoreline.
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)
Issue warning-high flammability
Evacuate area
Disperse and flush

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Miscellaneous Hydrocarbon Mixtures
3.2 Formula: (Mixture of hydrocarbons)
3.3 IMO/UN Designation: 3.1/1203
3.4 DOT ID No.: 1203
3.5 CAS Registry No.: Data not available

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless to brown
4.3 Odor: Gasoline

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Protective goggles, gloves.
5.2 Symptoms Following Exposure: Irritation of mucous membranes and stimulation followed by depression of central nervous system. Breathing of vapor may also cause dizziness, headache, and incoordination or, in more severe cases, anesthesia, coma, and respiratory arrest. If liquid enters lungs, it will cause severe irritation, coughing, gagging, pulmonary edema, and, later, signs of bronchopneumonia and pneumonitis. Swallowing may cause irregular heartbeat.
5.3 Treatment of Exposure: INHALATION: maintain respiration and administer oxygen; enforce bed rest if liquid is in lungs. INGESTION: do NOT induce vomiting, stomach should be lavaged (by doctor) if appreciable quantity is swallowed. EYES: wash with copious quantity of water. SKIN: wipe off and wash with soap and water.
5.4 Threshold Limit Value: 300 ppm
5.5 Short Term Inhalation Limits: 500 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg.
5.7 Late Toxicity: None
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.25 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: −36°F C.C.
6.2 Flammable Limits in Air: 1.4%-7.4%
6.3 Fire Extinguishing Agents: Foam, carbon dioxide, dry chemical
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: None
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 853°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 4 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 33

8. WATER POLLUTION

8.1 Aquatic Toxicity:
90 ppm/24 hr/juvenile American shad/TL_m/fresh water
91 mg/1/24 hr/juvenile American shad/TL_m/salt water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 8%, 5 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Various octane ratings; military specifications
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-T-U-V-W

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations:
Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health:	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	0
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: Not pertinent
12.3 Boiling Point at 1 atm:
140—390°F
= 60—199°C = 333—472°K
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity:
0.7321 at 20°C (liquid)
12.8 Liquid Surface Tension:
19-23 dynes/cm
= 0.019—0.023 N/m at 20°C
12.9 Liquid Water Interfacial Tension:
49-51 dynes/cm
= 0.049—0.051 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 3.4
12.11 Ratio of Specific Heats of Vapor (Gas):
(est.) 1.054
12.12 Latent Heat of Vaporization:
130—150 Btu/lb = 71—81 cal/g
= 3.0 — 3.4 X 10^5 J/kg
12.13 Heat of Combustion: −18,720 Btu/lb
= −10,400 cal/g = 435.1 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 7.4 psi

NOTES

KEROSENE

KRS

Common Synonyms	Watery liquid	Colorless	Fuel oil odor
Illuminating oil Kerosine Range oil Fuel oil No. 1 Jet Fuel JP-1	Floats on water.		

Stop discharge if possible
Call fire department
Avoid contact with liquid
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire

Combustible
Water may be ineffective on fire
Cool exposed containers with water

Exposure

CALL FOR MEDICAL AID

LIQUID
Irritating to 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

Dangerous to aquatic life in high concentrations
Fouling to shoreline
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)

Mechanical containment
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Miscellaneous Hydrocarbon Mixtures
3.2 Formula: C_nH_{2n+2}
3.3 IMO/UN Designation: 3.3/1223
3.4 DOT ID No.: 1223
3.5 CAS Registry No.: 8008-20-6

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless to light brown
4.3 Odor: Characteristic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Protective gloves; goggles or face shield.
5.2 Symptoms Following Exposure: Vapor causes slight irritation of eyes and nose. Liquid irritates stomach, if taken into lungs, causes coughing, distress, and rapidly developing pulmonary edema.
5.3 Treatment of Exposure: ASPIRATION: enforce bed rest, administer oxygen, call a doctor. INGESTION: do NOT induce vomiting, call a doctor. EYES: wash with plenty of water. SKIN: wipe off and wash with soap and water.
5.4 Threshold Limit Value: 200 ppm
5.5 Short Term Inhalation Limits: 2500 mg/m³ for 60 min.
5.6 Toxicity by Ingestion: Grade 1; LD_{Lo} = 5 to 15 g/kg
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 1 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 100°F (min.)C.C.
6.2 Flammable Limits in Air: 0.7%-5%
6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 444°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 4 mm/min
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 33

8. WATER POLLUTION

8.1 Aquatic Toxicity: 2990 ppm/24 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 53%, 5 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Light hydrocarbon distillate, 100%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Combustible liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	2
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	1
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	1
Aesthetic Effect	3
Reactivity	
Other Chemicals	0
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	0
Flammability (Red)	2
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: Not pertinent
12.3 Boiling Point at 1 atm: 392-500°F = 200—260°C = 473—533°K
12.4 Freezing Point: −50°F = −45.6°C = 227.6°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 0.80 at 15°C (liquid)
12.8 Liquid Surface Tension: 23-32 dynes/cm = 0.023-0.032 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 47-49 dynes/cm = 0.047-0.049 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: 110 Btu/lb = 60 cal/g = 2.5 X 10^4 J/kg
12.13 Heat of Combustion: −18,540 Btu/lb = −10,300 cal/g = −431.24 X 10^4 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.1 psia

NOTES

OILS, FUEL: 1-D

OOD

Common Synonyms	Oily liquid	Yellow-brown	Lube or fuel oil odor
Diesel oil (light)	Floats on water.		

Stop discharge if possible.
Call fire department.
Avoid contact with liquid.
Absorb and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible
Extinguish with dry chemical, foam or carbon dioxide.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

LIQUID
Irritating to 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

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
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)

Mechanical containment.
Should be removed.
Chemical and physical treatment.

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Miscellaneous Hydrocarbon Mixtures
3.2 Formula: Not applicable
3.3 IMO/UN Designation: 3.1/1270
3.4 DOT ID No.: 1270
3.5 CAS Registry No.: Data not available

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Light brown
4.3 Odor: Characteristic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Protective gloves; goggles or face shield.
5.2 Symptoms Following Exposure: INHALATION causes headache and slight giddiness. INGESTION causes nausea, vomiting, and cramping; depression of central nervous system ranging from mild headache to anesthesia, coma, and death; pulmonary irritation secondary to exhalation of solvent; signs of kidney and liver damage may be delayed. ASPIRATION causes severe lung irritation with coughing, gagging, dyspnea, substernal distress, and rapidly developing pulmonary edema; later, signs of bronchopneumonia and pneumonitis; acute onset of central nervous system excitement followed by depression.
5.3 Treatment of Exposure: INGESTION: do NOT induce vomiting; seek medical attention. ASPIRATION: enforce bed rest; administer oxygen. EYES: wash with copious quantity of water. SKIN: remove solvent by wiping and wash with soap and water.
5.4 Threshold Limit Value: No single value applicable.
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 1; LD_{50} = 5-15 g/kg
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Slight smarting of eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of skin.
5.10 Odor Threshold: 0.7 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 100°F C.C.
6.2 Flammable Limits in Air: 1.3%-6%
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 350—625°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 4 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 33

8. WATER POLLUTION

8.1 Aquatic Toxicity: 204 mg/1/24 hr/juvenile American shad/Tl_/ash water
8.2 Waterfowl Toxicity: 20 mg/kg LD_{50} (mallard)
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Diesel fuel 1-D (ASTM)
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Combustible liquid
11.2 MAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	0
Flammability (Red)	2
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 16°C and 1 atm: Liquid
12.2 Molecular Weight: Not pertinent
12.3 Boiling Point at 1 atm: 360—660°F = 182—293°C = 466—666°K
12.4 Freezing Point: —30°F = —34°C = 240°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 0.81—0.85 at 15°C (liquid)
12.8 Liquid Surface Tension: 23—32 dynes/cm = 0.023—0.032 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 47—48 dynes/cm = 0.047—0.048 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: 110 Btu/lb = 60 cal/g = 2.5 X 10^5 J/kg
12.13 Heat of Combustion: —18,540 Btu/lb = —10,300 cal/g = —431.24 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

OILS, FUEL: 2-D

OTD

Common Synonyms	Oily liquid	Yellow-brown	Lube or fuel oil odor
Diesel oil, medium	Floats on water.		

Stop discharge if possible
Call fire department
Avoid contact with liquid
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire

Combustible
Extinguish with dry chemical, foam, carbon dioxide
Water may be ineffective on fire
Cool exposed containers with water

Exposure

CALL FOR MEDICAL AID

LIQUID
Irritating to 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

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
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)
Mechanical containment
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Miscellaneous Hydrocarbon Mixtures
3.2 Formula: Not applicable
3.3 IMO/UN Designation: 3.1/1270
3.4 DOT ID No.: 1270
3.5 CAS Registry No.: Data not available

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Light brown
4.3 Odor: Characteristic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Protective gloves; goggles or face shield.
5.2 Symptoms Following Exposure: INGESTION causes nausea, vomiting, and cramping; depression of central nervous system ranging from mild headache to anesthesia, coma, and death; pulmonary irritation secondary to exhalation of solvent; signs of kidney and liver damage may be delayed. ASPIRATION causes severe lung irritation with coughing, gagging, dyspnea, substernal distress, and rapidly developing pulmonary edema; later, signs of bronchopneumonia and pneumonitis; acute onset of central nervous system excitement followed by depression.
5.3 Treatment of Exposure: INGESTION: do NOT induce vomiting. ASPIRATION: enforce bed rest; administer oxygen; seek medical attention. EYES: wash with copious quantity of water. SKIN: remove solvent by wiping and wash with soap and water.
5.4 Threshold Limit Value: No single TLV applicable.
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 1; LD_{50} = 9-15 g/kg
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Slight smarting of eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of skin.
5.10 Odor Threshold: Data not available
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 125°F C.C.
6.2 Flammable Limits in Air: 1.3%-6.0%
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 490—545°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 4 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 33

8. WATER POLLUTION

8.1 Aquatic Toxicity: 204 mg/l/24 hr/juvenile American shad/TL_m/salt water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Diesel fuel 2-D (ASTM)
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Combustible liquid
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	0
Flammability (Red)	2
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: Not pertinent
12.3 Boiling Point at 1 atm: 540—640°F = 282—338°C = 555—611°K
12.4 Freezing Point: 0°F = 18°C = 256°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 0.87—0.90 at 20°C (liquid)
12.8 Liquid Surface Tension: Data not available
12.9 Liquid Water Interfacial Tension: Data not available
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: —19,440 Btu/lb = —10,800 cal/g = —452.17 X 10^3 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

POLYCHLORINATED BIPHENYL

PCB

Common Synonyms	Oily liquid to solid powder	Light yellow liquid or white powder	Weak odor
PCB Chlorinated biphenyl Aroclor Halogenated waxes Polychlorobiphenyls	Sinks in water		

Stop discharge if possible. Keep people away.
Avoid contact with liquid and solid.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible

Exposure

CALL FOR MEDICAL AID

LIQUID OR SOLID
Irritating to skin and eyes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.

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)

Issue warning-water contaminant.
Should be removed.
Chemical and physical treatment.

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $(C_{12}H_{10-n})Cl_n$
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: 2315
3.5 CAS Registry No.: 1336-36-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid or solid
4.2 Odor: Pale yellow (liquid); colorless (solid)
4.3 Odor: Practically odorless

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Gloves and protective garments.
5.2 Symptoms Following Exposure: Acne from skin contact.
5.3 Treatment of Exposure: SKIN: wash with soap and water.
5.4 Threshold Limit Value: 0.5 to 1.0 mg/m³
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; oral rat LD_{50} = 3980 mg/kg
5.7 Late Toxicity: Causes chromosomal abnormalities in rats, birth defects in birds
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause severe irritation of eyes and throat and cause eye and lung injury. They cannot be tolerated even at low concentrations.
5.9 Liquid or Solid Irritant Characteristics: Contact with skin may cause irritation.
5.10 Odor Threshold: Data not available
5.11 IDLH Value: 5 to 10 mg/m³

6. FIRE HAZARDS

6.1 Flash Point: >266°F
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Water, foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Irritating gases are generated in fires.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Data not available
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Data not available
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: 0.278 ppm/96 hr/bluegill/TL_m/fresh water
0.005 ppm/336-1080 hr/pinfish/TL_m/salt water
8.2 Waterfowl Toxicity: LD_{50} 2000 ppm (mallard duck)
8.3 Biological Oxygen Demand (BOD): Very low
8.4 Food Chain Concentration Potential: High

9. SHIPPING INFORMATION

9.1 Grades of Purity: 11 grades (some liquid, some solids) which differ primarily in their chlorine content (20%-68% by weight)
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

II

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-E
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Solid
12.2 Molecular Weight: Not pertinent
12.3 Boiling Point at 1 atm: Very high
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.3—1.8 at 20°C (liquid)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent
12.12 Latent Heat of Vaporization: Not pertinent
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

TOLUENE

TOL

Common Synonyms	Watery liquid	Colorless	Pleasant odor
Toluol Methylbenzene Methylbenzol	Floats on water. Flammable, irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting or loss of consciousness.
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

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
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)

Issue warning-high flammability
Evacuate area

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: $C_6H_5CH_3$
3.3 IMO/UN Designation: 3.2/1294
3.4 DOT ID No.: 1294
3.5 CAS Registry No.: 108-88-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Pungent, aromatic, benzene-like, distinct, pleasant

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Air-supplied mask; goggles or face shield; plastic gloves.
5.2 Symptoms Following Exposure: Vapors irritate eyes and upper respiratory tract; cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration.
5.3 Treatment of Exposure: INHALATION: remove to fresh air, give artificial respiration and oxygen if needed; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 800 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg
5.7 Late Toxicity: Kidney and liver damage may follow ingestion.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.17 ppm
5.11 IDLH Value: 2,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 40°F C.C.; 55°F O.C.
6.2 Flammable Limits in Air: 1.27%-7%
6.3 Fire Extinguishing Agents: Carbon dioxide or dry chemical for small fires, ordinary foam for large fires.
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 997°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.7 mm/min.
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: 1180 mg/l/96 hr/sunfish/TL$_m$/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0%, 5 days; 36% (theor), 8 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research, reagent, nitration-all 99.8 + %; Industrial: contains 94 + %, with 5% xylene and small amounts of benzene and nonaromatic hydrocarbons; 90/120: less pure than Industrial.
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 92.14
12.3 Boiling Point at 1 atm: 231.1°F = 110.6°C = 383.8°K
12.4 Freezing Point: −139°F = −95.0°C = 178.2°K
12.5 Critical Temperature: 605.4°F = 318.6°C = 591.8°K
12.6 Critical Pressure: 596.1 psia = 40.55 atm = 4.108 MN/m²
12.7 Specific Gravity: 0.867 at 20°C (liquid)
12.8 Liquid Surface Tension: 29.0 dynes/cm = 0.0290 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 36.1 dynes/cm = 0.0361 N/m at 25°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.089
12.12 Latent Heat of Vaporization: 155 Btu/lb = 86.1 cal/g = 3.81 X 10⁴ J/kg
12.13 Heat of Combustion: −17,430 Btu/lb = −9686 cal/g = −405.5 X 10⁴ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 17.17 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 1.1 psia

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

m-XYLENE

XLM

Common Synonyms	Watery liquid	Colorless	Sweet odor
1, 3-Dimethylbenzene Xylol	Floats on water. Flammable, irritating vapor is produced		

Stop discharge if possible. Keep people away.
Call fire department.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
[illegible]
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose, and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, or loss of consciousness.
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.
Fouling to shoreline.
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)

Issue warning-high flammability
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: m-$C_6H_4(CH_3)_2$
3.3 IMO/UN Designation: 3.2/1307
3.4 DOT ID No.: 1307
3.5 CAS Registry No.: 108-38-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Like benzene; characteristic aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma; can be fatal. Kidney and liver damage can occur.
5.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 300 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3, LD_{50} = 50 to 500 g/kg
5.7 Late Toxicity: Kidney and liver damage
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.05 ppm
5.11 IDLH Value: 10,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 84°F C.C.
6.2 Flammable Limits in Air: 1.1%-6.4%
6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 986°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.8 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: 22 ppm/96 hr/bluegill/TL_/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0 lb/lb, 5 days, 0% (theor.), 8 days
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research: 99.99%; Pure: 99.9%; Technical: 99.2%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.16
12.3 Boiling Point at 1 atm: 269.4°F = 131.9°C = 405.1°K
12.4 Freezing Point: −54.2°F = −47.8°C = 225.3°K
12.5 Critical Temperature: 650.8°F = 343.8°C = 617.0°K
12.6 Critical Pressure: 513.6 atm = 34.95 psia = 3.540 MN/m²
12.7 Specific Gravity: 0.864 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.6 dynes/cm = 0.0286 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 36.4 dynes/cm = 0.0364 N/m at 30°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.071
12.12 Latent Heat of Vaporization: 147 Btu/lb = 81.9 cal/g = 3.43 X 10^5 J/kg
12.13 Heat of Combustion: −17,554 Btu/lb = −9752.4 cal/g = −408.31 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.17 Heat of Fusion: 26.01 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.34 psia

NOTES

JUNE 1985

o-XYLENE

XLO

Common Synonyms	Watery liquid	Colorless	Sweet odor
1, 2-Dimethylbenzene Xylol	Floats on water. Flammable, irritating vapor is produced		

Stop discharge if possible. Keep people away.
Call fire department.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Water spray may be ineffective.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, or loss of consciousness.
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

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
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)

Issue warning-high flammability
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: o-$C_6H_4(CH_3)_2$
3.3 IMO/UN Designation: 3.2/1307
3.4 DOT ID No.: 1307
3.5 CAS Registry No.: 95-47-6

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Benzene-like; characteristic aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur.
5.3 Treatment of Exposure: INHALATION: remove to fresh air, administer artificial respiration and oxygen if required, call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 300 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 Late Toxicity: Kidney and liver damage.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.05 ppm
5.11 IDLH Value: 10,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 83°F C.C.; 75°F O.C.
6.2 Flammable Limits in Air: 1.1%-7.0%
6.3 Fire Extinguishing Agents: Foam, dry chemical or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back
6.7 Ignition Temperature: 869°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.8 mm/min
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: >100 mg/l/96 hr/D. magna/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0 lb/lb, 5 days: 2.5% (theor.), 8 days
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research: 99.99%; Pure: 99.7%; Commercial: 95+%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No reaction
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.16
12.3 Boiling Point at 1 atm: 291.9°F = 144.4°C = 417.6°K
12.4 Freezing Point: −13.3°F = −25.2°C = 248.0°K
12.5 Critical Temperature: 674.8°F = 357.1°C = 630.3°K
12.6 Critical Pressure: 541.5 atm = 36.84 psia = 3.732 MN/m²
12.7 Specific Gravity: 0.880 at 20°C (liquid)
12.8 Liquid Surface Tension: 30.53 dynes/cm = 0.03053 N/m at 15.5°C
12.9 Liquid Water Interfacial Tension: 36.05 dynes/cm = 0.03606 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.068
12.12 Latent Heat of Vaporization: 149 Btu/lb = 82.8 cal/g = 3.47 X 10^5 J/kg
12.13 Heat of Combustion: −17,556 Btu/lb = −9754.7 cal/g = −408.41 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.35 Heat of Fusion: 30.64 cal/g
12.36 Limiting Value: Data not available
12.37 Reid Vapor Pressure: 0.28 psia

NOTES

p-XYLENE

XLP

Common Synonyms	Watery liquid	Colorless	Sweet odor
1,4-Dimethylbenzene Xylol	Floats on water. Flammable, irritating vapor is produced. Freezing point is 56°F.		

Stop discharge if possible. Keep people away.
Call fire department.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, loss of consciousness.
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.
Fouling to shoreline.
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)

Issue warning-high flammability
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: p-$C_6H_4(CH_3)_2$
3.3 IMO/UN Designation: 3.2/1307
3.4 DOT ID No.: 1307
3.5 CAS Registry No.: 106-42-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Like benzene; characteristic aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur.
5.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 300 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 Late Toxicity: Kidney and liver damage.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.05 ppm
5.11 IDLH Value: 10,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 81°F C.C.
6.2 Flammable Limits in Air: 1.1%-6.6%
6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 870°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.8 mm/min
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: 22 ppm/96 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0 lb/lb in 5 days
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research: 99.99%; Pure: 99.8%; Technical: 99.0%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.16
12.3 Boiling Point at 1 atm: 280.9°F = 138.3°C = 411.5°K
12.4 Freezing Point: 55.9°F = 13.3°C = 286.5°K
12.5 Critical Temperature: 649.4°F = 343.0°C = 616.2°K
12.6 Critical Pressure: 509.4 atm = 34.85 psia = 3.510 MN/m²
12.7 Specific Gravity: 0.861 at 20°C (liquid)
12.8 Liquid Surface Tension: 28.3 dynes/cm = 0.0283 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 37.8 dynes/cm = 0.0378 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.071
12.12 Latent Heat of Vaporization: 150 Btu/lb = 81 cal/g = 3.4 X 10⁵ J/kg
12.13 Heat of Combustion: −17,550 Btu/lb = −9754.7 cal/g = −408.41 X 10⁵ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 37.83 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.34 psia

NOTES

JUNE 1985

CHLOROBENZENE

CRB

Common Synonyms	Watery liquid	Colorless	Sweet, almond odor
Monochlorobenzene Phenyl chloride Benzene chloride MCB	Sinks in water. Flammable vapor is produced.		

Avoid contact with liquid and vapor. Keep people away.
Stop discharge if possible.
Call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.

Exposure

CALL FOR MEDICAL AID

VAPOR
If inhaled, will cause coughing or dizziness.
Not irritating to eyes, nose and throat.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to 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.

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)

Should be removed.
Chemical and physical treatment.

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: C_6H_5Cl
3.3 IMO/UN Designation: 3.3/1134
3.4 DOT ID No.: 1134
3.5 CAS Registry No.: 108-90-7

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Mild amine odor; sweet, almond- like; aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor-acid gas respirator where appropriate; neoprene or vinyl gloves; chemical safety spectacles, plus face shield where appropriate; rubber footwear; apron or impervious clothing for splash protection; hard hat.
5.2 Symptoms Following Exposure: Irritating to skin, eyes and mucous membranes. Repeated exposure of skin may cause dermatitis due to defatting action. Chronic inhalation of vapors or mist may result in damage to lungs, liver, and kidneys. Acute vapor exposures can cause symptoms ranging from coughing to transient anesthesia and central nervous system depression.
5.3 Treatment of Exposure: Get medical attention for all eye exposures and any serious over-exposures. Treat the symptoms. INHALATION: remove to clean air; administer oxygen as needed. INGESTION: dilute by drinking water; if vomiting occurs, administer more water. Administer saline laxative. EYES: flush thoroughly with water. SKIN: remove contaminated clothing, wash exposed area with soap and water.
5.4 Threshold Limit Value: 75 ppm
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg (rat, rabbit)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors are nonirritating to the eyes and throat.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.21 ppm
5.11 IDLH Value: 2,400 ppm

6. FIRE HAZARDS

6.1 Flash Point: 84°F C.C., 97°F O.C.
6.2 Flammable Limits in Air: 1.3%-7.1%
6.3 Fire Extinguishing Agents: Carbon dioxide, dry chemical, foam or water spray
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Burning in open flame can form toxic phosgene and hydrogen chloride gases
6.6 Behavior in Fire: Heavy vapor can travel a considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 1184°F
6.8 Electrical Hazard: Data not available
6.9 Burning Rate: (est.) 4.6 mm/min.
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity: 20 ppm/96 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0.3 lb/lb, 5 days
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: 99.5%; technical
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-X

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water

Transportation: Category	Rating
Fire	3
Health	
Vapor Irritant	0
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 112.56
12.3 Boiling Point at 1 atm: 270°F = 132°C = 405°K
12.4 Freezing Point: −50.1°F = −45.6°C = 227.6°K
12.5 Critical Temperature: 678°F = 359°C = 632°K
12.6 Critical Pressure: 656 psa = 44.8 atm = 4.52 MN/m²
12.7 Specific Gravity: 1.11 at 20°C (liquid)
12.8 Liquid Surface Tension: 33 dynes/cm = 0.033 N/m at 25°C
12.9 Liquid Water Interfacial Tension: 37.41 dynes/cm = 0.03741 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.094
12.12 Latent Heat of Vaporization: 135 Btu/lb = 75 cal/g = 3.140 X 10⁵ J/kg
12.13 Heat of Combustion: (est.) 12,000 Btu/lb = 6700 cal/g = 280 X 10⁵ J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.17 Heat of Fusion: 20.40 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.5 psa

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

DICHLOROMETHANE

DCM

Common Synonyms	Watery liquid	Colorless	Sweet, pleasant odor
Methylene chloride Methylene dichloride	Sinks in water. Irritating vapor is produced.		

Stop discharge if possible
Avoid contact with liquid and vapor
Isolate and remove discharged material
Notify local health and pollution control agencies

Fire

Not flammable
POISONOUS GASES ARE PRODUCED WHEN HEATED.
Wear goggles and self-contained breathing apparatus
Cool exposed containers with water

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea and dizziness.
Move to fresh air
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to 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

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and pollution control officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Disperse and flush

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: CH_2Cl_2
3.3 IMO/UN Designation: 6.1/1593
3.4 DOT ID No.: 1593
3.5 CAS Registry No.: 75-09-2

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Pleasant, aromatic; like chloroform; sweet, ethereal

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor canister mask, safety glasses, protective clothing.
5.2 Symptoms Following Exposure: INHALATION: anesthetic effects, nausea and drunkenness. CONTACT WITH SKIN AND EYES: skin irritation, irritation of eyes and nose.
5.3 Treatment of Exposure: INHALATION: remove from exposure. Give oxygen if needed. INGESTION: no specific antidote. CONTACT WITH SKIN AND EYES: remove contaminated clothing; wash skin or eyes if affected.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 500 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg
5.7 Late Toxicity: None
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: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 205-307 ppm
5.11 IDLH Value: 5,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: Not flammable under conditions likely to be encountered.
6.2 Flammable Limits in Air: 12%-19%
6.3 Fire Extinguishing Agents: Not pertinent
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Dissociation products generated in a fire may be irritating or toxic.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 1184°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not pertinent
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity: Not pertinent
8.2 Waterfowl Toxicity: Not pertinent
8.3 Biological Oxygen Demand (BOD): Not pertinent
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Aerosol grade; technical grade
9.2 Storage Temperature: Data not available
9.3 Inert Atmosphere: Inerted
9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-X

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	1
Health	
Vapor Irritant	2
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	1
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	1
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	0
Reactivity (Yellow)	1

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 84.93
12.3 Boiling Point at 1 atm: 104°F = 39.8°C = 313.0°K
12.4 Freezing Point: −142°F = −96.7°C = 176.5°K
12.5 Critical Temperature: 473°F = 245°C = 518°K
12.6 Critical Pressure: 865 psia = 60.8 atm = 6.17 MN/m²
12.7 Specific Gravity: 1.322 at 20°C (liquid)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: 2.9
12.11 Ratio of Specific Heats of Vapor (Gas): 1.198
12.12 Latent Heat of Vaporization: 142 Btu/lb = 78.7 cal/g = 3.30 X 10⁵ J/kg
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 16.89 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 13.9 psia

NOTES

TETRACHLOROETHYLENE

TTE

Common Synonyms	Watery liquid	Colorless	Sweet odor
Tetracap Perclene Perchloroethylene Perk	Sinks in water. Irritating vapor is produced.		

Stop discharge if possible.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable.
Poisonous gases are produced when heated.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to 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.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
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)

Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $Cl_2C{=}CCl_2$
3.3 IMO/UN Designation: 6.1/1897
3.4 DOT ID No.: 1897
3.5 CAS Registry No.: 127-18-4

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Ethereal, like chloroform; mildly sweet

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: For high vapor concentrations use approved canister or air-supplied mask; chemical goggles or face shield; plastic gloves.
5.2 Symptoms Following Exposure: Vapor can affect central nervous system and cause anesthesia. Liquid may irritate skin after prolonged contact. May irritate eyes but causes no injury.
5.3 Treatment of Exposure: INHALATION: If illness occurs, remove patient to fresh air, keep him warm and quiet, and get medical attention. INGESTION: Induce vomiting only on physician's recommendation. EYES AND SKIN: flush with plenty of water and get medical attention if irritation or injury occurs.
5.4 Threshold Limit Value: 50 ppm
5.5 Short Term Inhalation Limits: 100 ppm for 60 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg
5.7 Late Toxicity: None
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or throat if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard if spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 5 ppm
5.11 IDLH Value: 500 ppm

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Not pertinent
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic, irritating gases may be generated in fires.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Not flammable
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not flammable
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: Data not available

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): None
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Dry cleaning and industrial grades: 95+%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	0
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	1

11.3 NFPA Hazard Classification: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 165.83
12.3 Boiling Point at 1 atm: 250°F = 121°C = 394°K
12.4 Freezing Point: −8.3°F = −22.4°C = 250.8°K
12.5 Critical Temperature: 657°F = 347°C = 620°K
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.63 at 20°C (liquid)
12.8 Liquid Surface Tension: 31.3 dynes/cm = 0.0313 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 44.4 dynes/cm = 0.0444 N/m at 25°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.116
12.12 Latent Heat of Vaporization: 90.2 Btu/lb = 50.1 cal/g = 2.10×10^5 J/kg
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

TRICHLOROETHANE

TCE

Common Synonyms	Watery liquid	Colorless	Sweet odor
1,1,1-Trichloroethane Methylchloroform Aerothene Chloroethane	Sinks in water. Irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Avoid contact with liquid and vapor.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, carbon dioxide, or foam.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, may produce nausea.
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 and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
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)
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: CH_3CCl_3
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: 2831
3.5 CAS Registry No.: 71-55-6

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Chloroform-like; sweetish

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or polyvinyl-alcohol-type gloves; chemical safety goggles and face shield; neoprene safety shoes (or leather safety shoes plus neoprene footwear); neoprene or polyvinyl alcohol suit or apron for splash protection.

5.2 Symptoms Following Exposure: INHALATION: symptoms range from loss of equilibrium and incoordination to loss of consciousness; high concentration can be fatal due to simple asphyxiation combined with loss of consciousness. INGESTION: produces effects similar to inhalation and may cause some feeling of nausea. EYES: slightly irritating and lachrymatory. SKIN: defatting action may cause dermatitis.

5.3 Treatment of Exposure: Get medical attention for all eye exposures and any other serious overexposures. Do NOT administer adrenalin or epinephrine; otherwise, treatment is symptomatic. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting. EYES: flush thoroughly with water. SKIN: remove contaminated clothing and wash exposed area thoroughly with soap and warm water.

5.4 Threshold Limit Value: 350 ppm

5.5 Short Term Inhalation Limits: 1,000 ppm for 60 min. in man

5.6 Toxicity by Ingestion: Grade 1; LD_{50} = 5 to 15 g/kg (rat, mouse, rabbit, guinea pig)

5.7 Late Toxicity: Data not available

5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.

5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.

5.10 Odor Threshold: 100 ppm

5.11 IDLH Value: 1,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: Data not available
6.2 Flammable Limits in Air: 7%-16%
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic and irritating gases are generated in fires.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 937°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: (est.) 2.8 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: Reacts slowly, releasing corrosive hydrochloric acid.
7.2 Reactivity with Common Materials: Corrodes aluminum, but reaction is not hazardous.
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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity: 75-150 ppm/*/pinfish/TL_/salt water
*Time period not specified.
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Uninhibited; inhibited; industrial inhibited; white room; cold cleaning
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	1
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	1
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 133.41
12.3 Boiling Point at 1 atm: 165°F = 74°C = 347°K
12.4 Freezing Point: <—38°F = <—39°C = <234°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.31 at 20°C (liquid)
12.8 Liquid Surface Tension: 25.4 dynes/cm = 0.0254 N/m at 20°C
12.9 Liquid Water Interfacial Tension: (est.) 45 dynes/cm = 0.045 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 4.6
12.11 Ratio of Specific Heats of Vapor (Gas): 1.104
12.12 Latent Heat of Vaporization: 100 Btu/lb = 56 cal/g = 2.4 X 10^4 J/kg
12.13 Heat of Combustion: (est.) 4700 Btu/lb = 2600 cal/g = 110 X 10^6 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 4.0 psia

NOTES

CHLOROBENZENE

CRB

Common Synonyms	Watery liquid	Colorless	Sweet, almond odor
Monochlorobenzene Phenyl chloride Benzene chloride MCB	Sinks in water. Flammable vapor is produced		

Avoid contact with liquid and vapor. Keep people away.
Stop discharge if possible.
Call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, foam, or carbon dioxide.

Exposure

CALL FOR MEDICAL AID

VAPOR
If inhaled, will cause coughing or dizziness.
Not irritating to eyes, nose and throat.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to 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.

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)

Should be removed.
Chemical and physical treatment.

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: C_6H_5Cl
3.3 IMO/UN Designation: 3.3/1134
3.4 DOT ID No.: 1134
3.5 CAS Registry No.: 108-90-7

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Mild amine odor; sweet, almond- like; aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor-acid gas respirator where appropriate; neoprene or vinyl gloves; chemical safety spectacles, plus face shield where appropriate; rubber footwear; apron or impervious clothing for splash protection; hard hat.

5.2 Symptoms Following Exposure: Irritating to skin, eyes and mucous membranes. Repeated exposure of skin may cause dermatitis due to defatting action. Chronic inhalation of vapors or mist may result in damage to lungs, liver, and kidneys. Acute vapor exposures can cause symptoms ranging from coughing to transient anesthesia and central nervous system depression.

5.3 Treatment of Exposure: Get medical attention for all eye exposures and any serious over-exposures. Treat the symptoms. INHALATION: remove to clean air; administer oxygen as needed. INGESTION: dilute by drinking water; if vomiting occurs, administer more water. Administer saline laxative. EYES: flush thoroughly with water. SKIN: remove contaminated clothing, wash exposed area with soap and water.

5.4 Threshold Limit Value: 75 ppm

5.5 Short Term Inhalation Limits: Data not available

5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg (rat, rabbit)

5.7 Late Toxicity: Data not available

5.8 Vapor (Gas) Irritant Characteristics: Vapors are nonirritating to the eyes and throat.

5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.

5.10 Odor Threshold: 0.21 ppm

5.11 IDLH Value: 2,400 ppm

6. FIRE HAZARDS

6.1 Flash Point: 84°F C.C., 97°F O.C.

6.2 Flammable Limits in Air: 1.3%-7.1%

6.3 Fire Extinguishing Agents: Carbon dioxide, dry chemical, foam or water spray

6.4 Fire Extinguishing Agents Not to be Used: Not pertinent

6.5 Special Hazards of Combustion Products: Burning in open flame can form toxic phosgene and hydrogen chloride gases

6.6 Behavior in Fire: Heavy vapor can travel a considerable distance to a source of ignition and flash back.

6.7 Ignition Temperature: 1184°F

6.8 Electrical Hazard: Data not available

6.9 Burning Rate: (est.) 4.6 mm/min.

6.10 Adiabatic Flame Temperature: Data not available

(Continued)

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

7.7 Molar Ratio (Reactant to Product): Data not available

7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity: 20 ppm/96 hr/bluegill/TL$_m$/fresh water

8.2 Waterfowl Toxicity: Data not available

8.3 Biological Oxygen Demand (BOD): 0.3 lb/lb, 5 days

8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: 99.5%; technical

9.2 Storage Temperature: Ambient

9.3 Inert Atmosphere: No requirement

9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-X

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid

11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	0
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid

12.2 Molecular Weight: 112.56

12.3 Boiling Point at 1 atm: 270°F = 132°C = 405°K

12.4 Freezing Point: −50.1°F = −45.6°C = 227.6°K

12.5 Critical Temperature: 678°F = 358°C = 632°K

12.6 Critical Pressure: 656 psa = 44.6 atm = 4.52 MN/m²

12.7 Specific Gravity: 1.11 at 20°C (liquid)

12.8 Liquid Surface Tension: 33 dynes/cm = 0.033 N/m at 25°C

12.9 Liquid Water Interfacial Tension: 37.41 dynes/cm = 0.03741 N/m at 20°C

12.10 Vapor (Gas) Specific Gravity: Not pertinent

12.11 Ratio of Specific Heats of Vapor (Gas): 1.094

12.12 Latent Heat of Vaporization: 135 Btu/lb = 75 cal/g = 3.140×10^5 J/kg

12.13 Heat of Combustion: (est.) 12,000 Btu/lb = 6700 cal/g = 280×10^5 J/kg

12.14 Heat of Decomposition: Not pertinent

12.15 Heat of Solution: Not pertinent

12.16 Heat of Polymerization: Not pertinent

12.25 Heat of Fusion: 20.40 cal/g

12.26 Limiting Value: Data not available

12.27 Reid Vapor Pressure: 0.5 psa

6. FIRE HAZARDS (Continued)

6.11 Stoichiometric Air to Fuel Ratio: Data not available

6.12 Flame Temperature: Data not available

DICHLOROMETHANE

DCM

Common Synonyms	Watery liquid	Colorless	Sweet, pleasant odor
Methylene chloride Methylene dichloride	Sinks in water. Irritating vapor is produced.		

Stop discharge if possible.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable.
POISONOUS GASES ARE PRODUCED WHEN HEATED.
Wear goggles and self-contained breathing apparatus.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea and dizziness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to 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.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and pollution control officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Disperse and flush

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: CH_2Cl_2
3.3 IMO/UN Designation: 9.0/1593
3.4 DOT ID No.: 1593
3.5 CAS Registry No.: 75-09-2

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Pleasant, aromatic; like chloroform; sweet, ethereal

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor canister mask, safety glasses, protective clothing.
5.2 Symptoms Following Exposure: INHALATION: anesthetic effects, nausea and drunkenness. CONTACT WITH SKIN AND EYES: skin irritation, irritation of eyes and nose.
5.3 Treatment of Exposure: INHALATION: remove from exposure. Give oxygen if needed. INGESTION: no specific antidote. CONTACT WITH SKIN AND EYES: remove contaminated clothing; wash skin or eyes if affected.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 500 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 2, LD_{50} = 0.5 to 5 g/kg
5.7 Late Toxicity: None
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: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 205-307 ppm
5.11 IDLH Value: 5,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: Not flammable under conditions likely to be encountered.
6.2 Flammable Limits in Air: 12%-19%
6.3 Fire Extinguishing Agents: Not pertinent
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Dissociation products generated in a fire may be irritating or toxic.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 1184°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not pertinent
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: 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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity: Not pertinent
8.2 Waterfowl Toxicity: Not pertinent
8.3 Biological Oxygen Demand (BOD): Not pertinent
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Aerosol grade; technical grade
9.2 Storage Temperature: Data not available
9.3 Inert Atmosphere: Inerted
9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-X

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	1
Health	
Vapor Irritant	2
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	1
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	1
Sort Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	0
Reactivity (Yellow)	1

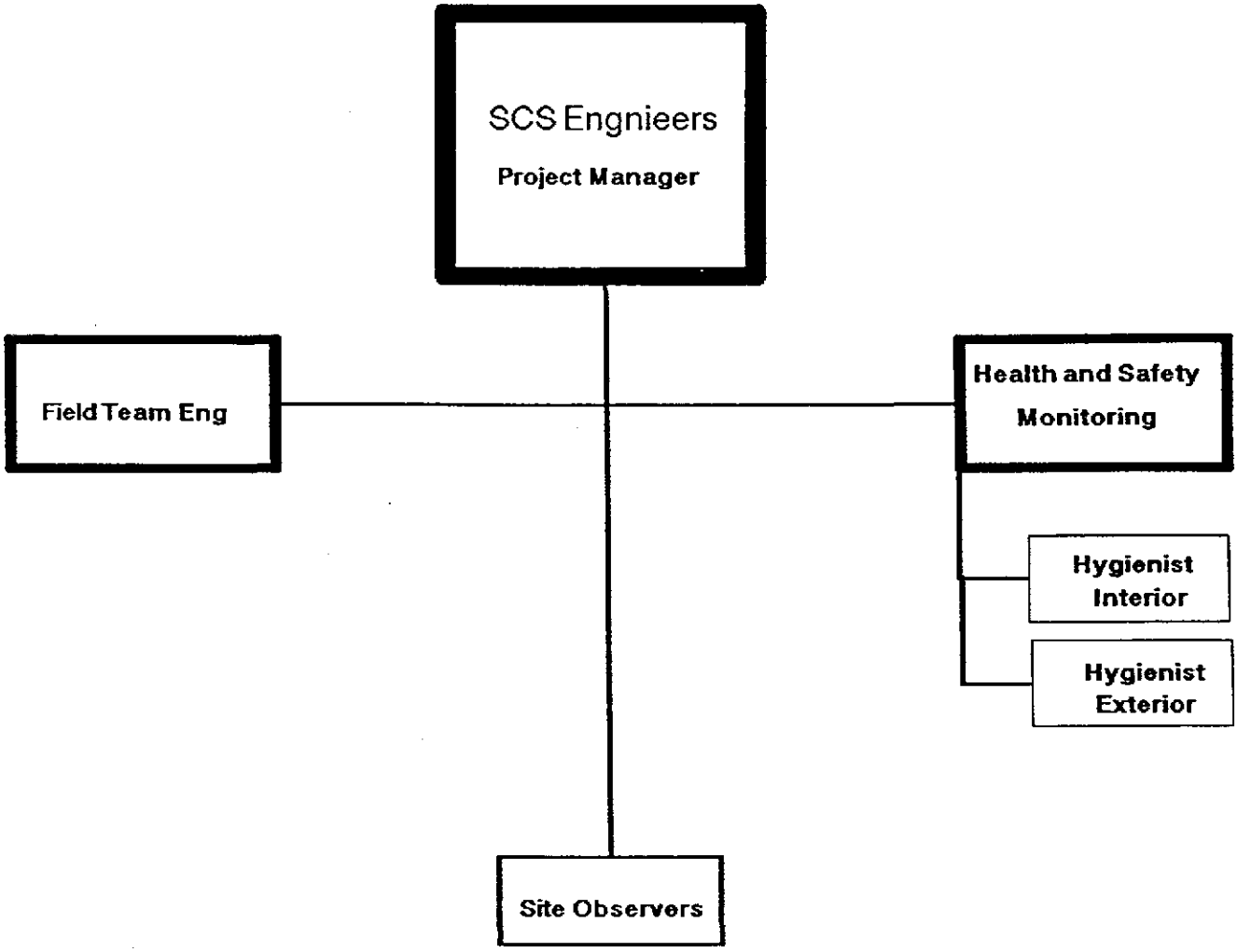
12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 84.93
12.3 Boiling Point at 1 atm: 104°F = 39.8°C = 313.0°K
12.4 Freezing Point: −142°F = −96.7°C = 176.5°K
12.5 Critical Temperature: 473°F = 245°C = 518°K
12.6 Critical Pressure: 895 psia = 60.9 atm = 6.17 MN/m²
12.7 Specific Gravity: 1.322 at 20°C (liquid)
12.8 Liquid Surface Tension: Not pertinent
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: 2.8
12.11 Ratio of Specific Heats of Vapor (Gas): 1.199
12.12 Latent Heat of Vaporization: 142 Btu/lb = 78.7 cal/g = 3.30 X 10⁵ J/kg
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 18.86 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 13.9 psia

NOTES

Appendix F

Project Personnel



TTE

TETRACHLOROETHYLENE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
35	103.400
40	103.099
45	102.900
50	102.599
55	102.299
60	102.000
65	101.700
70	101.400
75	101.099
80	100.799
85	100.500
90	100.200
95	99.310
100	99.610
105	99.320
110	99.020
115	98.730
120	98.429
125	98.139
130	97.839
135	97.549
140	97.250
145	96.959
150	96.669
155	96.370
160	96.080

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.198
10	.200
20	.201
30	.202
40	.203
50	.204
60	.205
70	.206
80	.207
90	.208
100	.210
110	.211
120	.212
130	.213
140	.214
150	.215
160	.216
170	.217
180	.218
190	.220
200	.221
210	.222

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
	NOT PERTINENT

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
55	.958
60	.929
65	.900
70	.873
75	.848
80	.823
85	.800
90	.777
95	.756
100	.736
105	.716
110	.698
115	.680
120	.663
125	.647
130	.631
135	.616
140	.601
145	.588
150	.574
155	.561
160	.549
165	.537
170	.526
175	.515

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
68.02	.016

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
60	.236
70	.318
80	.425
90	.561
100	.732
110	.948
120	1.217
130	1.548
140	1.953
150	2.446
160	3.042
170	3.756
180	4.607
190	5.616
200	6.805
210	8.199
220	9.824
230	11.710
240	13.890
250	16.390
260	19.260
270	22.520
280	26.230

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
60	.00702
70	.00929
80	.01216
90	.01575
100	.02022
110	.02571
120	.03242
130	.04055
140	.05032
150	.06199
160	.07583
170	.09215
180	.11130
190	.13360
200	.15940
210	.18910
220	.22330
230	.26230
240	.30660
250	.35680
260	.41330
270	.47680
280	.54790

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.108
25	.110
50	.113
75	.116
100	.118
125	.120
150	.122
175	.125
200	.127
225	.129
250	.131
275	.132
300	.134
325	.136
350	.138
375	.139
400	.141
425	.142
450	.143
475	.144
500	.146
525	.147
550	.148
575	.148
600	.149

TRICHLOROETHANE

TCE

Common Synonyms
1,1,1-Trichloroethane
Methylchloroform
Aerothene
Chloroethane

Watery liquid | Colorless | Sweet odor

Sinks in water. Irritating vapor is produced.

Stop discharge if possible. Keep people away.
Avoid contact with liquid and vapor.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, carbon dioxide, or foam.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, may produce nausea.
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 and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
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)
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: CH_3CCl_3
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: 2831
3.5 CAS Registry No.: 71-55-6

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Chloroform-like; sweetish

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or polyvinyl-alcohol-type gloves; chemical safety goggles and face shield; neoprene safety shoes (or leather safety shoes plus neoprene footwear); neoprene or polyvinyl alcohol suit or apron for splash protection.

5.2 Symptoms Following Exposure: INHALATION: symptoms range from loss of equilibrium and incoordination to loss of consciousness; high concentration can be fatal due to simple asphyxiation combined with loss of consciousness. INGESTION: produces effects similar to inhalation and may cause some feeling of nausea. EYES: slightly irritating and lachrymatory. SKIN: defatting action may cause dermatitis.

5.3 Treatment of Exposure: Get medical attention for all eye exposures and any other serious overexposures. Do NOT administer adrenalin or epinephrine; otherwise, treatment is symptomatic. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting. EYES: flush thoroughly with water. SKIN: remove contaminated clothing and wash exposed area thoroughly with soap and warm water.

5.4 Threshold Limit Value: 350 ppm
5.5 Short Term Inhalation Limits: 1,000 ppm for 60 min. in man
5.6 Toxicity by Ingestion: Grade 1; LD_{50} = 5 to 15 g/kg (rat, mouse, rabbit, guinea pig)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 100 ppm
5.11 IDLH Value: 1,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: Data not available
6.2 Flammable Limits in Air: 7%-16%
6.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic and irritating gases are generated in fire.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 932°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: (est.) 2.9 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: Reacts slowly, releasing corrosive hydrochloric acid.
7.2 Reactivity with Common Materials: Corrodes aluminum, but reaction is not hazardous.
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
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity: 75-150 ppm/*/pinfish/TL_m/salt water
*Time period not specified.
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Uninhibited; inhibited; industrial inhibited; white room; cold cleaning
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	1
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	1
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 133.41
12.3 Boiling Point at 1 atm: 165°F = 74°C = 347°K
12.4 Freezing Point: <—38°F = <—39°C = <234°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.31 at 20°C (liquid)
12.8 Liquid Surface Tension: 25.4 dynes/cm = 0.0254 N/m at 20°C
12.9 Liquid Water Interfacial Tension: (est.) 45 dynes/cm = 0.045 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 4.6
12.11 Ratio of Specific Heats of Vapor (Gas): 1.104
12.12 Latent Heat of Vaporization: 100 Btu/lb = 56 cal/g = 2.4 X 10^5 J/kg
12.13 Heat of Combustion: (est.) 4700 Btu/lb = 2600 cal/g = 110 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 4.0 psia

NOTES

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E694)
- Drinking Water (#955)
- Waste Water
- Consultation

ChromaLab File No.: 1090048

October 19, 1990

Attn:

RE: Six samples for Gasoline/BTEX analysis

Project Name: DAVIS PARKING
Date Sampled: Oct. 5, 1990
Date Extracted: Oct. 15-19, 1990
Date Submitted: Oct. 8, 1990
Date Analyzed: Oct. 15-19,1990

RESULTS:

Sample No.	Gasoline (mg/Kg)	Benzene (ug/Kg)	Toluene (ug/Kg)	Ethyl Benzene (ug/Kg)	Total Xylenes (ug/Kg)
CENTER FRONT DRIVE, UST	----	130000000	52000000	27000000	41000000
1428 DOOR UST	----	140000000	61000000	28000000	44000000
MUNCK, UST	----	50	72	82	97
HYDLIFT-1.5/ SKINNER	35	N.D.	13	36	72
HOLMES-ABBAS	N.D.	N.D.	N.D.	N.D.	N.D.
MULLER VENT	N.D.	N.D.	N.D.	N.D.	N.D.
BLANK	N.D.	N.D.	N.D.	N.D.	N.D.
SPIKED RECOVERY	91.7%	98.6%	99.1%	103.5%	105.8%
DUP SPIKED RECOVERY	91.1%	89.3%	89.7%	90.05	107.6%
DETECTION LIMIT	2.5	5	5	5	5
METHOD OF ANALYSIS	5030/ 8015	8020	8020	8020	8020

CHROMALAB, INC.

David Duong
Senior Chemist

Eric Tam
Laboratory Director

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E694)
- Drinking Water (#955)
- Waste Water
- Consultation

October 22, 1990

ChromaLab File # 1090137 D

Client:_____ Attn:_____
Date Sampled: Oct. 19, 1990 Date Submitted: Oct. 19, 1990
Date of Analysis: Oct. 20, 1990

Project Name: S Davis Garage, 1432 Harrison Street
Sample I.D.: LB-PP-D (OIL)
Method of Analysis: EPA 8240 Detection Limit: 75000ug/Kg

COMPOUND NAME	ug/Kg	Spike Recovery
CHLOROMETHANE	N.D	---
VINYL CHLORIDE	N.D.	---
BROMOMETHANE	N.D.	---
CHLOROETHANE	N.D.	---
TRICHLOROFLUOROMETHANE	N.D.	102.5% 82.3%
1,1-DICHLOROETHENE	N.D.	---
METHYLENE CHLORIDE	N.D.	---
1,2-DICHLOROETHENE (TOTAL)	N.D.	---
1,1-DICHLOROETHANE	N.D.	---
CHLOROFORM	N.D.	90.5% 91.7%
1,1,1-TRICHLOROETHANE	N.D.	---
CARBON TETRACHLORIDE	N.D.	---
BENZENE	450,000	---
1,2-DICHLOROETHANE	N.D.	---
TRICHLOROETHENE	60,000	---
1,2-DICHLOROPROPANE	N.D.	---
BROMODICHLOROMETHANE	N.D.	---
2-CHLOROETHYLVINYLETHER	N.D.	---
TRANS-1,3-DICHLOROPROPENE	N.D.	---
TOLUENE	3,200,000	93.2% 88.4%
CIS-1,3-DICHLOROPROPENE	N.D.	---
1,1,2-TRICHLOROETHANE	N.D.	---
TETRACHLOROETHENE	94,000	---
DIBROMOCHLOROMETHANE	N.D.	---
CHLOROBENZENE	N.D.	---
ETHYL BENZENE	1,000,000	---
BROMOFORM	N.D.	---
1,1,2,2-TETRACHLOROETHANE	N.D.	---
1,3-DICHLOROBENZENE	N.D.	---
1,4-DICHLOROBENZENE	N.D.	91.5% 87.5%
1,2-DICHLOROBENZENE	N.D.	---
TOTAL XYLENES	7,000,000	---

ChromaLab, Inc.

David Duong
Senior Chemist

Eric Tam
Lab Director

2239 Omega Road, #1 • San Ramon, California 94583
415/831-1788 • Facsimile 415/831-8798
Enviro ID #68-0140157

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E594)
- Drinking Water (#955)
- Waste Water
- Consultation

October 19, 1990

ChromaLab File # 1090048 C

Client: _____ Attn: _____
Date Sampled: Oct. 06, 1990 Date Submitted: Oct. 08, 1990
Date of Analysis: Oct. 18, 1990

Project Name: Davis Parking, 1432 Harrison, Oakland, CA
Sample I.D.: MUNCK UST (OIL)
Method of Analysis: EPA 8010 Detection Limit: 20 ug/Kg

COMPOUND NAME	ug/Kg	Spike Recovery
CHLOROMETHANE	N.D	---
VINYL CHLORIDE	N.D.	---
BROMOMETHANE	N.D.	---
CHLOROETHANE	N.D.	---
TRICHLOROFLUOROMETHANE	N.D.	98.5% 97.2%
1,1-DICHLOROETHENE	N.D.	---
METHYLENE CHLORIDE	N.D.	---
1,2-DICHLOROETHENE (TOTAL)	160	---
1,1-DICHLOROETHANE	N.D.	---
CHLOROFORM	N.D.	---
1,1,1-TRICHLOROETHANE	N.D.	101.3% 92.5%
CARBON TETRACHLORIDE	N.D.	---
1,2-DICHLOROETHANE	N.D.	---
TRICHLOROETHENE	N.D.	---
1,2-DICHLOROPROPANE	N.D.	---
BROMODICHLOROMETHANE	N.D.	---
2-CHLOROETHYLVINYLETHER	N.D.	---
TRANS-1,3-DICHLOROPROPENE	N.D.	---
CIS-1,3-DICHLOROPROPENE	N.D.	---
1,1,2-TRICHLOROETHANE	N.D.	108.3% 102.5%
TETRACHLOROETHENE	110	---
DIBROMOCHLOROMETHANE	N.D.	---
CHLOROBENZENE	N.D.	---
BROMOFORM	N.D.	---
1,1,2,2-TETRACHLOROETHANE	N.D.	---
1,3-DICHLOROBENZENE	N.D.	---
1,4-DICHLOROBENZENE	N.D.	---
1,2-DICHLOROBENZENE	N.D.	92.8% 96.5%

ChromaLab, Inc.

David Duong
Senior Chemist

Eric Tam
Lab Director

ROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E594)
- Drinking Water (#855)
- Waste Water
- Consultation

October 31, 1990

ChromaLab File # 1090171 A

Client: _____ Attn: _____
Date Sampled: Oct. 25, 1990 Date Submitted: Oct. 25, 1990
Date of Analysis: Oct. 31, 1990

Project Name: 1432 Harrison
Sample I.D.: # 1 (soil)
Method of Analysis: 8240 Detection Limit: 1000 ug/Kg

COMPOUND NAME	ug/Kg	Spike Recovery
CHLOROMETHANE	N.D	---
VINYL CHLORIDE	N.D.	---
BROMOMETHANE	N.D.	---
CHLOROETHANE	N.D.	---
TRICHLOROFLUOROMETHANE	N.D.	98.7% 95.6%
1,1-DICHLOROETHENE	N.D.	---
METHYLENE CHLORIDE	N.D.	---
1,2-DICHLOROETHENE (TOTAL)	N.D.	---
1,1-DICHLOROETHANE	N.D.	---
CHLOROFORM	N.D.	98.2% 96.8%
1,1,1-TRICHLOROETHANE	N.D.	---
CARBON TETRACHLORIDE	N.D.	---
BENZENE	11,000	---
1,2-DICHLOROETHANE	N.D.	---
TRICHLOROETHENE	N.D.	---
1,2-DICHLOROPROPANE	N.D.	---
BROMODICHLOROMETHANE	N.D.	---
2-CHLOROETHYLVINYLETHER	N.D.	---
TRANS-1,3-DICHLOROPROPENE	N.D.	---
TOLUENE	120,000	105.8% 95.2%
CIC-1,3-DICHLOROPROPENE	N.D.	---
1,1,2-TRICHLOROETHANE	N.D.	---
TETRACHLOROETHENE	N.D.	---
DIBROMOCHLOROMETHANE	N.D.	---
CHLOROBENZENE	N.D.	---
ETHYL BENZENE	29,000	---
BROMOFORM	N.D.	---
1,1,2,2-TETRACHLOROETHANE	N.D.	---
1,3-DICHLOROBENZENE	N.D.	--
1,4-DICHLOROBENZENE	N.D.	97.5% 96.8%
1,2-DICHLOROBENZENE	N.D.	---
TOTAL XYLENES	170,000	

ChromaLab, Inc.

David Duong
Senior Chemist

Eric Tam
Lab Director

2239 Omega Road, #1 • San Ramon, California 94583
415/831-1788 • Facsimile 415/831-8798
Federal ID #68-0140157

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#5804)
- Drinking Water (#955)
- Waste Water
- Consultation

October 31, 1990

ChromaLab File # 1090171 D

Client: _____ Attn: _____
Date Sampled: Oct. 25, 1990 Date Submitted: Oct. 25, 1990
Date of Analysis: Oct. 31, 1990

Project Name: 1432 Harrison
Sample I.D.: # 4 (soil)
Method of Analysis: 8240 Detection Limit: 1000 ug/Kg

COMPOUND NAME	ug/Kg	Spike Recovery
CHLOROMETHANE	N.D	---
VINYL CHLORIDE	N.D.	---
BROMOMETHANE	N.D.	---
CHLOROETHANE	N.D.	---
TRICHLOROFLUOROMETHANE	N.D.	99.7% 95.6%
1,1-DICHLOROETHENE	N.D.	---
METHYLENE CHLORIDE	N.D.	---
1,2-DICHLOROETHENE (TOTAL)	N.D.	---
1,1-DICHLOROETHANE	N.D.	---
CHLOROFORM	N.D.	98.2% 96.8%
1,1,1-TRICHLOROETHANE	N.D.	---
CARBON TETRACHLORIDE	N.D.	---
BENZENE	29,000	---
1,2-DICHLOROETHANE	N.D.	---
TRICHLOROETHENE	N.D.	---
1,2-DICHLOROPROPANE	N.D.	---
BROMODICHLOROMETHANE	N.D.	---
2-CHLOROETHYLVINYLETHER	N.D.	---
TRANS-1,3-DICHLOROPROPENE	N.D.	---
TOLUENE	230,000	105.8% 95.2%
CIS-1,3-DICHLOROPROPENE	N.D.	---
1,1,2-TRICHLOROETHANE	N.D.	---
TETRACHLOROETHENE	N.D.	---
DIBROMOCHLOROMETHANE	N.D.	---
CHLOROBENZENE	N.D.	---
ETHYL BENZENE	58,000	---
BROMOFORM	N.D.	---
1,1,2,2-TETRACHLOROETHANE	N.D.	---
1,3-DICHLOROBENZENE	N.D.	---
1,4-DICHLOROBENZENE	N.D.	---
1,2-DICHLOROBENZENE	N.D.	97.5% 96.8%
TOTAL XYLENES	350,000	---

ChromaLab, Inc.

David Duong
Senior Chemist

Eric Tam
Lab Director

CHROMALAB, INC.
Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E694)
- Drinking Water (#955)
- Waste Water
- Consultation

ChromaLab File No.: 1080171

November 1, 1990

Attn:

RE: One oil and three soil samples for PCB's analysis

Date Sampled: Oct. 25, 1990
Date Extracted: Oct. 29-31,1990

Date Submitted: Oct. 25, 1990
Date Analyzed: Oct. 29-31,1990

RESULTS:

Sample No.	PCB's* (ug/Kg)
1	1100
2	1100
3	2300
4	390
BLANK	N.D.
SPIKED RECOVERY	92.5%
DUPLICATED SPIKED RECOVERY	98.9%
DETECTION LIMIT	100
METHOD OF ANALYSIS	8080

*PCB 1260

CHROMALAB, INC.

David Duong
Senior Chemist

Eric Tam (by DD)
Eric Tam
Laboratory Director

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E694)
- Drinking Water (#965)
- Waste Water
- Consultation

October 22, 1990 ChromaLab File No.: 1090137D

RE: 8080 Analysis
Client Sample Number: LB-PP-D
Project Location: 1432 HARRISON STREET
Date Analyzed: October 22, 1990

CHLORINATED PESTICIDE ANALYSIS

COMPOUNDS	CONCENTRATION (ug/Kg)	DETECTION LIMIT (ug/Kg)	SPIKE RECOVERY
ALDRIN	N.D.	10	----
DIELDRIN	N.D.	10	----
ENDRIN ALDEHYDE	N.D.	50	----
ENDRIN	N.D.	10	102.0%
HEPTACHLOR	N.D.	10	----
HEPTACHLOR EPOXIDE	N.D.	10	----
p,p' - DDT	N.D.	50	101.8%
p,p' - DDE	N.D.	10	93.3%
p,p' - DDD	N.D.	50	----
ENDOSULFAN I	N.D.	50	107.7%
ENDOSULFAN II	N.D.	50	----
α - BHC	N.D.	10	----
β - BHC	N.D.	10	----
δ - BHC (LINDANE)	N.D.	10	103.6%
δ - BHC	N.D.	10	----
ENDOSULFAN SULFATE	N.D.	100	----
p,p' - METHOXYCHLOR	N.D.	100	----
TOXAPHENE	N.D.	100	----
PCB's*	21000	100	----
CHLORDANE	N.D.	100	98.1%

*PCB 1260

CHROMALAB, INC.

David Duong
Senior Chemist

Eric Tam
Laboratory Director

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E694)
- Drinking Water (#966)
- Waste Water
- Consultation

October 22, 1990

ChromaLab File # 1090137 D

Client: Tech/Art
Attn: Lew Schalit
Date Sampled: Oct. 19, 1990
Date Submitted: Oct. 19, 1990
Date of Analysis: Oct. 20, 1990

Project Name: S Davis Garage, 1432 Harrison Street
Sample I.D.: LB-PP-D 1 (OIL)
Method of Analysis: EPA 8240
Detection Limit: 75000ug/Kg

COMPOUND NAME	ug/Kg	Spike Recovery
CHLOROMETHANE	N.D	---
VINYL CHLORIDE	N.D.	---
BROMOMETHANE	N.D.	---
CHLOROETHANE	N.D.	---
TRICHLOROFLUOROMETHANE	N.D.	102.5% 82.3%
1,1-DICHLOROETHENE	N.D.	---
METHYLENE CHLORIDE	N.D.	---
1,2-DICHLOROETHENE (TOTAL)	N.D.	---
1,1-DICHLOROETHANE	N.D.	---
CHLOROFORM	N.D.	90.5% 91.7%
1,1,1-TRICHLOROETHANE	N.D.	---
CARBON TETRACHLORIDE	N.D.	---
BENZENE	450,000	---
1,2-DICHLOROETHANE	N.D.	---
TRICHLOROETHENE	60,000	---
1,2-DICHLOROPROPANE	N.D.	---
BROMODICHLOROMETHANE	N.D.	---
2-CHLOROETHYLVINYLETHER	N.D.	---
TRANS-1,3-DICHLOROPROPENE	N.D.	---
TOLUENE	3,200,000	93.2% 88.4%
CIS-1,3-DICHLOROPROPENE	N.D.	---
1,1,2-TRICHLOROETHANE	N.D.	---
TETRACHLOROETHENE	94,000	---
DIBROMOCHLOROMETHANE	N.D.	---
CHLOROBENZENE	N.D.	---
ETHYL BENZENE	1,000,000	---
BROMOFORM	N.D.	---
1,1,2,2-TETRACHLOROETHANE	N.D.	---
1,3-DICHLOROBENZENE	N.D.	---
1,4-DICHLOROBENZENE	N.D.	---
1,2-DICHLOROBENZENE	N.D.	91.5% 87.5%
TOTAL XYLENES	7,000,000	---

ChromaLab, Inc.

David Duong
Senior Chemist

Eric Tam
Lab Director

2239 Omega Road, #1 • San Ramon, California 94583
415/831-1788 • Facsimile 415/831-8798

EXHIBIT 5
BOWERS
10/23/90

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E694)
- Drinking Water (#958)
- Waste Water
- Consultation

October 22, 1990

ChromaLab File # 1090137 C

Client: Tech/Art
Attn: Lew Schalit
Date Sampled: Oct. 19, 1990
Date Submitted: Oct. 19, 1990
Date of Analysis: Oct. 20, 1990

Project Name: S Davis Garage, 1432 Harrison Street
Sample I.D.: LB-PP-C \ (AIR)
Method of Analysis: EPA 8240 Detection Limit: 4 ug/L

COMPOUND NAME	ug/L	Spike Recovery
CHLOROMETHANE	N.D	---
VINYL CHLORIDE	N.D.	---
BROMOMETHANE	N.D.	---
CHLOROETHANE	N.D.	---
TRICHLOROFLUOROMETHANE	N.D.	110.8% 95.8%
1,1-DICHLOROETHENE	N.D.	---
METHYLENE CHLORIDE	N.D.	---
1,2-DICHLOROETHENE (TOTAL)	N.D.	---
1,1-DICHLOROETHANE	N.D.	---
CHLOROFORM	N.D.	93.7% 92.8%
1,1,1-TRICHLOROETHANE	N.D.	---
CARBON TETRACHLORIDE	N.D.	---
BENZENE	N.D.	---
1,2-DICHLOROETHANE	N.D.	---
TRICHLOROETHENE	N.D.	---
1,2-DICHLOROPROPANE	N.D.	---
BROMODICHLOROMETHANE	N.D.	---
2-CHLOROETHYLVINYLETHER	N.D.	---
TRANS-1,3-DICHLOROPROPENE	N.D.	---
TOLUENE	N.D.	106.2% 98.5%
CIS-1,3-DICHLOROPROPENE	N.D.	---
1,1,2-TRICHLOROETHANE	N.D.	---
TETRACHLOROETHENE	N.D.	---
DIBROMOCHLOROMETHANE	N.D.	---
CHLOROBENZENE	N.D.	---
ETHYL BENZENE	N.D.	---
BROMOFORM	N.D.	---
1,1,2,2-TETRACHLOROETHANE	N.D.	---
1,3-DICHLOROBENZENE	N.D.	---
1,4-DICHLOROBENZENE	N.D.	---
1,2-DICHLOROBENZENE	N.D.	97.1% 103.1%
TOTAL XYLENES	4.4	---

ChromaLab, Inc.

David Duong
Senior Chemist

Eric Tam
Lab Director

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E694)
- Drinking Water (#955)
- Waste Water
- Consultation

October 22, 1990

ChromaLab File No.: 1090137D

TECH-ART

Attn: Lew Schalit

RE: 8080 analysis
Client Sample Number: LS-PP-D
Project Location: 1432 HARRISON STREET
Date Analyzed: October 22, 1990

CHLORINATED PESTICIDE ANALYSIS

COMPOUNDS	CONCENTRATION (ug/Kg)	DETECTION LIMIT (ug/Kg)	SPIKE RECOVERY
ALDRIN	N.D.	10	----
DIELDRIN	N.D.	10	----
ENDRIN ALDEHYDE	N.D.	50	----
ENDRIN	N.D.	10	102.0%
HEPTACHLOR	N.D.	10	----
HEPTACHLOR EPOXIDE	N.D.	10	----
p,p' - DDT	N.D.	50	101.6%
p,p' - DDE	N.D.	10	93.3%
p,p. - DDD	N.D.	50	----
ENDOSULFAN I	N.D.	50	107.7%
ENDOSULFAN II	N.D.	50	----
α - BHC	N.D.	10	----
β - BHC	N.D.	10	----
δ - BHC (LINDANE)	N.D.	10	103.6%
δ - BHC	N.D.	10	----
ENDOSULFAN SULFATE	N.D.	100	----
p,p' - METHOXYCHLOR	N.D.	100	----
TOXAPHENE	N.D.	100	----
PCB's*	21000	100	----
CHLORDANE	N.D.	100	98.1%

*PCB 1260

CHROMALAB, INC.

David Duong
Senior Chemist

Eric Tam
Laboratory Director

2239 Omega Road, #1 • San Ramon, California 94583
415/831-1788 • Facsimile 415/831-8798

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#5604)
- Drinking Water (#965)
- Waste Water
- Consultation

October 22, 1990

ChromaLab File # 1090137 B

Client: Tech/Art
Date Sampled: Oct. 19, 1990
Date of Analysis: Oct. 20, 1990

Attn: Lew Schalit
Date Submitted: Oct. 19, 1990

Project Name: S Davis Garage, 1432 Harrison Street
Sample I.D.: MGF-B-MUNCK (AIR)
Method of Analysis: EPA 8240 Detection Limit: 4 ug/L

COMPOUND NAME	ug/L	Spike Recovery
CHLOROMETHANE	N.D	---
VINYL CHLORIDE	N.D.	---
BROMOMETHANE	N.D.	---
CHLOROETHANE	N.D.	---
TRICHLOROFLUOROMETHANE	N.D.	110.8% 95.8%
1,1-DICHLOROETHENE	N.D.	---
METHYLENE CHLORIDE	N.D.	---
1,2-DICHLOROETHENE (TOTAL)	N.D.	---
1,1-DICHLOROETHANE	N.D.	---
CHLOROFORM	N.D.	93.7% 92.8%
1,1,1-TRICHLOROETHANE	N.D.	---
CARBON TETRACHLORIDE	N.D.	---
BENZENE	N.D.	---
1,2-DICHLOROETHANE	N.D.	---
TRICHLOROETHENE	N.D.	---
1,2-DICHLOROPROPANE	N.D.	---
BROMODICHLOROMETHANE	N.D.	---
2-CHLOROETHYLVINYLETHER	N.D.	---
TRANS-1,3-DICHLOROPROPENE	N.D.	---
TOLUENE	N.D.	106.2% 98.5%
CIS-1,3-DICHLOROPROPENE	N.D.	---
1,1,2-TRICHLOROETHANE	N.D.	---
TETRACHLOROETHENE	N.D.	---
DIBROMOCHLOROMETHANE	N.D.	---
CHLOROBENZENE	N.D.	---
ETHYL BENZENE	N.D.	---
BROMOFORM	N.D.	---
1,1,2,2-TETRACHLOROETHANE	N.D.	---
1,3-DICHLOROBENZENE	N.D.	---
1,4-DICHLOROBENZENE	N.D.	97.1% 103.1%
1,2-DICHLOROBENZENE	N.D.	---
TOTAL XYLENES	N.D.	---

ChromaLab, Inc.

David Duong
Senior Chemist

Eric Tam
Lab Director

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E684)
- Drinking Water (#955)
- Waste Water
- Consultation

October 12, 1990

ChromaLab File No.: 0990181

TECH-ART

Attn: Lew Schallit

RE: Four soil samples for Gasoline/BTEX, and Oil & Grease analyses

Date Sampled: Sept. 28,1990
Date Extracted: Oct. 4-11, 1990

Date Submitted: Sept. 28, 1990
Date Analyzed: Oct. 4-11, 1990

RESULTS:

Sample No.	Gasoline (mg/Kg)	Benzene (ug/Kg)	Toluene (ug/Kg)	Ethyl Benzene (ug/Kg)	Total Xylenes (ug/Kg)	Oil & Grease (mg/Kg)
floor drain LB #1	----	N.D.	7.3	6.9	21	----
LB #2	N.D.	N.D.	N.D.	N.D.	N.D.	----
CHUNK #5	----	----	----	----	----	N..D.
LB #6	N.D.	N.D.	N.D.	N.D.	N.D.	----
BLANK SPIKED	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
RECOVERY	91.7%	98.6%	99.1%	103.5%	105.6%	----
DUP SPIKED RECOVERY	91.1%	89.3%	89.7%	90.05	107.6%	----
DETECTION LIMIT	2.5	5	5	5	5	10
METHOD OF ANALYSIS	5030/ 8015	8020	8020	8020	8020	503 D&E

CHROMALAB, INC.

David Duong
Senior Chemist

Eric Tam
Laboratory Director

floor drain channel LB#1 B:T:E:X = 5:7:7:21 = ~1:1:3

CHROMALAB, INC.

street level sale near elevator

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E894)
- Drinking Water (#D85)
- Waste Water
- Consultation

October 12, 1990

ChromaLab File # 0990161 a

Client: Tech-Art
Date Sampled: Sept. 28, 1990
Date of Analysis: Oct. 12, 1990

Attn: Lew Schalit
Date Submitted: Sept. 28, 1990

Project Name:
Sample I.D.: MGF # 7
Method of Analysis: EPA 8240

Project No.:
Detection Limit: 10 ug/Kg

COMPOUND NAME	ug/Kg	Spike Recovery
CHLOROMETHANE	N.D.	---
VINYL CHLORIDE	N.D.	---
BROMOMETHANE	N.D.	---
CHLOROETHANE	N.D.	---
TRICHLOROFLUOROMETHANE	N.D.	---
1,1-DICHLOROETHENE	N.D.	98.5% 97.2%
METHYLENE CHLORIDE	N.D.	---
1,2-DICHLOROETHENE (TOTAL)	18	---
1,1-DICHLOROETHANE	N.D.	---
CHLOROFORM	N.D.	---
1,1,1-TRICHLOROETHANE	N.D.	---
CARBON TETRACHLORIDE	N.D.	96.5% 98.2%
BENZENE	N.D.	---
1,2-DICHLOROETHANE	10	---
TRICHLOROETHENE	N.D.	---
1,2-DICHLOROPROPANE	N.D.	---
BROMODICHLOROMETHANE	N.D.	---
2-CHLOROETHYLVINYLETHER	N.D.	---
TRANS-1,3-DICHLOROPROPENE	N.D.	---
TOLUENE	N.D.	---
CIS-1,3-DICHLOROPROPENE	30	---
1,1,2-TRICHLOROETHANE	N.D.	---
TETRACHLOROETHENE	N.D.	110.5% 102.5%
DIBROMOCHLOROMETHANE	N.D.	---
CHLOROBENZENE	N.D.	---
ETHYLBENZENE	16	---
BROMOFORM	10	---
1,1,2,2-TETRACHLOROETHANE	N.D.	---
1,3-DICHLOROBENZENE	N.D.	---
1,4-DICHLOROBENZENE	N.D.	---
1,2-DICHLOROBENZENE	N.D.	---
TOTAL XYLENES	68	92.3% 110.6%

ChromaLab, Inc

B:T:E:X = 1:3:1:7

David Duong
Senior Chemist

Eric Tam
Lab Director

2239 Omega Road, #1 • San Ramon, California 94583
415/831-1788 • Facsimile 415/831-8798
Federal ID #68-0142157

8-4

CHROMALAB, INC.

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#2094)
- Drinking Water (#955)
- Waste Water
- Consultation

October 12, 1990

basement

ChromaLab File # 0990165

Tech-Art

Attn: Lew Schalit

Re: One soil sample for Gasoline/BTEX analysis

Date Sampled: Sept. 29, 1990
Date Analyzed: Oct. 12, 1990
Date Submitted: Sept. 29, 1990

Results:

Sample No.	Gasoline (mg/Kg)	Benzene (ug/Kg)	Toluene (ug/Kg)	Ethyl Benzene (ug/Kg)	Total Xylenes (ug/Kg)
a*	24	N.D.	N.D.	6.0	4.7
BLANK	N.D.	N.D.	N.D.	N.D.	N.D.
SPIKE RECOVERY	91.1%	89.3%	89.7%	90.0%	107.6%
DETECTION LIMIT	2.5	5.0	5.0	5.0	5.0
METHOD OF ANALYSIS	5030/8015	8020	8020	8020	8020

*Sample may consist of aged gasoline and/or diesel fuel

ChromaLab, Inc.

David Duong
Senior Chemist

Eric Tam
Laboratory Director

E; X ≅

2239 Omega Road, #1 • San Ramon, California 94583
415/831-1788 • Facsimile 415/831-8798

B-6

FEDERAL EXPRESS

QUESTIONS? CALL 800-238-5355 TOLL FREE

AIRBILL
PACKAGE TRACKING NUMBER 814258126

8142581263

RECIPIENT'S COPY

Date

From (Your Name) Please Print: Jonathan W. Redding

Your Phone Number (Very Important): (415)451-3300

Company: FITZGERALD ABBOTT & BEARDSLEY

Department/Floor No.

Street Address: 1221 BROADWAY 21ST FLR

City: OAKLAND State: CA ZIP Required: 94612

To (Recipient's Name) Please Print: Selinda Bendix, Ph.D.

Recipient's Phone Number: ( )

Company: Bendix Enviornmental Reasearch, I

Department

Exact Street Address: 1390 Market Street, Suite 418

City: San Francisco State: CA ZIP Required: 94102

YOUR INTERNAL BILLING REFERENCE INFORMATION (First 24 characters will appear on invoice.)

IF HOLD FOR PICK-UP, Print FEDEX Address Here: Street Address, City, State, ZIP Required

PAYMENT 1 [X] Bill Sender 2 [ ] Bill Recipient's FedEx Acct. No. 3 [ ] Bill 3rd Party FedEx Acct. No. 4 [ ] Bill Credit Card 5 [ ] Cash

SERVICES (Check only one box)

Priority Overnight Service (Delivery by next business morning†)
- 11 [ ] YOUR PACKAGING
- 16 [X] FEDEX LETTER *
- 12 [ ] FEDEX PAK *
- 13 [ ] FEDEX BOX
- 14 [ ] FEDEX TUBE

Standard Overnight Service (Delivery by next business afternoon†)
- 51 [ ]
- 56 [ ] FEDEX LETTER *
- 52 [ ] FEDEX PAK *
- 53 [ ] FEDEX BOX
- 54 [ ] FEDEX TUBE

Economy Service (formerly Standard Air) (Delivery by second business day†)
- 30 [ ] ECONOMY SERVICE

Heavyweight Service (for Extra Large or any package over 150 lbs.)
- 70 [ ] HEAVYWEIGHT **
- 80 [ ] DEFERRED HEAVYWEIGHT **

† Delivery commitment may be later in some areas. * Declared Value Limit $100 ** Call for delivery schedule

DELIVERY AND SPECIAL HANDLING
- 1 [ ] HOLD FOR PICK-UP
- 2 [X] DELIVER WEEKDAY
- 3 [ ] DELIVER SATURDAY (Extra charge)
- 4 [ ] DANGEROUS GOODS (Extra charge)
- 5 [ ] CONSTANT SURVEILLANCE SVC. (CSS) (Extra charge)
- 6 [ ] DRY ICE ____ Lbs.
- 7 [ ] OTHER SPECIAL SERVICE
- 8 [ ]
- 9 [ ] SATURDAY PICK-UP (Extra charge)
- 10 [ ]
- 11 [ ]
- 12 [ ] HOLIDAY DELIVERY (Extra charge)

Packages / Weight / Your Declared Value / Total Total Total

DIM SHIPMENT [ ] ____ lbs

Received At: Regular Stop / Drop Box / On-Call Stop / S.C. Station

FedEx Emp. No.

Emp. No. / Date
- [ ] Cash Received
- [ ] Return Shipment
- [ ] Third Party [ ] Chg. To Del. [ ] Chg. To Hold

Street Address / City / State / Zip

Received By X

Date/Time Received / FedEx Employee Number

5 Release Signature

Date/Time

Federal Express Use: Base Charges / Declared Value Charge / Other 1 / Other 2 / Total Charges

014

8

CHROMALAB, INC.

Dup

Analytical Laboratory
Specializing in GC-GC/MS

- Environmental Analysis
- Hazardous Waste (#E694)
- Drinking Water (#955)
- Waste Water
- Consultation

October 12, 1990

ChromaLab File # 0990161 C

Client: Tech-Art
Attn: Lew Schalit
Date Sampled: Sept. 28, 1990
Date Submitted: Sept. 28, 1990
Date of Analysis: Oct. 12, 1990

Project Name:
Project No.:
Sample I.D.: LB #3
Method of Analysis: EPA 8240
Detection Limit: 200 mg/Kg*

COMPOUND NAME	mg/Kg	Spike Recovery
CHLOROMETHANE	N.D	---
VINYL CHLORIDE	N.D.	---
BROMOMETHANE	N.D.	---
CHLOROETHANE	N.D.	---
TRICHLOROFLUOROMETHANE	N.D.	98.5% 97.2%
1,1-DICHLOROETHENE	N.D.	---
METHYLENE CHLORIDE	N.D.	---
1,2-DICHLOROETHENE (TOTAL)	N.D.	---
1,1-DICHLOROETHANE	N.D.	---
CHLOROFORM	N.D.	96.5% 98.2%
1,1,1-TRICHLOROETHANE	N.D.	---
CARBON TETRACHLORIDE	N.D.	---
BENZENE	950 ←	---
1,2-DICHLOROETHANE	N.D.	---
TRICHLOROETHENE	N.D.	---
1,2-DICHLOROPROPANE	N.D.	---
BROMODICHLOROMETHANE	N.D.	---
2-CHLOROETHYLVINYLETHER	N.D.	---
TRANS-1,3-DICHLOROPROPENE	N.D.	---
TOLUENE	6300 ←	---
CIS-1,3-DICHLOROPROPENE	N.D.	---
1,1,2-TRICHLOROETHANE	N.D.	110.5% 102.5%
TETRACHLOROETHENE	N.D.	---
DIBROMOCHLOROMETHANE	N.D.	---
CHLOROBENZENE	N.D.	---
ETHYLBENZENE	1000 ←	---
BROMOFORM	N.D.	---
1,1,2,2-TETRACHLOROETHANE	N.D.	---
1,3-DICHLOROBENZENE	N.D.	---
1,4-DICHLOROBENZENE	N.D.	---
1,2-DICHLOROBENZENE	N.D.	92.3% 110.8%
TOTAL XYLENES	5900 ←	---

*High detection limit due to presence of high concentration of compounds in sample.

ChromaLab, Inc.

David Duong
Senior Chemist

Eric Tam
Lab Director

CHROMALAB, INC.

2239 Omeg
415/

CHROMALAB FILE # 990161

13

Chain of Cust

PROJ. MGR. Lew Scheidt
COMPANY Tech-Ltt
ADDRESS
SAMPLERS (SIGNATURE) (PHONE NO.)

DATE PAGE OF

ANALYSIS REQUEST

SAMPLE ID.	DATE	TIME	MATRIX	LAB ID.	TPH - Gasoline (EPA 5030)	TPH - Gasoline (5030) W/BTEX (EPA 602, 8020)	TPH - Diesel (EPA 3510, 3550)	PURGEABLE AROMATICS BTEX (EPA 602, 8020)	PURGEABLE HALOCARBONS (EPA 601, 8010)	VOLATILE ORGANICS (EPA 624, 8240)	BASE/NEUTRALS, ACIDS (EPA 625/627, 8270)	TOTAL OIL & GREASE (EPA 5030E)	PESTICIDES/PCB (EPA 608, 8080)	PHENOLS (EPA 604, 8040)	ASBESTOS		METALS: Cd, Cr, Pb, Zn	CAM METALS (17) W/Cr VI	PRIORITY POLLUTANT METALS (13)						
LB #1 / CONTRACOIL CH	9-28	8:05A	oily					X																
LB #2 soil under R-H. TANK	↓	8:10	soil			X																		
LB #3 L.H. TANK Contact		9:00	oily									FOR RH DOUBLE TANK SET								any hint of				
LB #4 [illegible] CEILING PICK INS			ASB							X		FOR WHICH TANK, DOUBLE SET												
CHUNK #5 Black Stuff		8:45	soil												76					Composite				
LB #6 Corner, Surface, UST		9:00									X			TK SUMP										
MGF #7 [illegible] & CRUSHED STONE					X										250									
									X											MAP GROUP #1				
				1	300		115		190		95			75										

PROJECT INFORMATION	
PROJECT:	
PO NO.	
SHIPPING ID. NO.	
VIA:	

SAMPLE RECEIPT	
TOTAL NO. OF CONTAINERS	
CHAIN OF CUSTODY SEALS	
REC'D GOOD CONDITION/COLD	
CONFORMS TO RECORD	
LAB NO.	

SPECIAL INSTRUCTIONS/COMMENTS:

10 DAYS T-A-T

RELINQUISHED BY 1.	RELINQUISHED BY 2.	RELINQUISHED BY
(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
(Company)	(Company)	(Company)
RECEIVED BY 1.	RECEIVED BY 2.	RECEIVED BY (LABORATORY)
(Signature) (Time)	(Signature) (Time)	(Signature) (Time)
(Printed Name) (Date)	(Printed Name) (Date)	(Printed Name) (Date)
(Company)		

CHROMALAB, INC.

2239 Omega Road, #1 • San Ramon, California 94583
415/831-1788 • Facsimile 415/831-8798

Chain of Custody

DATE 9/29/90 PAGE 1 OF 1

OR. L. SCHALIT
INV TECH/ART
ESS 462 DOUGLASS ST
SAN FRANCISCO CA 94114

RS (SIGNATURE) (PHONE NO.)
Lew Schalit 415-550-2435

MPLE ID.	DATE	TIME	MATRIX	LAB ID.
	9/29	10[13]	SOIL	
R. BASEMENT				
SWEL UNDER R				

ANALYSIS REQUEST

TPH - Gasoline (EPA 5030)	TPH - Gasoline (5030) w/BTEX (EPA 602, 8020)	TPH - Diesel (EPA 3510, 3550)	PURGEABLE AROMATICS BTEX (EPA 602, 8020)	PURGEABLE HALOCARBONS (EPA 601, 8010)	VOLATILE ORGANICS (EPA 624, 8240)	BASE/NEUTRALS, ACIDS (EPA 625/627, 8270)	TOTAL OIL & GREASE (EPA 5030E)	PESTICIDES/PCB (EPA 608, 8080)	PHENOLS (EPA 604, 8040)			METALS: Cd, Cr, Pb, Zn	CAM METALS (18) w/Cr VI	PRIORITY POLLUTANT METALS (13)							NUMBER OF CONTAINERS
	X		look for diesel fraction & information																		1
			take sample from jar top																		
	150																				

CHROMALAB FILE # 990165

PROJECT INFORMATION
Harrison ST
PO. NO.

SAMPLE RECEIPT

TOTAL NO. OF CONTAINERS	1
CHAIN OF CUSTODY SEALS	
REC'D GOOD CONDITION/COLD	
CONFORMS TO RECORD	
LAB NO.	

INSTRUCTIONS/COMMENTS:
10 DAY TURNAROUND
RUSH 10/10

RELINQUISHED BY 1.	RELINQUISHED BY 2.	RELINQUISHED BY 3.
(Signature) Lew Schalit 11[19] (Time)	(Signature) (Time)	(Signature) (Time)
(Printed Name) LEW SCHALIT 9/29/90 (Date)	(Printed Name) (Date)	(Printed Name) (Date)
(Company)	(Company)	(Company)
RECEIVED BY 1.	**RECEIVED BY 2.**	**RECEIVED BY (LABORATORY) 3**
(Signature) (Time)	(Signature) (Time)	1115 (Time)
(Printed Name) (Date)	(Printed Name) (Date)	(Signature) (Time)
(Company)	(Company)	(Printed Name) (Date)
		(LAB)

SECTION 2
SITE DESCRIPTION AND HISTORY

The subject site is located in downtown Oakland and is bordered by Harrison Street on the west and Alice Street on the east, between 14th and 15th Streets (Figure 1). Lake Merritt is located approximately one-quarter mile east of the subject site. Figure 2 presents a site plan that outlines the building perimeter, adjacent streets, and suspected locations of both on-site and off-site USTs.

A garage facility utilized for parking automobiles and light trucks currently exists on the site, and essentially consists of two directly adjoining buildings. The first is the principal entrance to the parking garage at 1432 Harrison Street. This single-story building contains a partial mezzanine and is constructed of timber and masonry. The second is a multi-story garage that is on the Alice Street portion of the property and is constructed of reinforced concrete. Historical aerial photographs date construction of the buildings back some forty to fifty years.

Results of Previous Investigations

Previous investigations by others indicate that the soil is contaminated beneath the site and that such contamination includes measurable quantities of gasoline and diesel fuels, benzene, toluene, ethylbenzene, and xylenes (BTEX) aromatic constituents, and PCBs. The reported analytical results (Table 1) are based on analyses of selected soil samples collected during the drilling of 6 exploratory borings by Subsurface Consultants in October 1990. The Subsurface Consultants' report also indicates that subsurface materials consist primarily of dense, fine-grained sands containing varying amounts of clay and silt. Published geologic maps indicate that these sediments are part of the Merritt Sand Formation. Groundwater was encountered by Subsurface Consultants during the drilling at depths ranging from 23 to 25 feet below the Harrison Street grade. Information regarding groundwater flow direction is not available; however, it is presumed to flow eastward toward Lake Merritt.

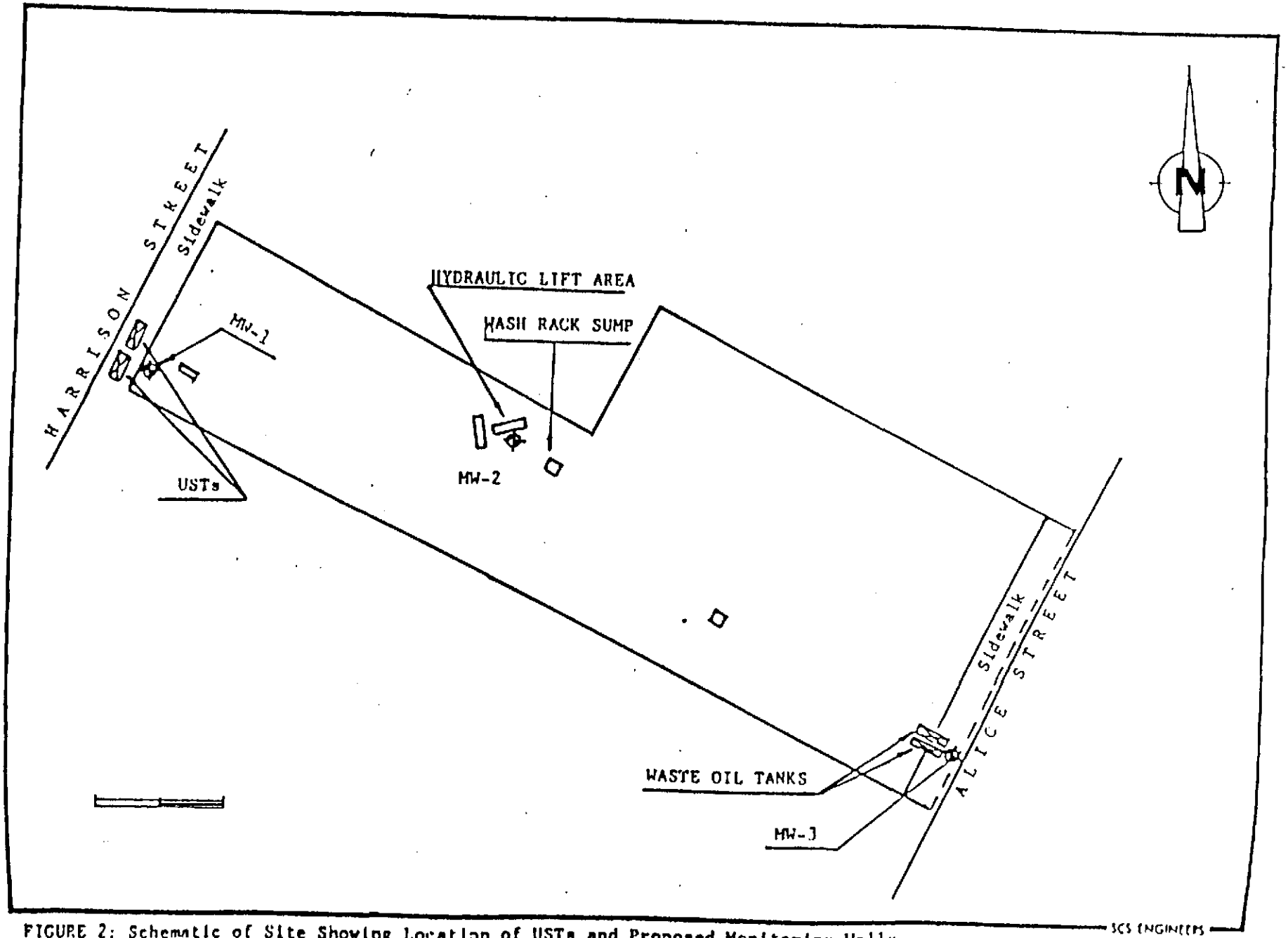


FIGURE 2: Schematic of Site Showing Location of USTs and Proposed Monitoring Wells

TABLE 1. CONTAMINANT CONCENTRATIONS IN SOIL (CONT'D)
(Results of Subsurface Consultants October 1990 Investigation)

Boring No. & Depth (ft)	TVH[1] (ppm)	B[2] (ppb)	T[3] (ppb)	X[4] (ppb)	X[5] (ppb)	TOG[6] (ppm)	TKH[7] (ppm) Keros./Diesel	OTHER 8010/Sol Pb/PCBs ---/(ppm)/(ppb)
B7 @ 13	ND	ND	ND	ND	ND			
B7 @ 20	2,500	3,500	34,000	130,000	33,000	---	---/---	---/0.07/---
B8 @ 22.5	1,200	2,300	38,000	89,000	18,000	---	---/---	---/---/---

1 Total Volatile Hydrocarbons, mg/kg = ppm
2 Benzene, ug/kg = ppb
3 Toluene
4 Xylene
5 Ethylbenzene
6 Total Oil & Grease
7 Total Extractable Hydrocarbons (as kerosene and diesel)
8 --- = Not tested for
9 ND = Not detected

Suspected sources of contamination may include either on-site and/or off-site USTs. The lateral and vertical extent of contamination has not yet been defined. A previous geophysical investigation by J. R. Associates completed in August 1990 disclosed the presence of several USTs and associated facilities within the boundaries of the subject site. A description of these tanks and a summary of investigative and remedial actions which have been performed to date are presented below.

Waste Oil Tanks

Two waste oil tanks are located beneath the basement floor of the multi-story parking structure along Alice Street. Figure 3 shows the tanks and associated piping and vent lines in the area. The date of installation of these tanks is unknown. No records have been located which have documented the capacity or composition of these tanks. However, it is believed that each tank has an approximately 1000-gallon capacity and is of steel construction. On October 27, 1990, Falcon Energy drained the contents of both tanks by removing a combined total of 1300-gallons of waste oil from them.

Gasoline Tanks

Two gasoline tanks are located near the western property boundary beneath the Harrison Street sidewalk in front of the entrance to the garage. Permits issued to a former long-term tenant of the garage, Douglas Motor Services, show that these tanks each have 1000-gallon capacities, are of steel construction, and were installed in 1975 and 1982, respectively. On October 27, 1990, Falcon Energy removed most gasoline (total less than 200 gallons) from the tanks. The condition of these two tanks is unknown, although a sample collected from one was discolored by rust. The recovered gasoline and waste oil was accepted and utilized by a recycling contractor.

It should be noted that there is evidence of two other abandoned-in-place USTs a few feet west of the above-described gasoline tanks, beneath the Harrison Street sidewalk of the adjacent property. These tanks and property are owned and operated by other parties.

Hydraulic Lift Area

The recent J. R. Associates geophysical investigation also identified a probable underground fluid reservoir located near the hydraulic lift area as well as three hydraulic lift rams inside the Harrison Street parking garage. Figure 4 shows the hydraulic lifts and associated piping in the area; the area of the Ground Penetrating Radar (GPR) anomaly marks the suspected location of the underground fluid reservoir.

There is no available record to indicate that integrity testing has ever been performed on any of the above-described tanks. The tanks are suspected to be the principal source(s) of the site's contamination. However, the time(s) of occurrence and total quantity of product(s) lost cannot be estimated at this time.

Addendum 1 to the
RGA Environmental, Inc., May 8, 1992
Health and Safety Plan for the
Harrison Street Garage
Underground Tank Closure Project
Oakland, California

August 31, 1992
2680.02

Prepared for:

Alvin H. Bacharach and Barbara Jean Borsuk
383 Diablo Road, Suite 100
Danville, California 94526

LEVINE·FRICKE

LEVINE•FRICKE
ENGINEERS, HYDROGEOLOGISTS & APPLIED SCIENTISTS

August 31, 1992 LF 2680.2

Mr. Paul Smith
Senior Hazardous Materials Specialist
Alameda County Health Care Services
Department of Environmental Health
80 Swan Way, Room 200
Oakland, California 94621

Subject: Enclosed Addendum to the Site Health and Safety Plan for the Harrison Street Garage UST Closure Project, 1432 - 1434 Harrison Street, Oakland, California

Dear Mr. Smith:

Enclosed are two copies of Levine•Fricke's Addendum to the Site Health and Safety Plan (HSP) for the subject project. Levine•Fricke prepared this HSP Addendum in response to a request from Mr. Alvin H. Bacharach and Mrs. Barbara Jean Borsuk.

This plan addresses human health and safety concerns that have been identified in the original HSP, which was prepared by RGA Environmental, Inc., dated March 26, 1992. It is our intent to implement the RGA HSP in addition to this enclosed addendum.

In our meeting on July 16, 1992, we discussed a number of issues concerning the UST closure project. Many of the issues discussed were health and safety concerns that have been addressed in this addendum. Some issues, which were not primarily health and safety issues, will be described in a Work Plan that will be submitted to you. The Work Plan will describe the order of work activities. Additionally, the Work Plan will describe the sampling and analysis procedures for soil sampling under the waste oil tank and wipe sampling of the hydraulic lifts.

1900 Powell Street, 12th Floor
Emeryville, California 94608
(510) 652-4500
Fax (510) 652-2246

If you have any questions, please call either of the undersigned.

Sincerely,

Shari A. Samuels
Health and Safety Director

John Sturman, P.E.
Senior Project Engineer

cc: Mr. Alvin H. Bacharach
Mr. Randall Morrison - Crosby, Heafey, Roach & May

CONTENTS

CONTENTS
(continued)

August 31, 1992 2680.02

**ADDENDUM 1 TO THE
RGA ENVIRONMENTAL, INC., MAY 8, 1992
HEALTH AND SAFETY PLAN FOR THE
HARRISON STREET GARAGE
UNDERGROUND TANK CLOSURE PROJECT
OAKLAND, CALIFORNIA**

1.0 INTRODUCTION

This Addendum Number 1 to the May 8, 1992 Health and Safety Plan (HSP), which was prepared by RGA Environmental, Inc., addresses health- and safety-related issues associated with the planned underground tank closure at the Harrison Street Garage in Oakland, California (herein referred to as "the Site"). Specifically, this addendum provides an air monitoring plan, describes precautions to be taken in connection with ventilation during work in the basement area, and stipulates the levels of personal protective equipment (PPE), the site security and work zones, and the responsibilities of health and safety personnel. The Addendum does not address asbestos exposure. A qualified asbestos contractor will remove all accessible pipe before commencement of work addressed in the current HSP and this Addendum.

The current HSP and the Addendum shall be kept on site and made available for reference during all field activities. All site personnel and visitors must read the current HSP and Addendum before accessing the Site. In addition to the procedures and safeguards outlined in the current HSP and this Addendum, Levine·Fricke personnel and contract/subcontract employees shall follow applicable federal, State of California, and local regulations.

2.0 SOIL STOCKPILING AND SAMPLING

Remedial activities to be conducted at the Site will require excavation and stockpiling of soil that is affected and unaffected. Excavated soil will be segregated into affected and unaffected stockpiles to the extent possible, before being removed off site. Affected soils will be stockpiled away from the work area and covered with plastic sheeting. One sample for every 50 cubic yards of soil will be collected from all stockpiles for analysis of the chemicals of concern by a state-certified laboratory. Analytical results will be used

to assess treatment and/or disposal methods. The Levine·Fricke Site Safety Office (see Section 7.0) will monitor soil stockpiling using an organic vapor analyzer (OVA) or photoionization detector (PID). A record of the concentrations detected will be maintained in the project file.

3.0 CHEMICALS OF CONCERN

Table 1 provides the chemicals of concern and their exposure limits for planned field activities at the Site. This includes investigation and analytical data from previous reports prepared by Subsurface Consultants, SCS Engineers, Chromalab, Inc., and RGA Environmental. Appendix A contains chemical descriptions of these chemicals.

Mercury was detected at concentrations of 49.7 parts per million (ppm) to 74.2 ppm in borings in the basement area. The potential health hazard associated with soil containing mercury at these concentrations is addressed in Appendix B. Based on this evaluation, monitoring for heavy metals will not be conducted.

4.0 AIR MONITORING PLAN

Air quality will be monitored inside the garage area and at all access points during removal and/or remediation activities. Monitoring will be conducted by the Levine·Fricke Site Safety Officer (see Section 7.0) or a qualified designee. Air monitoring results will be maintained in an on-site log book, which will be available for review and will become part of the permanent project record. The proper operation and calibration of all monitoring equipment will be in accordance with the manufacturer's instructions.

Table 2 outlines the tasks to be performed, each constituent of concern, the monitoring device that will be used to detect the constituent, and the frequency of sampling.

5.0 BASEMENT VENTILATION

Ventilation in the basement area will include opening the sidewalk vents and removing the "glass bottle" portion of the sidewalk to increase the natural dilution ventilation within the garage. In addition, one of more local fans will be provided in the basement to improve air circulation if

necessary. Carbon monoxide concentrations will be continually measured in accordance with Table 2 to check that sufficient air movement is occurring.

6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 Purpose

The purpose of Personal Protective Equipment (PPE) is to protect employees from hazards and potential hazards they are likely to encounter.

6.2 Description of Levels of Protection

Levels of protection have been defined by the EPA in the EPA Standard Operating Guide, 1984, although there are numerous variations and modifications possible with each level. The levels are defined below.

- Level A requires a totally encapsulated, chemically resistant suit with self-contained breathing apparatus (SCBA).
- Level B requires provision of maximal respiratory protection using supplied air or SCBA, with dermal protection being selected on the basis of anticipated hazards.
- Level C incorporates an air-purifying respirator that is specific to the chemicals or particulates of concern. The degree of dermal protection depends on anticipated hazards.
- Level D is an industrial work uniform, including steel-toed boots, hard hat, and safety glasses.

The type and material of PPE will be modified or upgraded to accommodate the hazards present during each operation as specified by the Site Safety Officer (see Section 7.0).

6.3 Inside the Garage Area

All personnel performing tasks within the exclusion zone inside the garage area (nonbasement area) will wear the following PPE:

- Tyvek coveralls taped at the boot and gloves
- steel-toed boots

- latex inner and nitrile outer gloves
- safety glasses
- hearing protection.

6.4 Inside the Basement Area

All personnel performing tasks within the exclusion zone inside the basement area of the garage will wear the following PPE:

- NIOSH-approved half-face air-purifying respirator (APR) equipped with a Organic Vapor cartridges
- Tyvek coveralls taped at the boot and gloves
- steel-toed boots
- latex inner and nitrile outer gloves
- safety glasses
- hearing protection.

6.5 On the Sidewalk Outside the Garage Area

All personnel performing the tasks within the exclusion zone on the sidewalk outside of the garage area will wear the following PPE:

- Tyvek coveralls taped at the boot and gloves
- steel-toed boots
- latex inner and nitrile outer gloves
- safety glasses
- hearing protection.

6.6 Action Levels

The Site Safety Officer (see Section 7.3) shall impose a temporary stop work and contact the Levine·Fricke Health and Safety Director immediately if the following conditions are observed, or if there is a questions about site conditions:

- uncontrolled dust generation
- indications of heat stress
- changes in the general health profile of on-site personnel, including symptoms discussed in Appendix A and headaches, dizziness, breathing difficulties, irritation to the eyes, nose, throat, and hands
- a lower explosive limit/oxygen reading in excess of 10
- detection of benzene in the breathing zone using the sensidyne pump and tubes.

Action Level for Upgrade to Level C Protection

Detection of ambient air VOC concentrations in the breathing zone at 50 ppm or greater on the PID or OVA will require upgrading to Level C protection.

7.0 KEY PERSONNEL AND RESPONSIBILITIES

John Sturman (Levine•Fricke)	Project Manager
Michael J. Stoll (Levine•Fricke)	Site Safety Officer
Shari A. Samuels (Levine•Fricke)	Health and Safety Director
Dr. M. Joseph Fedoruk	Certified Industrial Hygienist

7.1 Levine•Fricke Project Manager

The Levine•Fricke Project Manager, Mr. John Sturman, has the ultimate responsibility for assuring compliance with the HSP for all personnel on site. As part of his duties, Mr. Sturman will be responsible for the following:

1. informing the Levine•Fricke Health and Safety Director of developments on the project
2. monitoring that all Levine•Fricke personnel on site have received the proper training and have been educated as to the potential hazards anticipated on the Site, as well as the procedures and precautions to be implemented on the job

3. informing all subcontractors and observers as to the hazards expected at the Site and appropriate protective measures (subcontractors and observers also will be given a copy of Levine•Fricke's HSP for review)

4. securing all necessary resources to provide a safe and healthy work environment for all personnel.

7.2 Levine•Fricke Health and Safety Director

The Levine•Fricke Health and Safety Director is Shari A. Samuels. Ms. Samuels is responsible for the following:

1. monitoring the health and safety impacts of this project on personnel performing work at the Site

2. assessing the potential health and safety hazards existing on site

3. recommending appropriate safeguards and procedures

4. modifying the HSP, when necessary

5. approving any changes in safeguards used or operating procedures employed on site.

The Levine•Fricke Health and Safety Director shall have the authority to:

1. require that additional safety precautions or procedures be implemented

2. order an evacuation of portions of the Site or shut down any of the work activities if she believes a health or safety hazard exists

3. deny access to the Site to unauthorized personnel and restrict observers to the Support Zone (see Section 8.3.3)

4. require that any worker obtain immediate medical attention

5. approve or disallow any proposed modifications to safety precautions or working procedures.

7.3 Site Safety Officer

The Site Safety Officer (SSO) designated by Levine•Fricke is Michael J. Stoll, Staff Geotechnical Engineer.

The SSO, or a trained designated alternate, will be present at the Site during work activities. The SSO shall be notified of and approve activities in which persons may be reasonably expected to be exposed to affected soils and/or ground water.

The SSO shall be responsible for the following:

1. monitoring that all Levine·Fricke and subcontractor personnel complying with the requirements of the HSP

2. limiting access to the Contamination Reduction and Exclusion Zones (see Section 8.0) at the Site

3. reporting unusual or potentially hazardous conditions to the Levine·Fricke Health and Safety Director, the Levine·Fricke Project Manager, and Alameda County representatives

4. reporting injuries, exposures, or illnesses to the Levine·Fricke Health and Safety Director, and the Levine·Fricke Project Manager

5. communicating proposed changes in work scope or procedures to the Levine·Fricke Health and Safety Director and Alameda County representatives for approval

6. recommending to the Levine·Fricke Health and Safety Director, the Levine·Fricke Project Manager, and Alameda County representatives additional safety procedures or precautions that might be implemented

7. conducting required air monitoring.

The SSO shall have the authority to:

1. order an evacuation of portions of the Site or shut down any of the work activities if he/she believes a health or safety hazard exists

2. deny site access to unauthorized personnel and restrict observers to the Support Zones (see Section 8.3.3)

3. require that any worker, including the subcontractor's personnel, obtain immediate medical attention.

7.4 Certified Industrial Hygienist (CIH)

Levine·Fricke will subcontract the services of M. Joseph Fedoruk, M.D., Inc. Dr. Fedoruk is a Certified Industrial

Hygienist (CIH). He will work directly with Levine·Fricke's Health and Safety Director to provide his professional expertise to oversee and approve the procedures and safeguards included in the HSP and Addendum.

8.0 SITE SECURITY AND WORK ZONES

8.1 Purpose

Controls must be implemented at the Site to reduce the possibility of exposure to any chemicals of concern present and to limit their transport from the Site by personnel or equipment.

8.2 Control

A control system is required to ensure that personnel and equipment working on hazardous waste sites are subjected to appropriate health and safety surveillance and site access control. The possibility of exposure or translocation of chemicals of concern will be reduced or eliminated in a number of ways, including the following:

- setting security or physical barriers at control points to regulate and/or exclude unnecessary personnel from the general area
- minimizing the number of personnel and equipment on site consistent with effective operations
- establishing work zones within the Site
- conducting operations in a manner that will reduce the exposure of personnel and equipment
- minimizing the airborne dispersion of contaminants (using dust control procedures; vapor suppressing foam or water will be made available, if necessary)
- implementing appropriate decontamination procedures for both personnel and equipment
- spill control and contamination procedures (a vacuum truck will be on call, if needed).

8.3 Field Operations Work Zones

Work zones will be established based on anticipated contamination and projected work activities. Within these zones, prescribed operations will occur using appropriate Personal Protective Equipment (see Section 6.0). Movement between zones will be controlled at checkpoints. The planned zones are as follows:

- Exclusion (contaminate)
- Contamination Reduction
- Support (noncontaminated).

8.3.1 Exclusion Zone

The Exclusion Zone is the innermost area of the three concentric "areas" and is considered to have contaminated materials present. Within this area, the prescribed protection must be worn by personnel. An entry checkpoint is established at the periphery of the exclusion zone to control flow of personnel and equipment between contiguous zones, and to monitor that the procedures established to enter and exit the zones are followed.

The Exclusion Zone boundary will be established initially on the presence of the chemicals of concern within the area. Subsequent to initial operations, the boundary may be readjusted based on observations and/or measurements. The boundary will be physically secured and posted and access will be limited.

8.3.2 Contamination Reduction Zone

Between the Exclusion and the Support Zone is the Contamination Reduction Zone (CRZ). This zone provides an area to prevent or reduce the transfer of chemicals of concern that may have been picked up by personnel or equipment returning from the Exclusion Zone. All decontamination activities occur in this area. The boundary between the Support Zone and the CRZ is the contamination control line. This boundary separates the potentially contaminated area from the clean area. Entry into the CRZ from the clean area will be through an access control point. Personnel entering at this station will be wearing the prescribed PPE for work in the CRZ. Exiting the CRZ to the clean area requires the removal of any suspected or known contaminated PPE, and compliance with the established decontamination procedures.

8.3.3 Support Zone

The Support Zone is the outermost of the three concentric "areas" and is considered decontaminated, or the "Clean Area." It contains the field office Command Post for field operations and other elements necessary to support site activities. Normal street or Level D work clothes are appropriate apparel for this area.

8.4 Zone Dimensions

Considerable judgment balanced with practical work considerations will be used to ensure a safe working area for each zone. Physical and topographical barriers may constrain ideal locations. Zones will be established on site after work areas are determined to allow enough room for all equipment and personnel. When the zones are established, the Alameda County representative will be notified to inspect the work zones. Field/laboratory measurements may assist in establishing the control zone distances. When not working in areas that require the use of chemical-resistant clothing, work zone procedures may still need to limit the movement of personnel and retain adequate site control.

8.5 Decontamination Procedures

8.5.1 General

As part of the system to prevent or reduce the physical transfer of chemicals of concern by people and/or equipment from the Site, procedures will be instituted for decontaminating anything leaving the Exclusion Zone and CRZ. These procedures will include decontamination of personnel, protective equipment, monitoring equipment, cleanup equipment, etc. Unless otherwise demonstrated, everything leaving the Exclusion Zone should be considered contaminated.

Decontamination is addressed in two ways: the physical arrangement and control of contamination zones, and the effective use of decontamination procedures. The decontamination process uses cleaning solutions, followed by rinse solutions. Used solutions, brushed, sponges, and containers must be properly disposed. In general, decontamination at the Site may consist of rinsing equipment, personnel, etc., with a detergent and water solution. Reusable decontaminated PPE will be stored for air drying.

8.5.2 Decontamination Solutions

Description	Usage
3 cups Alconox or TSP to 5 to 8 gallons of water	Light contamination
Commercial Detergent- Full strength or diluted	Organic contamination

As with all alkaline cleaners, continuous or repeated contact with the skin should be avoided. If an employee's skin becomes contaminated, he/she will move to the decontamination area and remove contaminated clothing, and wash with a mild soap/detergent and water to remove any contaminant from the skin. He/she will then seek first aid treatment.

A rinse solution will be used to remove the contamination solution and neutralize any excess decontamination solution. All personnel will follow these decontamination procedures:

1. When entering from the Exclusion Zone, remove heavy soil, as necessary, from boots, gloves, and clothing by using a towel or hose before entering the CRZ.

2. At the decontamination area, step into a decontamination tub(s) and brush boots and gloves clean.

3. Remove disposable suit and discard in proper container.

4. Step into a rinse tub(s), then remove boots.

5. Remove outer gloves and properly dispose.

6. Remove respirator and hard hat.

7. Remove inner gloves and dispose of properly.

Decontamination procedures may be modified, if necessary, with the approval of the Health and Safety Director.

8.5.3 Personal Decontamination During Medical Emergencies

In the event of personal injury, first aid personnel must decide if the victim's injuries are potentially the type that would be aggravated by movement. If there is any doubt, or if the victim is unconscious and cannot respond, no attempt should be made to move the victim to the decontamination area.

Only off-site paramedics may move such victims. If the paramedics approve, the victim's PPE will be cut off in the CRZ. If the decision is made not to remove the victim's PPE, he/she will be wrapped in a tarp or similar object to protect the ambulance and crew during transport. If the victim is contaminated with material that threaten to cause additional injury or immediate health hazards, the PPE will be carefully removed and the victim washed appropriately.

8.6 Site Security

The work will be performed on weekends, when the garage is closed. If it is necessary to continue any work on weekdays, the Alameda County representative will be consulted to determine the extent to which the garage must be shut down. Fencing will be used to secure the gas tank area and prohibit unauthorized access. Trench plates will be used to cover the excavations at the end of each day.

At a minimum, all visitors entering the Exclusion Zone and the CRZ must wear the protective clothing and equipment worn by Levine•Fricke personnel. Permission to enter the work area must be obtained from at least one of the personnel named in Section 7.0. Visitor's name and purpose of visit will be recorded in the field notes.

9.0 APPROVALS

9.1 Levine·Fricke Personnel

This HSP Addendum 1, covering activities at the Harrison Street Garage Site in Oakland, California, is approved by the following personnel:

Shari A. Samuels
Health and Safety Director

Date 8/31/92

John Sturman, P.E.
Project Manager

Date 8/31/92

Thomas M. Johnson, R.G.
Quality Assurance Reviewer

Date 8/31/92

Dr. M Joseph Fedoruk, CIH
Certified Industrial Hygienist

Date 8.27.92

9.2 Contractor and Subcontractor Personnel

Contractor and Subcontractor Agreement:

1. The Contractor certifies that the following personnel to be employed on the Harrison Street Garage Site have met the requirements of the Federal and California OSHA Hazardous Waste Operations and Emergency Response Standard 29 CFR 1910.120 and GISO 5192.

2. The Contractor certifies that in addition to meeting the OSHA requirements, it has received a copy of the HSP and this Addendum 1, and will ensure that its employees are informed and will comply with both OSHA requirements and the guidelines in this HSP.

3. The Contractor further certifies that its representative has read, understands, and will comply with all provisions of the HSP and this Addendum 1, and it will take full responsibility for the health and safety of its employees.

Contractor	Signature	Date

TABLE 1

EXPOSURE LIMITS AND SELECTED CHEMICALS OF CONCERN HARRISON STREET GARAGE SITE OAKLAND, CALIFORNIA

Chemical Compound	OSHA PEL (ppm unless noted)
Barium	0.5*
Benzene	1
Bromodichloromethane	NA
Chloroform	2
Chromium	1*
Ethylbenzene	100
Lead	0.05 *
Mercury	0.01 *
Methylene Chloride	500
PCBs	0.5*
PCE	100
Selenium	0.2 *
TCE	100
Toluene	100
TPH as diesel	NA
TPH as gasoline	300
Xylene	100

Notes:

PCB - Polychlorinated biphenyls
PCE - Tetrachloroethene
TCE - Trichloroethene
TPH - Total petroleum hydrocarbons
PEL - Permissible Exposure Limit
ppm - parts per million
* - noted in milligrams per cubic meter
NA - Not Applicable

TABLE 2
AIR MONITORING STRATEGY

Task	Constituents of Concern	Instrument	Frequency
Area: Sump and Lift Area/Gasoline Pump Area			
Soil boring sampling and excavation	Benzene, toluene, ethylbenzene, xylenes, bromodichloromethane, PCE, TCE	PID (with appropriate lamp; see Appendix C) and OVA Sensidyne pump and benzene tubes	At start of work and 30 minutes to continuously. Every 4 hours or if PID or OVA detect 50 ppm.
Monitoring well installation	Benzene, toluene, ethylbenzene, xylenes, bromodichloromethane, PCE, TCE	PID/OVA Sensidyne pump and benzene tubes	At start of work and 30 minutes to continuously. Every 4 hours or if PID or OVA detect 50 ppm.
Monitoring well survey	Benzene, toluene, ethylbenzene, xylenes, bromodichloromethane, PCE, TCE	PID/OVA Sensidyne pump and benzene tubes	Start-up of work at each well location. Every 4 hours or if PID or OVA detect 50 ppm.
Monitoring well development	Benzene, toluene, ethylbenzene, xylenes, bromodichloromethane, PCE, TCE	PID/OVA Sensidyne pump and benzene tubes	Start-up of work at each well location. Every 4 hours or if PID or OVA detect 50 ppm.
Ground-water sampling	Benzene, toluene, ethylbenzene, xylenes, bromodichloromethane, PCE, TCE	PID/OVA Sensidyne pump and benzene tubes	Start-up of work at each location. Every 4 hours or if PID or OVA detect 50 ppm.
Excavation activities	PCBs	SKC personal air sampling pump (according to NIOSH Method 5503; see Appendix D)	One 8-hour sample will be collected the first day of activity
Area: Basement			
Soil sampling and excavation	Benzene, toluene, ethylbenzene, xylenes, carbon monoxide, flammable vapors, oxygen levels	PID/OVA, CO meter, and O_2 meter Sensidyne pump and benzene tubes	At start of work and 30 minutes to continuously. Every 4 hours or if PID or OVA detect 50 ppm.
Monitoring well installation	Benzene, toluene, ethylbenzene, xylenes, carbon monoxide, flammable vapors, oxygen levels	PID/OVA, CO meter, and O_2 meter Sensidyne pump and benzene tubes	At start of work and 30 minutes to continuously. Every 4 hours or if PID or OVA detect 50 ppm.
Monitoring well survey	Benzene, toluene, ethylbenzene, xylenes, carbon monoxide, flammable vapors, oxygen levels	PID/OVA, CO meter, and O_2 meter	Start-up of work at each well location

TABLE 2
AIR MONITORING STRATEGY

Task	Constituents of Concern	Instrument	Frequency
Monitoring well development	Benzene, toluene, ethylbenzene, xylenes, flammable vapors, oxygen levels	PID/OVA, CO meter, and O_2 meter	Start-up of work at each well location
Ground-water sampling	Benzene, toluene, ethylbenzene, xylenes, flammable vapors, oxygen levels	PID/OVA, CO meter, and O_2 meter	Start-up of work at each well location
Excavation activities	PCBs	SKC personal air sampling pump (according to NIOSH Method 5503; see Appendix D)	One 8-hour sample will be collected the first day of activity

PCE - Tetrachloroethene
TCE - Trichloroethene
PCB - Polychlorinated biphenyl
PID - Photo ionization detector
OVA - organic vapor analyzer

APPENDIX A

CHEMICAL DESCRIPTIONS OF THE CHEMICALS OF CONCERN

CHEMICAL DESCRIPTIONS OF THE CHEMICALS OF CONCERN

Barium

The soluble barium salts, such as the chloride and sulfide, are poisonous when ingested. The insoluble sulfate used in radiography is not acutely toxic. The chromate is a human carcinogen. Some salts are skin, eye, and mucous membrane irritants producing dermatitis.

The Permissible Exposure Limit (PEL) for barium is 0.5 mg/m^3.

Benzene

Benzene is a clear colorless liquid. Exposure to high concentrations (3,000 parts per million [ppm]) may result in acute poisoning, characterized by the narcotic action of benzene on the central nervous system. Chronic poisoning occurs most commonly through inhalation and dermal absorption. Benzene is also a recognized carcinogen.

The PEL for benzene is 1 ppm.

Bromodichloromethane

Bromodichloromethane is a colorless liquid. Short-term exposure to high concentrations of bromodichloromethane may be narcotic. Bromodichloromethane is classified by the U.S. Environmental Protection Agency as a Group B2, probable human carcinogen.

The PEL for bromodichloromethane is 200 ppm.

Chloroform

Chloroform is a colorless liquid with a pleasant, sweet odor. Short-term exposure to chloroform vapor may cause headaches, drowsiness, vomiting, dizziness, unconsciousness, irregular heart beat, and death. Liver and kidney damage may result from exposure to chloroform vapor.

The PEL for chloroform is 2 ppm.

Chromium

Chromium is a greenish-blue, odorless solid. Exposure to chromium has been associated with lung changes in workers exposed to chromium alloys. Chromium dust exposure may cause minor lung changes.

The PEL for chromium is 1 mg/m^3.

Diesel Fuel

Diesel fuel is a gas oil fraction available in various grades as required by different engines. Composition of diesel varies in ratios of predominantly aliphatic, olefinic, cycloparaffinic, and aromatic hydrocarbons, and additives.

Ingestion of diesel can lead to systemic effects such as gastrointestinal irritation, vomiting, diarrhea, and in severe cases, drowsiness and central nervous system depression, progressing to coma and death. Aspiration of diesel fuel can cause hemorrhaging and pulmonary edema, progressing to pneumonitis and renal involvement.

Ethylbenzene

Ethylbenzene is a clear, colorless liquid. Exposure to high concentrations of ethylbenzene vapor may result in irritation of the skin and mucous membranes, dizziness, irritation of the nose and throat, and a sense of constriction of the chest.

The PEL for ethylbenzene is 100 ppm.

Gasoline

Gasoline is produced from the light distillates during petroleum fractionation; its major components include paraffins, olefins, naphthenes, aromatics, and recently ethanol. Gasoline also contains various functional additives as required for different uses, such as antiknock fluids, antioxidants, metal deactivators, corrosion inhibitors, anti-icing agents, pre-ignition preventors, upper-cylinder lubricants, dyes, and decolorizers. Lead additives in particular were widely used in gasoline until the introduction of vehicle catalytic converters.

Mild cases of gasoline ingestion can cause inebriation, vomiting, vertigo, drowsiness, confusion, and fever. Aspiration into the lungs and secondary pneumonia may occur unless prevented. Gasoline can cause hyperemia of the conjunctiva and other eye disturbances. Gasoline is a skin irritant and a possible allergen. Repeated or chronic dermal contact can result in drying of the skin, lesions, and other dermatologic conditions.

The PEL TWA for gasoline is 300 ppm. The PEL STEL is 500 ppm.

Lead

Lead (inorganic) is a bluish-white, silver, or gray odorless solid.

Short-term exposure to lead can cause decreased appetite, insomnia, headache, muscle and joint pain, colic, and constipation.

The PEL for lead is 0.05 mg/m^3.

Mercury

Mercury is a silvery, mobile, odorless liquid. Short-term exposure to inhaled mercury vapors may cause headache, cough, chest pains, chest tightness, and difficulty in breathing. In addition, it may cause soreness of the mouth, loss of teeth, nausea, and diarrhea. Liquid mercury may irritate the skin.

The PEL TWA for mercury is 0.1 mg/m^3.

Methylene Chloride

Methylene chloride is a colorless liquid with an odor similar to chloroform.

Methylene chloride is an anesthetic. Short-term exposure to methylene chloride can cause mental confusion, light-headedness, nausea, vomiting, and headache. Continued exposure may cause increased light-headedness, staggering, unconsciousness, and death. High vapor concentrations may also cause irritation of the eyes and respiratory tract. Exposure to methylene chloride may make the symptoms of angina worse. Skin exposure to the liquid can cause irritation. If the liquid is held in contact with the skin, it can cause skin burns. Splashes of the liquid into the eye can cause irritation.

Methylene chloride is classified by the U.S. Environmental Protection Agency as a Group B2 probable human carcinogen.

The PEL for methylene chloride is 100 ppm in air.

Perchloroethylene (PCE)

PCE, also known as tetrachloroethylene, is a colorless liquid with an ether-like odor.

Short-term exposure to PCE may cause headaches, nausea, drowsiness, dizziness, incoordination, unconsciousness, irritation of the eyes, nose, and throat, and flushing of the face and neck. In addition, it may cause liver damage with such findings as yellow jaundice and dark urine. Liver damage may become evident several weeks after exposure.

PCE is classified by the U.S. Environmental Protection Agency as a Group B2 probable human carcinogen.

The PEL for PCE is 25 ppm in air.

Polychlorinated Biphenyls (PCBs)

PCBs pale yellow viscous liquids with a mild hydrocarbon odor. Exposure to PCBs may cause irritation of the eyes, nose, and throat, and an acne-like skin rash. It also may injure the liver, resulting in such effects as fatigue, dark urine, and yellow jaundice. Skin irritation may result from repeated skin contact.

The PEL for PCBs is 0.5 mg/m^3.

Selenium

Selenium is a black, gray, or red odorless solid.

Prolonged exposure to selenium can cause paleness, coated tongue, stomach disorders, nervousness, metallic taste, and a garlic odor of the breath. Fluid in the abdominal cavity, damage to the liver and spleen, and anemia have been reported in animals.

The PEL TWA for selenium is 0.2 mg/m^3.

Trichloroethene (TCE)

TCE is a colorless liquid with a sweet odor similar to chloroform.

Short-term inhalation exposure to TCE can cause drowsiness, dizziness, headache, blurred vision, incoordination, mental confusion, flushed skin, tremors, nausea, vomiting, fatigue, and cardiac arrhythmia. Irritation of the skin, mucous membranes, and eyes also can occur.

TCE is classified by the U.S. Environmental Protection Agency as a Group B2 probable human carcinogen.

The PEL for TCE is 50 ppm in air.

Toluene

Toluene is a colorless liquid with a benzol-like odor. Inhalation of high vapor concentrations may cause impairment of coordination and reaction time, headaches, nausea, eye irritation, loss of appetite, a bad taste, and lassitude.

The PEL for toluene is 100 ppm.

Xylenes

Xylenes are clear, colorless liquids. Exposure to high concentrations of xylene vapor may result in eye and skin irritation. Eye irritation may occur at concentrations of about 200 ppm.

The PEL for total xylene is 100 ppm.

APPENDIX B

HEALTH HAZARDS ASSOCIATED WITH SOIL CONTAINING ELEVATED CONCENTRATIONS OF MERCURY

M. Joseph Fedoruk M.D., Inc.

Diplomate American Board of Preventive Medicine, certified in Occupational Medicine
Diplomate American Board of Toxicology
Certified Industrial Hygienist

1401 N. Tustin Avenue
Suite 240
Santa Ana, California 92701
Telephone: (714) 550-7211
FAX: (714) 550-7215

Medicine
Toxicology
Exposure Assessment

June 21, 1991

Ms. Shari Samuels
Levine-Fricke
1900 Powell Street
Emeryville, California 94608

Regarding : mercury exposure potential at Oakland remediation project.

Dear Ms.Samuels:

The purpose of this letter is to provide you with my opinion regarding the potential health hazard that soil containing mercury at concentrations of 70-80 ppm poses to remediation workers at a Levine-Fricke project in Oakland, California.

The potential health hazard of this mercury containing soil to industrial workers can be assessed by determining the airborne concentration of mercury that could be produced from remediation activities at this site which disturb the soil and comparing this predicted concentration to the industrial exposure limit for mercury. To be conservative an assumption will me made that the soil contains 100 ppm of mercury.

Since no specific information is available regarding the form of mercury which is present in the soil, for the purpose of this assessment it will be assumed that the soil contains alkyl mercury compounds. Alkyl mercury compounds have the lowest Threshold Limit Value (TLV) of 0.01 mg/m^3 (10 ug/m^3) for an eight-hour time-weighted average of all mercury compounds. The Cal/OSHA Permissible Exposure Limit (PEL) for alkyl mercury compounds is also 0.01 mg/m^3 for an eight-hour time-weighted average. By contrast the TLV for aryl and inorganic mercury compounds is 100 ug/m^3 for an eight-hour time-weighted average and 50 ug/m^3 for all other mercury forms.

The first step is to identify the concentration of mercury that is present in 1 mg of soil.

The concentration in the soil is assumed to be 100 ppm, therefore:

100 ppm = 100 mg/kg
100 mg/kg = 100 ug/g
100 ug/g = 0.1 ug/mg

Therefore 1 mg of soil will contain 0.1 ug of mercury assuming the soil contains 100 ppm or 100 mg/kg of mercury.

The next step is to identify what airborne concentration of dust could be produced at this site from

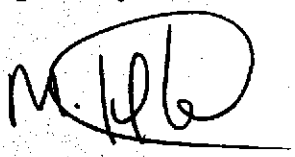
soil disturbance associated with remediation activities. Although there are no published data concerning airborne concentrations of suspended soil at various remediation projects it is extremely unlikely, based upon personal experience, that the ambient dust concentrations could exceed 5 mg/m^3. At this ambient dust concentration the airborne concentration of mercury would only be 0.5 ug/m^3 which is 1/20 of the TLV or PEL for the species of mercury with the lowest exposure limit. Even if the airborne dust concentrations were unrealistically high, such as 20 mg/m^3, the airborne mercury concentration would still only be 1/5 of the TLV or PEL.

There is no evidence to suggest that airborne concentrations of mercury due to airborne suspension of soil at this site would approach the industrial exposure limit for the mercury, even if the soil contained the mercury species with the lowest industrial exposure limit. Therefore based upon information that soil at this site does not contain mercury in excess of 100 ppm, the hazard posed by inhalation of this soil is low and there is no evidence to suggest that airborne concentrations of mercury would exceed any regulated exposure limit.

The site safety plan should ensure that remediation workers utilize adequate dermal protective equipment to prevent inadvertent dermal absorption of mercury as well as other compounds at this site. Similarly although the airborne concentrations of mercury at this site are anticipated to be very low, respiratory protection for other compounds at the site such as volatile organic compounds will likely be required. The site safety plan should include adequate decontamination measures to avoid inadvertent ingestion of any contaminated soil. The exact level of personal protective equipment that would be required should be based upon an evaluation of exposure potential to all compounds.

I hope this information is of use in assessing the magnitude of the industrial hazard that mercury containing soils pose to remediation workers at this site. If you have any further questions please contact me directly.

Respectfully,



M. Joseph Fedoruk, M.D., CIH, DABT
Diplomate, American Board of Preventive Medicine, certified in Occupational Medicine
Certified Industrial Hygienist (Toxicological Aspects)
Diplomate, American Board of Toxicology

APPENDIX C

MOLECULAR IONIZATION POTENTIAL

B. MOLECULAR IONIZATION POTENTIALS

Acetamide	9.71	P.I.
Acetic acid	10.35	P.I.
Acetic acid-d_3	10.71	E.I.
Acetophenone	9.27	P.I.
Acetyl bromide	10.55	P.I.
Acetyl chloride	11.02	P.I.
Acridine	7.78	P.I.
Acrylonitrile	10.91	P.I.
Allyl alcohol	9.67	P.I.
Allylamine	9.6	E.I.
Aluminum monofluoride	9.5	E.I.
Aluminum monoxide	9.5	E.I.
Aluminum tribromide	12.2	E.I.
Aluminum trichloride	12.8	E.I.
α-aminonaphthalene	7.30	P.I.
β-aminonaphthalene	7.25	P.I.
4-aminopyridine	8.97	E.I.
2-aminotropone	9.43	E.I.
Ammonia (I)	10.154	P.I.
(II)	23.5	E.I.
Ammonia-d_1	11.47	E.I.
Ammonia-d_3	11.52	E.I.
Ammonium hydroxide	10.8	E.I.
i-amylamine	9.5	E.I.
N-*n*-amylaniline	7.5	U.V.
Anabasine	8.70	E.I.
Aniline	7.70	P.I.
p-anisidine	7.82	E.I.
Anisole	8.22	P.I.
Anthracene	7.23	S.
Anthraquinone	9.34	P.I.
Antimony (Sb_1)	9.5	E.I.
Antimony (Sb_4)	9.1	E.I.
Antimony monochloride	10.9	E.I.
Antimony trichloride	11.4	E.I.
Arsenic (As_2)	11.0	E.I.
Arsenic (As_4)	10.8	E.I.
Arsenic (As_6)	8.9	E.I.
Arsenic dichloride	8.4	E.I.
Arsenic trichloride	11.7	E.I.
Arsenic trimethyl	8.3	E.I.
Arsenic triphosphide	10.3	E.I.
Arsine	10.6	E.I.
Azacyclobutane	8.9	E.I.
Barium oxide	6.0	E.I.
Benzaldehyde	9.53	P.I.
Benz(a)anthracene	7.53	E.I.
Benzene	9.245	P.I.
Benzene-d_1 (I)	9.44	E.I.
(II)	16.6	E.I.
(III)	18.	E.I.
Benzene-d_6	9.251	S.
Benzonitrile	9.71	P.I.
Benzo(c)phenanthrene	8.40	E.I.
Benzophenone	9.45	P.I.
Benzoyl chloride	10.6	E.I.
Benzoyl fluoride	10.6	E.I.
Benzylamine	7.56	P.I.
Benzylmethyl ether	8.85	P.I.
Benzyne	9.75	E.I.
Bicyclo(2.2.1)-heptadiene	8.60	E.I.
Bis-(*n*-butyl) amine	7.69	P.I.
Bis-(2-chloroethyl) ether	9.85	P.I.
Biscyclopentadienyl chromium	6.91	E.I.
Biscyclopentadienyl cobalt	6.2	E.I.
Biscyclopentadienyl iron	7.05	E.I.
Biscyclopentadienyl manganese	7.25	E.I.
Biscyclopentadienyl nickel	7.06	E.I.
Biscyclopentadienyl vanadium	7.56	E.I.
Bis(*p*-methylphenyl) amine	7.8	E.I.
Bismuth (Bi_1)	8.	E.I.
Bismuth monosulfide	8.	E.I.
Bis-(*n*-propyl) amine	7.84	P.I.
Bis-(*i*-propyl) amine	7.73	P.I.
Bis(trifluoromethyl) arsine	10.9	E.I.
Bis(trifluoromethyl) chloroarsine	11.0	E.I.
Bis(trifluoromethyl) methylarsine	10.5	E.I.
Borazine	10.2	E.I.
Boric oxide	13.2	E.I.
Borine	10.5	E.I.
Boron (B_1)	12.06	E.I.
Boron dibromide	7.06	E.I.
Boron dichloride	7.20	E.I.
Boron diethyl	5.98	E.I.
Boron dihydride	8.12	E.I.
Boron diiodide	7.13	E.I.
Boron dimethyl	6.44	E.I.
Boron monobromide	9.25	E.I.
Boron monochloride	10.44	E.I.
Boron monoethyl	8.73	E.I.
Boron monohydride	10.06	E.I.
Boron monoiodide	8.96	E.I.

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

Boron monomethyl	9.28	E.I.
Boron monoxide	7.0	S.
Boron tribromide	9.7	E.I.
Boron trichloride	12.0	E.I.
Boron triethyl	9.0	E.I.
Boron trifluoride	15.5	E.I.
Boron triiodide	9.0	E.I.
Boron trimethyl	8.8	E.I.
Boroxine	13.5	E.I.
Bromine (I)	10.55	P.I.
(II)	19.5	E.I.
Bromine difluoride	11.2	E.I.
Bromine trifluoride	12.9	E.I.
Bromine tetrafluoride	15.6	E.I.
Bromine monochloride	11.1	E.I.
Bromobenzene	8.98	P.I.
1-bromo-bicyclo-(2.2.1)-heptane	9.90	E.I.
1-bromo-bicyclo-(2.2.2)-octane	9.76	E.I.
1-bromobutane	10.13	P.I.
2-bromobutane	9.98	P.I.
1-bromobutanone	9.54	P.I.
1-bromo-2-chloroethane	10.63	P.I.
Bromochloromethane	10.77	P.I.
Bromodichloromethane	10.88	E.I.
Bromodifluoromethane	12.0	E.I.
Bromodurene	8.0	E.I.
Bromoethane	10.24	P.I.
Bromoethene	9.8	P.I.
1-bromo-4-fluorobenzene	8.99	P.I.
Bromoform	10.51	P.I.
1-bromo-3-hexanone	9.26	P.I.
Bromomethane	10.53	P.I.
Bromomethyl ethyl ether	10.08	P.I.
2-(bromomethyl)-propane	10.15	E.I.
1-bromo-2-methyl propane	10.09	P.I.
2-bromo-2-methylpropane	9.89	P.I.
1-bromopentane	10.10	P.I.
p-bromophenol	9.04	E.I.
1-bromopropane	10.18	P.I.
2-bromopropane	10.08	P.I.
1-bromopropene	9.30	P.I.
3-bromopropene	9.7	P.I.
1-bromopropyne	10.1	E.I.
2-bromopyridine	9.65	E.I.
4-bromopyridine	9.94	E.I.
2-bromothiophene	8.63	P.I.
o-bromotoluene	8.78	P.I.
m-bromotoluene	8.81	P.I.
p-bromotoluene	8.67	P.I.
Bromotrifluoromethane	11.78	P.I.
1,2-butadiene	9.57	E.I.
1,3-butadiene (*cis*)	9.07	P.I.
1,3-butadiene (*trans*)	9.07	P.I.
1,3-butadiyne	10.74	S.
n-butanal	9.86	P.I.
n-butane	10.63	P.I.
2,3-butanedione	9.23	P.I.
n-butanoic acid	10.16	P.I.
1-butanol	10.04	P.I.
2-butanol	10.1	P.I.
Butanone	9.53	P.I.
2-butenal	9.73	P.I.
1-butene	9.58	P.I.
2-butene (*cis*)	9.13	P.I.
2-butene (*trans*)	9.13	P.I.
Buteneone	9.91	E.I.
n-butylamine	8.71	P.I.
i-butylamine	8.70	P.I.
sec-butylamine	8.70	P.I.
t-butylamine	8.64	P.I.
N-*n*-butylaniline	7.5	U.V.
n-butylbenzene	8.69	P.I.
i-butylbenzene	8.69	P.I.
sec-butylbenzene	8.68	P.I.
t-butylbenzene	8.68	P.I.
n-butyl ethanoate	10.00	P.I.
i-butyl ethanoate	9.95	P.I.
sec-butyl ethanoate	9.91	P.I.
n-butyl methanoate	10.50	P.I.
i-butyl methanoate	10.46	P.I.
n-butyl pentanoate	9.57	P.I.
2-butylthiophene	8.5	E.I.
1-butyne	10.18	P.I.
2-butyne	9.85	P.I.
1-butyne-3-ene	9.87	E.I.
Calcium monofluoride	5.5	E.I.
Carbon (C_1)	12.0	E.I.
Carbon (C_2)	12.6	E.I.
Carbon (C_3)	12.6	E.I.
Carbon (C_5)	12.5	E.I.
Carbon tetrachloride	11.47	P.I.
Carbon tetrafluoride	<15.0	E.I.
Carbon dioxide (I)	13.79	P.I.
(II)	22.6	E.I.

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

Carbon disulfide	10.076	P.I.
Carbon monoxide (I)	14.01	P.I.
(II)	27.7	E.I.
Carbon monosulfide	11.8	E.I.
Carbon suboxide	10.8	E.I.
Carbonyl sulfide	11.17	E.I.
Chlorine (I)	11.48	P.I.
(II)	21.0	E.I.
Chlorine difluoride	11.0	E.I.
Chlorine dioxide	11.1	E.I.
Chlorine monoxide	10.4	E.I.
Chlorine trifluoride	13.0	E.I.
Chlorine trioxide	11.7	E.I.
o-chloroaniline	7.9	U.V.
Chlorobenzene	9.07	P.I.
1-chloro-2-bromoethane	10.63	P.I.
Chlorobromomethane	10.77	P.I.
2-chloro-1,3-butadiene	8.79	S.
1-chlorobutane	10.67	P.I.
2-chlorobutane	10.65	P.I.
1-chlorobutanone	9.54	P.I.
Chlorocyanomethane	12.2	P.I.
Chlorocyclopropane	10.10	E.I.
Chlorodibromomethane	10.59	P.I.
1-chloro-1,1-difluoroethane	11.98	P.I.
Chlorodifluoromethane	12.45	P.I.
Chloroethane	10.97	P.I.
Chloroethene	10.00	P.I.
1-chloro-2-fluorobenzene	9.155	P.I.
1-chloro-3-fluorobenzene	9.21	P.I.
1-chloro-2-fluoroethene (*cis*)	9.87	P.I.
1-chloro-2-fluoroethene (*trans*)	9.87	P.I.
Chloroform	11.42	P.I.
o-chloroiodobenzene	8.35	P.I.
Chloromethane	11.28	P.I.
Chloromethyl ethyl ether	10.08	P.I.
Chloromethylmethyl ether	10.25	P.I.
1-chloro-2-methylpropane	10.66	P.I.
2-chloro-2-methylpropane	10.2	S.
o-chlorophenol	9.28	E.I.
p-chlorophenol	9.07	E.I.
Chloroprene	8.8	S.
1-chloropropane	10.82	P.I.
2-chloropropane	10.78	P.I.
1-chloropropanone	9.71	P.I.
3-chloropropene	10.04	P.I.
1-chloropropyne	9.9	E.I.
2-chloropyridine	9.91	E.I.
4-chloropyridine	10.15	E.I.
2-chlorothiophene	8.68	E.I.
o-chlorotoluene	8.83	P.I.
m-chlorotoluene	8.83	P.I.
p-chlorotoluene	8.69	P.I.
Chlorotrifluoroethene	10.4	E.I.
Chlorotrifluoromethane	12.8	P.I.
Chromium hexacarbonyl	8.03	P.I.
Chromium monoxide	8.2	E.I.
Chromyl chloride	12.6	E.I.
Chromyl fluoride	14.0	E.I.
Chrysene	7.75	U.V.
Coronene	7.6	U.V.
o-cresol	8.93	E.I.
m-cresol	8.98	E.I.
p-cresol	8.97	E.I.
Cyanoethane	11.84	P.I.
Cyanoethene	10.91	P.I.
Cyanoethyne	11.6	E.I.
Cyanogen	13.57	E.I.
Cyanogen bromide	11.95	E.I.
Cyanogen chloride	12.49	E.I.
Cyanogen iodide	10.98	E.I.
Cyanomethane	12.22	P.I.
1-cyanopropane	11.67	P.I.
3-cyanopropene	10.39	P.I.
Cyclobutane	10.50	P.I.
Cycloheptatriene	8.55	E.I.
N-cycloheptylaniline	7.45	U.V.
Cyclohexadiene	8.40	S.
Cyclohexane	9.88	P.I.
Cyclohexanone	9.14	P.I.
Cyclohexene	8.95	P.I.
N-cyclohexylaniline	7.45	U.V.
Cyclooctatetraene	7.99	P.I.
Cyclopentadiene	8.58	S.
Cyclopentane	10.52	P.I.
Cyclopentanone	9.26	P.I.
Cyclopentene	9.01	P.I.
N-cyclopentylaniline	7.45	U.V.
Cyclopropane	11.06	P.I.

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

Cyclopropene	9.95	E.I.
Cyclopropyl chloride	10.10	E.I.
Cyclopropyl cyanide	11.2	E.I.
Decaborane	10.7	E.I.
Decafluorocyclohexene	11.3	E.I.
Decafluoro-*o*-xylene	10.6	E.I.
n-decane	10.19	E.I.
2-decanone	9.40	P.I.
1-decene	9.51	E.I.
N-*n*-decylaniline	7.5	U.V.
Deuterium	15.457	S.
Dialuminum monoxide	7.7	E.I.
N, N-di-*n*-amylaniline	7.1	U.V.
Diazirine	10.18	E.I.
Diazomethane	9.00	S.
Diborane	11.9	E.I.
Diborane-d_6	12.0	E.I.
Diboron dihydride	11.36	E.I.
Diboron dihydride-d_2	11.50	E.I.
Diboron dioxide	13.3	E.I.
Diboron monodeuteride	8.7–11.7	E.I.
Diboron monohydride	10.62	E.I.
Diboron pentahydride	7.86	E.I.
Diboron pentahydride-d_5	8.01	E.I.
Diboron tetrahydride	10.93	E.I.
Diboron tetrahydride-d_4	10.90	E.I.
Diboron trihydride	8.79	E.I.
Diboron trihydride-d_3	8.81	E.I.
1, 4-dibromobutane	10.28	E.I.
Dibromochloromethane	10.59	P.I.
Dibromodifluoromethane	11.07	P.I.
1,1-dibromoethane	10.19	P.I.
1,2-dibromoethane	10.30	E.I.
1,2-dibromoethene (*cis*)	9.45	P.I.
1,2-dibromoethene (*trans*)	9.46	P.I.
Dibromomethane	10.49	P.I.
1,3-dibromopropane	10.07	P.I.
N,N-di-*n*-butylaniline	7.15	U.V.
Di-*n*-butyl ether	9.18	P.I.
o-Dichlorobenzene	9.07	P.I.
m-dichlorobenzene	9.12	P.I.
p-dichlorobenzene	8.94	P.I.
1,2-dichloro-1,2-bis (trifluoromethyl)-ethene	10.36	P.I.
Dichlorobromomethane	10.88	E.I.
Dichlorocyanomethane	12.9	E.I.
1,1-dichlorocyclopropane	10.30	E.I.
Dichlorodifluoromethane	12.31	P.I.
Dichlorodifluoroethene	10.0	E.I.
1,2-dichloroethane	11.12	P.I.
1,1-dichloroethene	9.46	S.
1,2-dichloroethene (*cis*)	9.66	P.I.
1,2-dichloroethene (*trans*)	9.96	P.I.
Dichloroethyne	13.	E.I
Dichlorofluoromethane	12.39	E.I
Dichloromethane	11.35	P.I
Dichloromethyl methyl ether	10.25	P.I
1,2-dichloropropane	10.87	P.I
1,3-dichloropropane	10.85	P.I
1,1-dichloropropanone	9.71	P.I
2,3-dichloropropene	9.82	P.I
Dicyanoacetylene	11.4	E.
Dicyanodiacetylene	11.4	E.
N,N-di-*n*-decylaniline	7.1	U.
Diethoxymethane	9.70	P.
N,N-diethylacetamide	8.60	P.
Diethylamine	8.01	P.
N,N-diethylaniline	7.15	U
Diethylbenzene	8.88	E.
1,2-diethylbenzene	8.91	E.
1,3-diethylbenzene	8.99	E
1,4-diethylbenzene	8.93	E
Diethyl ether	9.53	P
N,N-diethyl formamide	8.89	P
Diethyl sulfide	8.43	P
Diethyl sulfite	9.68	P
o-difluorobenzene	9.31	P
p-difluorobenzene	9.15	P
1,1-difluoro-1-chloroethane	11.98	P
Difluorochloromethane	12.45	P
Difluorocyanomethane	12.4	I
1,1-difluoro-1,2-dibromoethane	10.83	I
1,1-difluoroethene	10.30	I
Difluorodibromomethane	11.07	I
Difluorodichloroethene	10.0	I
Difluorodichloromethane	12.31	
Difluoromethane	12.55	
Difluoromethylbenzene	9.45	

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

N,N-di-*n*-hexylaniline	7.1	U.V.
Dihydropyran	8.34	P.I.
Diimide	9.85	E.I.
Diiodomethane	9.34	P.I.
Diketene	9.4	E.I.
Dilithium iodide	8.75	E.I.
Dilithium oxide	6.8	E.I.
Dimethoxyborine	4.46	E.I.
1,1-dimethoxyethane	9.65	P.I.
Dimethoxymethane	10.00	P.I.
N,N-dimethylacetamide	8.81	P.I.
Dimethylamine	8.24	P.I.
N,N-dimethylaniline	7.14	P.I.
Dimethylarsine	9.0	E.I.
2,3-dimethylbutadiene	8.72	P.I.
2,2-dimethylbutane	10.05	P.I.
2,3-dimethylbutane	10.01	P.I.
3,3-dimethylbutanone	9.17	P.I.
2,3-dimethyl-2-butene	8.30	P.I.
Dimethyl chloroarsine	9.9	E.I.
Dimethyl disulfide	8.46	P.I.
Dimethyl ether	10.00	P.I.
N,N-dimethylformamide	9.12	P.I.
2,3-dimethylfuran	8.01	E.I.
3,5-dimethyl-4-heptanone	9.04	P.I.
1,1-dimethylhydrazine	8.12	E.I.
1,2-dimethylhydrazine	7.75	E.I.
Dimethyl mercury	8.90	E.I.
2,2-dimethyl-3-pentanone	8.98	P.I.
2,2-dimethylpropane	10.35	P.I.
Dimethyl sulfide	8.69	P.I.
Dimethyl sulfoxide	8.85	P.I.
Dimethyltrifluoromethyl arsine	9.2	E.I.
Dimethyl zinc	8.86	E.I.
Dinitrogen difluoride	13.1	E.I.
Dinitrogen tetrafluoride	12.0	E.I.
N,N-di-*n*-octylaniline	7.1	U.V.
1,3-dioxane	10.15	E.I.
1,4-dioxane	9.13	P.I.
Diphenyl	8.27	P.I.
Diphenylamine	7.4	U.V.
Diphenylbutadiene	7.75	U.V.
Diphenyldecapentaene	7.4	U.V.
Diphenylhexadiene	8.2	U.V.
Diphenylhexatriene	7.6	U.V.
Diphenyloctatetraene	7.5	U.V.
Diphosphine	8.7	E.I.
Diphosphorusdiarsenide	10.3	E.I.
Diphosphorus tetrachloride	9.36	E.I.
N,N-di-*n*-propylaniline	7.15	U.V.
Di-*n*-propyl disulfide	8.27	P.I.
Di-*n*-propyl ether	9.27	P.I.
Di-*i*-propyl ether	9.20	P.I.
Di-*n*-propyl sulfide	8.30	P.I.
Disilicon dioxide	10.0	E.I.
Disulfur monoxide	10.3	E.I.
2,3-dithiabutane	8.46	P.I.
3,4-dithiahexane	8.27	P.I.
N-*n*-dodecylaniline	7.5	U.V.
Durene	8.03	P.I.
3,4-epoxy-1-butene	9.7	E.I.
1,2-epoxypropane	9.81	E.I.
Ethanal	10.21	P.I.
Ethane	11.65	P.I.
Ethane-d_1	11.70	E.I.
Ethanoic acid	10.35	P.I.
Ethanoic acid-d_1	10.71	E.I.
Ethanol	10.48	P.I.
Ethanol-d_1(OD)	10.45	E.I.
Ethene	10.51	P.I.
Ethene-d_1	10.52	S.
Ethylamine	8.86	P.I.
N-ethylaniline	7.5	U.V.
Ethylbenzene	8.76	P.I.
Ethyl boron difluoride	11.8	E.I.
Ethyl bromide	10.29	P.I.
Ethyl bromoacetate	10.13	P.I.
Ethyl ω-bromobutanoate	9.85	P.I.
2-ethyl-1-butene	9.21	E.I.
Ethyl chloride	10.97	P.I.
Ethyl chloroacetate	10.20	P.I.
Ethyl decaborane	9.0	E.I.
Ethyl disulfane	9.4	E.I.
Ethyleneimine	9.94	E.I.
Ethylene oxide	10.565	P.I.
Ethyl ethanoate	10.10	P.I.
Ethyl hexanoate	9.67	P.I.
Ethyl iodide	9.33	P.I.
Ethyl isothiocyanate	9.10	P.I.
Ethyl mercaptan	9.29	P.I.
Ethyl methanoate	10.61	P.I.
Ethyl nitrate	11.22	P.I.
Ethyl propanoate	10.00	P.I.
2-ethylthiophene	8.8	E.I.
Ethyl thiocyanate	9.89	P.I.
Ethyl vinyl ether	8.3	

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

Ethyl trichloroacetate	10.44	P.I.
Ethyne	11.41	P.I.
Ethyne-d_1	11.39	E.I.
Ethynylbenzene	8.82	P.I.
Ferrous chloride (monomer)	11.5	E.I.
Ferrous chloride (dimer)	10.5	E.I.
Fluorene	8.63	E.I.
Fluorine	15.7	P.I.
o-fluoroaniline	7.95	P.I.
m-fluoroaniline	7.90	P.I.
p-fluoroaniline	7.82	P.I.
Fluorobenzene	9.20	P.I.
Fluorocyanomethane	13.0	E.I.
1-fluoro-1, 2-dibromoethane	10.75	P.I.
Fluoroethane	12.00	E.I.
Fluoroethene	10.37	P.I.
Fluoroform	13.84	S.
Fluoromethanal	11.4	P.I.
Fluoromethane	12.80	S.
o-fluorophenol	8.66	P.I.
o-fluorotoluene	8.91	P.I.
m-fluorotoluene	8.91	P.I.
p-fluorotoluene	8.78	P.I.
Fluorotribromomethane	10.67	P.I.
Fluorotrichloromethane	11.77	P.I.
Fluorotrifluoromethyl-benzene	9.12	P.I.
Formamide	10.20	P.I.
Formic acid	11.05	P.I.
Formic acid-d_1	11.57	E.I.
Furan	8.89	P.I.
Furfural	9.21	P.I.
d-galactose	9.1	E.I.
Germane	12.3	E.I.
Germanium tetrachloride	11.90	E.I.
Germanium tetramethyl	9.2	E.I.
d-glucose	8.8	E.I.
Glycine	9.5	E.I.
n-heptane	10.07	P.I.
2-heptanone	9.33	P.I.
4-heptanone	9.12	P.I.
1-heptene	9.54	E.I.
N-*n*-heptylaniline	7.5	U.V.
1,5-hexadiene	9.51	E.I.
2,4-hexadiyne	10.65	S.
Hexafluoroacetone	11.81	
Hexafluorobenzene	9.39	
Hexafluoropropene	10.3	
Hexamethylbenzene	7.85	
Hexamethyleneimine	8.76	
n-hexane	10.17	
2-hexanone	9.34	
1,3,5-hexatriene	8.26	
1-hexene	9.46	
2-hexene (*trans*)	9.16	
3-hexene (*trans*)	9.12	
3-hexene-1,5-diyne	9.46	
N-*n*-hexylaniline	7.5	
Hydrazine	9.00	
Hydrazoic acid	10.3	
Hydrogen	15.427	
Hydrogen bromide (I)	11.62	
(II)	21.6	
Hydrogen chloride (I)	12.74	
(II)	22.9	
Hydrogen cyanide (I)	13.73	
(II)	26.3	
Hydrogen disulfide	10.2	
Hydrogen fluoride	15.77	
Hydrogen iodide (I)	10.38	
(II)	19.6	
Hydrogen peroxide	10.92	
Hydrogen selenide	9.88	
Hydrogen selenide-d_2	9.88	
Hydrogen sulfide	10.46	
Hydrogen sulfide-d_2	10.47	
Hydrogen telluride	9.138	
Hydrogen telluride-d_2	9.14	
4-hydroxypyridine	9.70	
Indene	8.81	
Iodine	9.28	
Iodine difluoride	10.7	
Iodine monobromide	9.98	
Iodine monochloride	10.31	
Iodine pentafluoride	13.5	
Iodine tetrafluoride	14.5	
Iodine trifluoride	9.7	
Iodobenzene	8.73	
1-iodobutane	9.21	
2-iodobutane	9.09	
Iodoethane	9.33	
Iodomethane	9.54	
1-iodo-2-methylpropane	9.18	
2-iodo-2-methylpropane	9.02	

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

N,N-di-*n*-hexylaniline	7.1	U.V.
Dihydropyran	8.34	P.I.
Diimide	9.85	E.I.
Diiodomethane	9.34	P.I.
Diketene	9.4	E.I.
Dilithium iodide	8.75	E.I.
Dilithium oxide	6.8	E.I.
Dimethoxyborine	4.46	E.I.
1,1-dimethoxyethane	9.65	P.I.
Dimethoxymethane	10.00	P.I.
N,N-dimethylacetamide	8.81	P.I.
Dimethylamine	8.24	P.I.
N,N-dimethylaniline	7.14	P.I.
Dimethylarsine	9.0	E.I.
2,3-dimethylbutadiene	8.72	P.I.
2,2-dimethylbutane	10.05	P.I.
2,3-dimethylbutane	10.01	P.I.
3,3-dimethylbutanone	9.17	P.I.
2,3-dimethyl-2-butene	8.30	P.I.
Dimethyl chloroarsine	9.9	E.I.
Dimethyl disulfide	8.46	P.I.
Dimethyl ether	10.00	P.I.
N,N-dimethylformamide	9.12	P.I.
2,3-dimethylfuran	8.01	E.I.
3,5-dimethyl-4-heptanone	9.04	P.I.
1,1-dimethylhydrazine	8.12	E.I.
1,2-dimethylhydrazine	7.75	E.I.
Dimethyl mercury	8.90	E.I.
2,2-dimethyl-3-pentanone	8.98	P.I.
2,2-dimethylpropane	10.35	P.I.
Dimethyl sulfide	8.69	P.I.
Dimethyl sulfoxide	8.85	P.I.
Dimethyltrifluoromethyl arsine	9.2	E.I.
Dimethyl zinc	8.86	E.I.
Dinitrogen difluoride	13.1	E.I.
Dinitrogen tetrafluoride	12.0	E.I.
N,N-di-*n*-octylaniline	7.1	U.V.
1,3-dioxane	10.15	E.I.
1,4-dioxane	9.13	P.I.
Diphenyl	8.27	P.I.
Diphenylamine	7.4	U.V.
Diphenylbutadiene	7.75	U.V.
Diphenyldecapentaene	7.4	U.V.
Diphenylhexadiene	8.2	U.V.
Diphenylhexatriene	7.6	U.V.
Diphenyloctatetraene	7.5	U.V.
Diphosphine	8.7	E.I.
Diphosphorusdiarsenide	10.3	E.I.
Diphosphorus tetrachloride	9.36	E.I.
N,N-di-*n*-propylaniline	7.15	U.V.
Di-*n*-propyl disulfide	8.27	P.I.
Di-*n*-propyl ether	9.27	P.I.
Di-*i*-propyl ether	9.20	P.I.
Di-*n*-propyl sulfide	8.30	P.I.
Disilicon dioxide	10.0	E.I.
Disulfur monoxide	10.3	E.I.
2,3-dithiabutane	8.46	P.I.
3,4-dithiahexane	8.27	P.I.
N-*n*-dodecylaniline	7.5	U.V.
Durene	8.03	P.I.
Epichlorohydrine	10.6	
3,4-epoxy-1-butene	9.7	E.I.
1,2-epoxypropane	9.81	E.I.
Ethanal	10.21	P.I.
Ethane	11.65	P.I.
Ethane-d_1	11.70	E.I.
Ethanoic acid	10.35	P.I.
Ethanoic acid-d_4	10.71	E.I.
Ethanol	10.48	P.I.
Ethanol-d_1(OD)	10.45	E.I.
Ethene	10.51	P.I.
Ethene-d_4	10.52	S.
Ethylamine	8.86	P.I.
N-ethylaniline	7.5	U.V.
Ethylbenzene	8.76	P.I.
Ethyl boron difluoride	11.8	E.I.
Ethyl bromide	10.29	P.I.
Ethyl bromoacetate	10.13	P.I.
Ethyl ω-bromobutanoate	9.85	P.I.
2-ethyl-1-butene	9.21	E.I.
Ethyl chloride	10.97	P.I.
Ethyl chloroacetate	10.20	P.I.
Ethyl decaborane	9.0	E.I.
Ethyl disulfane	9.4	E.I.
Ethyleneimine	9.94	E.I.
Ethylene oxide	10.565	P.I.
Ethyl ethanoate	10.10	P.I.
Ethyl hexanoate	9.67	P.I.
Ethyl iodide	9.33	P.I.
Ethyl isothiocyanate	9.10	P.I.
Ethyl mercaptan	9.29	P.I.
Ethyl methanoate	10.61	P.I.
Ethyl nitrate	11.22	P.I.
Ethyl propanoate	10.00	P.I.
2-ethylthiophene	8.8	E.I.
Ethyl thiocyanate	9.89	P.I.
Ethyl trichloroacetate	10.44	P.I.
Ethyne	11.41	P.I.
Ethyne-d_1	11.39	E.I.
Ethynylbenzene	8.82	P.I.
Ferrous chloride (monomer)	11.5	E.I.
Ferrous chloride (dimer)	10.5	E.I.
Fluorene	8.63	E.I.
Fluorine	15.7	P.I.
o-fluoroaniline	7.95	P.I.
m-fluoroaniline	7.90	P.I.
p-fluoroanilne	7.82	P.I.
Fluorobenzene	9.20	P.I.
Fluorocyanomethane	13.0	E.I.
1-fluoro-1, 2-dibromoethane	10.75	P.I.
Fluoroethane	12.00	E.I.
Fluoroethene	10.37	P.I.
Fluoroform	13.84	S.
Fluoromethanal	11.4	P.I.
Fluoromethane	12.80	S.
o-fluorophenol	8.66	P.I.
o-fluorotoluene	8.91	P.I.
m-fluorotoluene	8.91	P.I.
p-fluorotoluene	8.78	P.I.
Fluorotribromomethane	10.67	P.I.
Fluorotrichloromethane	11.77	P.I.
Fluorotrifluoromethyl-benzene	9.12	P.I.
Formamide	10.20	P.I.
Formic acid	11.05	P.I.
Formic acid-d_1	11.57	E.I.
Furan	8.89	P.I.
Furfural	9.21	P.I.
d-galactose	9.1	E.I.
Germane	12.3	E.I.
Germanium tetrachloride	11.90	E.I.
Germanium tetramethyl	9.2	E.I.
d-glucose	8.8	E.I.
Glycine	9.5	E.I.
n-heptane	10.07	P.I.
2-heptanone	9.33	P.I.
4-heptanone	9.12	P.I.
1-heptene	9.54	E.I.
N-*n*-heptylaniline	7.5	U.V.
1,5-hexadiene	9.51	E.I.
2,4-hexadiyne	10.65	S.
Hexafluoroacetone	11.81	
Hexafluorobenzene	9.39	
Hexafluoropropene	10.3	
Hexamethylbenzene	7.85	
Hexamethyleneimine	8.76	
n-hexane	10.17	
2-hexanone	9.34	
1,3,5-hexatriene	8.26	
1-hexene	9.46	
2-hexene (*trans*)	9.16	
3-hexene (*trans*)	9.12	
3-hexene-1,5-diyne	9.46	
N-*n*-hexylaniline	7.5	
Hydrazine	9.00	
Hydrazoic acid	10.3	
Hydrogen	15.427	
Hydrogen bromide (I)	11.62	
(II)	21.6	
Hydrogen chloride (I)	12.74	
(II)	22.9	
Hydrogen cyanide (I)	13.73	
(II)	26.3	
Hydrogen disulfide	10.2	
Hydrogen fluoride	15.77	
Hydrogen iodide (I)	10.38	
(II)	19.6	
Hydrogen peroxide	10.92	
Hydrogen selenide	9.88	
Hydrogen selenide-d_2	9.88	
Hydrogen sulfide	10.46	
Hydrogen sulfide-d_2	10.47	
Hydrogen telluride	9.138	
Hydrogen telluride-d_2	9.14	
4-hydroxypyridine	9.70	
Indene	8.81	
Iodine	9.28	
Iodine difluoride	10.7	
Iodine monobromide	9.98	
Iodine monochloride	10.31	
Iodine pentafluoride	13.5	
Iodine tetrafluoride	14.5	
Iodine trifluoride	9.7	
Iodobenzene	8.73	
1-iodobutane	9.21	
2-iodobutane	9.09	
Iodoethane	9.33	
Iodomethane	9.54	
1-iodo-2-methylpropane	9.18	
2-iodo-2-methylpropane	9.02	

APPENDIX IV

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

Iodopentaborane	11.1	E.I.
1-iodopentane	9.19	P.I.
1-iodopropane	9.26	P.I.
2-iodopropane	9.17	P.I.
o-iodotoluene	8.62	P.I.
m-iodotoluene	8.61	P.I.
p-iodotoluene	8.50	P.I.
Iron pentacarbonyl	7.95	P.I.
Isoleucine	9.5	E.I.
Isoprene	8.845	P.I.
Isothiocyanic acid	10.4	E.I.
Ketene	9.61	S.
Lanthanum monoxide	4.8	E.I.
Lead tetramethyl	8.0	E.I.
Lithium (diatomic)	4.96	S.
Lithium iodide	8.55	E.I.
Lithium oxide	6.8	E.I.
2,3-lutidine	8.85	P.I.
2,4-lutidine	8.85	P.I.
2,6-lutidine	8.85	P.I.
Magnesium dicyclopentadienide	7.76	E.I.
Maleic anhydride	9.9	P.I.
Mercuric chloride	12.1	E.I.
Mercury dimethyl	8.90	E.I.
Metaboric acid	12.6	E.I.
Methanal	10.87	E.I.
Methanal-d_1	10.83	E.I.
Methanal dimer	10.51	P.I.
Methane	12.98	P.I.
Methane-d_1	13.12	E.I.
Methane-d_2	13.14	E.I.
Methane-d_3	13.18	E.I.
Methane-d_4	13.19	E.I.
Methanoic acid	11.05	P.I.
Methanoic acid-d_1	11.57	E.I.
Methanol	10.85	P.I.
Methanol-d_1(OD)	11.04	E.I.
Methionine	9.5	E.I.
N-methylacetamide	8.90	P.I.
N-methylaniline	7.35	P.I.
Methylamine	8.97	P.I.
p-methylaniline	8.14	E.I.
Methylarsine	9.7	E.I.
Methyl azide	9.5	E.I.
Methyl benzoate	10.0	E.I.
Methyl boron difluoride	12.54	E.I.
Methyl bromide	10.53	P.I.
2-methyl-1,3-butadiene	8.85	P.I.
2-methylbutanal	9.71	P.I.
3-methylbutanal	9.92	E.I.
2-methylbutane	10.31	P.I.
Methyl *n*-butanoate	10.07	P.I.
Methyl *i*-butanoate	9.98	P.I.
3-methyl-2-butanone	9.32	P.I.
2-methyl-1-butene	9.12	P.I.
3-methyl-1-butane	9.51	P.I.
2-methyl-2-butene	8.68	P.I.
3-methyl-1-butyne	10.35	E.I.
Methyl chloride	11.28	P.I.
Methyl chloroacetate	10.35	P.I.
Methylcyclohexane	9.85	P.I.
4-methylcyclohexene	8.91	P.I.
Methylcyclopentane	10.45	E.I.
Methylcyclopropane	9.88	E.I.
Methyl dichloroacetate	10.44	P.I.
Methyldichloroarsine	10.4	E.I.
Methyl disulfane	8.8	E.I.
Methylene chloride	11.35	P.I.
Methyl ethanoate	10.27	P.I.
Methyl ethyl ether	9.81	E.I.
Methyl ethyl sulfide	8.55	P.I.
Methyl fluoride	12.80	S.
N-methylformamide	9.25	P.I.
2-methylfuran	8.39	P.I.
Methyl iodide	9.54	P.I.
Methyl isothiocyanate	9.13	E.I.
Methyl mercaptan	9.44	P.I.
Methyl methanoate	10.82	P.I.
α-methylnaphthalene	7.96	P.I.
β-methylnaphthalene	7.955	P.I.
Methyl nitrite	10.7	E.I.
2-methylpentane	10.11	P.I.
3-methylpentane	10.07	P.I.
Methyl pentanoate	9.87	P.I.
4-Methyl-2-pentanone	9.30	P.I.
2-methyl-2-pentene-4-one	9.08	E.I.
p-methylphenylamine	8.2	E.I.
2-methylpropane	10.56	P.I.
2-methylpropanal	9.74	P.I.
Methyl propanoate	10.15	P.I.
2-methylpropanoic acid	10.02	P.I.
2-methyl-2-propanol	9.7	P.I.
2-methylpropene	9.23	P.I.
Methyl *i*-propyl sulfide	8.7	E.I.
Methyl *n*-propyl sulfide	8.80	E.I.

methyl acrylate – 10.72

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

N-methylpyrrolidine	8.06	E.I.
α-methylstyrene	8.35	P.I.
3-methyl-2-thiabutane	8.7	E.I.
Methyl thiocyanate	10.065	P.I.
Molybdenum dioxide	9.4	E.I.
Molybdenum hexacarbonyl	8.12	P.I.
Molybdenum monoxide	8.0	E.I.
Molybdenum trioxide	12.0	E.I.
Monoaluminum oxide	9.5	E.I.
Monobromobenzene	8.98	P.I.
Monobromodifluoromethane	12.0	E.I.
Monobromoethane	10.29	P.I.
Monobromoethene	9.80	P.I.
Monobromomethane	10.53	P.I.
Monobromotrifluoromethane	11.78	P.I.
Monochlorobenzene	9.07	P.I.
Monochlorocyclopropane	10.10	E.I.
Monochloroethane	10.97	P.I.
Monochloroethene	10.00	P.I.
Monochloromethane	11.28	P.I.
Monochlorotrifluoromethane	12.8	P.I.
Monofluorobenzene	9.20	P.I.
Monofluorodichloromethane	13.06	E.I.
Monofluoroethane	12.00	E.I.
Monofluoroethene	10.37	P.I.
Monofluoromethane	12.80	S.
Monoiodobenzene	8.73	P.I.
Monoiodoethane	9.33	P.I.
Monoiodomethane	9.54	P.I.
Monolithium oxide	9.0	E.I.
Monomethylarsine	9.7	E.I.
Monomethylhydrazine	8.63	E.I.
Naphthalene (I)	8.12	P.I.
(II)	14.7	E.I.
(III)	17.2	E.I.
1-naphthylamine	7.30	P.I.
2-naphthylamine	7.25	P.I.
Nickel chloride	11.2	E.I.
Nickel tetracarbonyl	8.28	P.I.
Nicotine	8.01	E.I.
Nitric oxide (I)	9.25	P.I.
(II)	30.6	E.I.
Nitric sulfide	8.8	P.I.
Nitritomethane	10.7	
o-nitroaniline	8.68	
m-nitroaniline	8.80	
p-nitroaniline	8.85	
Nitrobenzene	9.92	
Nitroethane	10.88	
Nitrogen (I)	15.576	
(II)	27.8	
Nitrogen difluoride	11.4	
Nitrogen dioxide	9.78	
Nitrogen monofluoride	12.0	
Nitrogen trifluoride	12.9	
Nitromethane	11.08	
p-nitrophenol	9.52	
1-nitropropane	10.81	
2-nitropropane	10.71	
p-nitrotoluene	9.82	
Nitrous oxide	12.89	
n-nonane	10.21	
5-nonanone	9.10	
N-*n*-nonylaniline	7.5	
Nornicotine	9.30	
Octafluoroacetophenone	11.25	
Octafluorotoluene	10.4	
n-octane	10.24	
3-octanone	9.19	
4-octanone	9.10	
1,3,5,7-octatetraene	7.8	
1-octene	9.52	
2-octene	9.11	
N-*n*-octylaniline	7.5	
Osmium tetroxide	12.6	
Osmium trioxide	12.3	
Oxacyclobutane	9.85	
Oxygen	12.075	
Oxygen difluoride	13.7	
Ozone	12.80	
Pentaborane	10.8	
1,2-pentadiene	9.42	
1,3-pentadiene	8.68	
1,4-pentadiene	9.58	
2,3-pentadiene	9.26	
Pentafluorobenzene	9.84	
Pentamethylbenzene	7.92	
n-pentanal	9.82	
n-pentane	10.34	
2,4-pentanedione	8.87	
n-pentanoic acid	10.12	

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

2-pentanone	9.39	P.I.
3-pentanone	9.32	P.I.
1-pentene	9.50	P.I.
2-pentene (*cis*)	9.11	E.I.
2-pentene (*trans*)	9.06	E.I.
n-pentyl ethanoate	9.92	P.I.
1-pentyne	10.39	E.I.
Perchloryl fluoride	13.6	E.I.
Perfluoroheptane	12.5	E.I.
Perfluoro-1-heptene	10.48	P.I.
(*n*-perfluoropropyl)-chloromethane	11.84	P.I.
n-perfluoropropyl iodide	10.36	P.I.
(*n*-perfluoropropyl)-iodomethane	9.96	P.I.
(*n*-perfluoropropyl)-methyl ketone	10.58	P.I.
Perylene	7.15	U.V.
Phenanthrene	7.8	S.
Phenetole	8.13	P.I.
Phenol	8.50	P.I.
Phenylacetylene	8.82	P.I.
o-Phenylenediamine	8.00	E.I.
m-Phenylenediamine	7.96	E.I.
p-Phenylenediamine	7.58	E.I.
Phenylhydrazine	7.64	P.I.
Phenyl isocyanete	8.77	P.I.
Phenyl isothiocyanate	8.52	P.I.
Phosgene	11.78	S.
Phosphine	10.1	E.I.
Phosphorous acid	12.6	E.I.
Phosphorus (P_1)	11.1	E.I.
Phosphorus (P_2)	11.2	E.I.
Phosphorus (P_4)	9.0	E.I.
Phosphorus arsenide	11.2	E.I.
Phosphorus dichloride	9.0	E.I.
Phosphorus monoarsenide	11.2	E.I.
Phosphorus monochloride	9.6	E.I.
Phosphorus triarsenide	10.0	E.I.
Phosphorus trichloride	10.75	E.I.
2-picoline	9.02	P.I.
3-picoline	9.04	P.I.
4-picoline	9.04	P.I.
Piperidine	8.49	E.I.
Polymethylene	10.15	E.I.
Potassium (K_2)	4.09	S.
Potassium iodide	8.3	E.I.
Propanal	9.98	P.I.
Propane	11.07	P.I.
Propadiene	10.19	P.I.
Propanoic acid	10.24	P.I.
1-Propanol	10.17	P.I.
2-Propanol	10.17	P.I.
Propanone	9.69	P.I.
Propenal	10.10	P.I.
Propene	9.73	P.I.
Prop-1-ene-2-ol	8.2	P.I.
Prop-2-ene-1-ol	9.67	P.I.
Propenoic acid	10.90	E.I.
Propiolactone	9.70	P.I.
n-propylamine	8.78	P.I.
i-propylamine	8.72	P.I.
N-*n*-propylaniline	7.5	U.V.
N-*i*-propylaniline	7.5	U.V.
1-propylbenzene	8.72	P.I.
2-propylbenzene	8.69	P.I.
Propylene oxide	9.81	E.I.
Propylene sulfide	8.6	E.I.
n-propyl ethanoate	10.04	P.I.
i-propyl ethanoate	9.99	P.I.
i-propyl isothiocyanate	9.4	E.I.
n-propyl methanoate	10.54	P.I.
n-propyl nitrate	11.07	P.I.
2-propyl thiophene	8.6	E.I.
Propyne	10.36	P.I.
Pyrazine	10.00	E.I.
Pyrene	7.72	E.I.
Pyridazine	9.86	E.I.
Pyridine	9.266	S.
2-pyridinecarboxaldehyde	9.75	E.I.
4-pyridinecarboxaldehyde	10.12	E.I.
Pyrimidine	9.91	E.I.
Pyrrole	8.20	P.I.
Quadricyclene	8.70	E.I.
Quinoline	8.30	P.I.
Quinone	9.68	P.I.
Selenium dioxide	11.94	E.I.
Selenium dioxydifluoride	13.15	E.I.
Selenium oxydifluoride	12.50	E.I.
Silane	12.2	E.I.
Silicon carbide	9.3	E.I.
Silicon dichloride	11.8	E.I.
Silicon dioxide	11.7	E.I.
Silicon monofluoride	7.26	P.I.
Silicon monoxide	10.8	E.I.
Silicon tetrachloride	12.06	E.I.

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

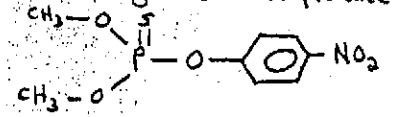
Silicon tetrafluoride	15.4	E.I.
Silicon tetramethyl	9.80	E.I.
Sodium (Na_1)	4.87	S.
Sodium azide	11.7	E.I.
Sodium hydroxide	9.	E.I.
Sodium iodide	8.8	E.I.
Stannane	11.7	E.I.
Stibine	9.58	P.I.
Stilbene	7.95	U.V.
Styrene	8.47	P.I.
Sulfur (S_1)	9.9	E.I.
Sulfur (S_2)	10.5	E.I.
Sulfur (S_3)	10.4	E.I.
Sulfur (S_4)	9.9	E.I.
Sulfur (S_6)	9.4	E.I.
Sulfur (S_7)	9.2	E.I.
Sulfur (S_8)	8.9	E.I.
Sulfur dioxide	12.34	S.
Sulfur hexafluoride	19.3	E.I.
Sulfur monoxide	12.1	E.I.
Tetracene	6.88	P.I.
1,1,2,2-tetrachloroethane	11.10	E.I.
Tetrachloroethene	9.32	P.I.
Tetrachloromethane	11.47	P.I.
1,2,3,4-tetrafluoro-benzene	9.61	P.I.
1,2,3,5-tetrafluoro-benzene	9.55	P.I.
1,2,4,5-tetrafluoro-benzene	9.39	P.I.
Tetrafluoroethene	10.12	P.I.
Tetrafluoromethane	<15.0	E.I.
Tetrahydrofuran	9.45	E.I.
Tetrahydropyran	9.26	P.I.
Tetrahydropyrrole	8.60	E.I.
2,3,5,6-tetramethyl-aniline	7.7	E.I.
1,2,4,5-tetramethyl-benzene	8.03	P.I.
2,2,3,3-tetramethyl-butane	9.79	E.I.
Tetramethyl germanium	9.2	E.I.
Tetramethyl hydrazine	7.76	E.I.
Tetramethyl lead	8.0	E.I.
2,2,4,4-tetramethyl-3-pentanone	8.65	P.I.
Tetramethyl silane	9.80	E.I.
Tetramethyl tin	8.25	E.I.
2-thiabutane	8.53	P.I.
Thiacyclobutane	8.9	
Thiacyclohexane	8.36	
Thiacyclopentane	8.48	
Thiacyclopropane	8.87	
Thiadioxane	8.50	
4-thiaheptane	8.30	
2-thiapentane	8.80	
3-thiapentane	8.43	
4-thia-1-pentane	8.70	
2-thiapropane	8.69	
Thioanisole	8.9	
1-thiobutanol	9.14	
i-thiobutanol	8.79	
Thioethanoic acid	10.00	
Thioethanol	9.29	
Thiomethanol	9.44	
Thiophene	8.86	
Thiophenol	8.33	
1-thiopropanol	9.20	
Tin tetramethyl	8.25	
Titantium tetrachloride	11.7	
Titantium trichloride	13.0	
Toluene (I)	8.82	
(II)	15.5	
(III)	17.5	
o-toluidine	7.75	
m-toluidine	7.50	
p-toluidine	7.50	
p-tolunitrile	9.76	
Triazene	9.6	
s-triazine	10.07	
Tribromoethene	9.27	
Tribromofluoromethane	10.67	
Tribromomethane	10.51	
1,1,1-trichlorobutanone	9.54	
Trichlorofluoromethane	11.77	
Trichloroethene	9.45	
Trichloromethane	11.42	
Trichloromethyl ethyl ether	10.08	
Trichlorovinylsilane	10.79	
Triethylamine	7.50	
Triethylphosphine	8.27	
Trifluoroacetophenone	10.25	
1,2,4-trifluorobenzene	9.37	
1,3,5-trifluorobenzene	9.3	
Trifluorochloromethane	12.91	
Trifluoroethane	10.4	
Trifluoroethene	10.14	

B. MOLECULAR IONIZATION POTENTIALS (CONT.)

1,1,1-trifluoro-2-iodethane	10.00	P.I.
Trifluoroiodomethane	10.40	P.I.
Trifluoromethane	13.84	S.
Trifluoromethylbenzene	9.68	P.I.
Trifluoromethyl-cyclohexane	10.46	P.I.
1,1,1-trifluoropropene	10.9	P.I.
1,1,1-trifluoro-2,2,2-trichloroethane	11.78	P.I.
1,1,2-trifluoro-1,2,2-trichloroethane	11.99	P.I.
Trimethoxyborine	8.9	E.I.
Trimethylamine	7.82	P.I.
2,4,6-trimethylaniline	7.7	E.I.
Trimethyl arsine	8.3	E.I.
1,2,3-trimethylbenzene	8.48	P.I.
1,2,4-trimethylbenzene	8.27	P.I.
1,3,5-trimethylbenzene	8.39	P.I.
2,2,3-trimethylbutane	10.09	E.I.
Trifnethylene oxide	9.85	E.I.
Trimethyl hydrazine	7.93	E.I.
2,2,4-trimethylpentane	9.85	P.I.
2,2,4-trimethyl-3-pentanone	8.82	P.I.
Trimethylphosphine	8.60	E.I.
Trimethylsilane	9.8	E.I.
Triphenylamine	7.6	E.I.
Triphenylene	7.8	U.V.
Tris-(*p*-methylphenyl)-amine	7.4	E.I.
Tris-(perfluoroethyl)-amine	11.7	P.I.
Tris(*n*-propyl) amine	7.23	P.I.
Tris (trifluoromethyl)-arsine	11.0	E.I.
Tris(trifluoromethyl)-phosphorus	11.3	E.I.
2,3,4-trithiapentane	8.80	E.I.
Tropolone	9.83	E.I.
Tropone	9.68	E.I.
Tungsten dioxide	9.9	E.I.
Tungsten hexacarbonyl	8.18	P.I.
Tungsten monoxide	9.1	E.I.
Tungsten trioxide	11.7	E.I.
Uranium dioxide	4.3	E.I.
Uranium hexafluoride	15.0	E.I.
Uranium monoxide	4.7	E.I.
Uranium tetrachloride	11.5	E.I.
Uranium trioxide	10.4	E.I.
Vinyl acetate	9.19	P.I.
Vinyl benzene	8.47	P.I.
Vinyl boron difluoride	11.06	E.I.
Vinyl bromide	9.80	P.I.
Vinyl chloride	10.00	P.I.
4-vinylcyclohexene	8.93	P.I.
Vinyl ethanoate	9.19	P.I.
Vinyl fluoride	10.37	P.I.
Vinyl methyl ether	8.93	P.I.
Water (I)	12.59	P.I.
(II)	16.7	S.
(III)	24.2	S.
(IV)	33.4	S.
Water-d_1	12.58	E.I.
Water-d_2	12.60	E.I.
Xenon difluoride	11.5	S.
Xenon tetrafluoride	12.9	E.I.
o-xylene	8.56	P.I.
m-xylene	8.56	P.I.
p-xylene	8.445	P.I.
Zinc chloride	12.9	E.I.
Zinc dimethyl	8.86	E.I.
Zinc phthalocyanine	7.	U.V.

PCB's — less than 10.2 but
. no IP's listed, only
relative sensitivities.

methyl parathion — <10.2 because of its large size and presence of ⬡



C. RADICAL IONIZATION POTENTIALS

Acetyl	7.90	E.I.
Allyl	8.16	E.I.
Amino	11.3	E.I.
Aminocyclopentadienyl	7.55	E.I.
Anilino	8.26	E.I.
Azido	11.6	E.I.
Benzoyl	7.40	E.I.
Benzyl	7.76	E.I.
Bromocyclopentadienyl	8.85	E.I.
Bromomethynyl	10.43	E.I.
2-buten-1-yl	7.71	E.I.
n-butyl	8.64	E.I.
i-butyl	8.35	E.I.
sec-butyl	7.93	E.I.
t-butyl	7.42	E.I.
p-chlorobenzyl	7.95	E.I.
Chlorodioxy	11.1	E.I.
Chlorocyclopentadienyl	8.78	E.I.
Chloromethynyl	12.9	E.I.
Chlorotrioxy	11.7	E.I.
Chloroxy	10.4	E.I.
m-cyanobenzyl	8.58	E.I.
p-cyanobenzyl	8.36	E.I.
Cyanocyclopentadienyl	9.44	E.I.
1-cyanoethyl	9.76	E.I.
2-cyano-1-ethyl	9.85	E.I.
Cyanomethyl	10.87	E.I.
2-(2-cyanopropyl)	9.15	E.I.
Cyclobutyl	7.88	E.I.
Cycloheptatrienyl	6.24	S.
Cyclohexyl	7.66	E.I.
Cyclopentadienyl	8.69	E.I.
Cyclopentyl	7.79	E.I.
Cyclopropyl	8.05	E.I.
Dibromomethynyl	10.11	E.I.
Dibromomethyl	8.13	E.I.
Dichloromethynyl	13.10	E.I.
Dichloromethyl	8.67	E.I.
Difluoroamino	11.4	E.I.
Difluoromethynyl	13.30	E.I.
Difluoromethyl	9.45	E.I.
Dimethylhydrazyl	5.29	E.I.
Dimethylsilyl	7.1	E.I.
Diphenylmethyl	7.32	E.I.
Dithiomethylperoxy	9.4	E.I.
Ethenyl	9.45	E.I.
Ethoxy	10.30	E.I.
Ethyl	8.30	E.I.
Ethylenimnyl	7.6	
Fluorenyl	7.07	
m-fluorobenzyl	8.18	
p-fluorobenzyl	7.78	
Fluorocyclopentadienyl	8.82	
Fluoroimino	12.0	
Fluoromethynyl	13.81	
Fluorophenyl	10.86	
Fluoroxy	13.0	
Formyl	9.43	
Formyl-d_1	9.82	
Hydrazyl	11.53	
Hydroperoxy	10.50	
Hydrosulfyl	6.20	
Hydroxyl	13.53	
Imino	13.10	
Indenyl	8.35	
Isothiocyanato	<10.4	
Methenyl	10.39	
Methoxy	10.7	
p-methoxybenzyl	6.82	
Methyl	9.83	
Methyl-d_3	9.83	
Methylcyclopentadienyl	8.54	
Methylhydrazyl	5.12	
Methylnitrosyl	8.2	
2-methyl-1-propen-1-yl	8.03	
Methylsilyl	9.3	
Methynyl	11.13	
Monobromomethyl	8.34	
Monochloromethyl	8.70	
Monofluoromethyl	9.35	
Nitrile	14.2	
m-nitrobenzyl	8.56	
Pentafluorophenyl	10.6	
2-pentyl	7.73	
3-pentyl	7.86	
neo-pentyl	8.33	
t-pentyl	7.12	
Phenyl	9.89	
Propargyl	8.25	
Propionyl	7.66	
1-propyl	7.37	
2-propyl	7.21	
p-(*i*-propylbenzyl)	7.42	
2-pyridylmethyl	8.17	
3-pyridylmethyl	7.92	

C. RADICAL IONIZATION POTENTIALS (CONT.)

4-pyridylmethyl	8.40	E.I.
Thioethoxy	8.15	E.I.
Thiomethoxy	8.06	E.I.
Thiophenoxy	8.63	E.I.
Trichloromethyl	8.78	E.I.
Trifluoromethyl	10.10	E.I.
Trimethylgermanyl	8.0	E.I.
Trimethylstanyl	7.6	E.I.
Trimethylplumbyl	7.5	E.I.
Trimethylsilyl	7.8	E.I.
Tropylium	6.24	S.
Vinyl	9.45	E.I.
Vinylcyclopentadienyl	8.44	E.I.
o-xylyl	7.61	E.I.
m-xylyl	7.65	E.I.
p-xylyl	7.46	E.I.

APPENDIX V

GENERAL BIBLIOGRAPHY

Applied Mass Spectrometry, Report of a conference organized by the spectroscopy panel of the Institute of Petroleum, London, Oct. 2 1953, The Institute of Petroleum, London, 1954, 333 pp.

F. W. Aston, *Mass Spectra and Isotopes*, second edition, Edward A and Company, London, 1942, 276 pp.

G. P. Barnard, *Modern Mass Spectrometry*, The Institute of Physics, Lo 1953, 326 pp.

C. E. Berry and J. K. Walker, "Industrial Applications (Mass Sp metry)," in *Annual Reviews of Nuclear Physics*, Vol. 5, J. G. Beck M. D. Kamen, and L. I. Schiff (eds.), Annual Reviews, Inc., Sta Calif., 1955, pp. 197–211.

J. H. Beynon, *Mass Spectrometry and Its Applications to Organic Chen* Elsevier Publishing Company, Amsterdam, 1960, 640 pp.

J. H. Beynon, and A. E. Williams, *Mass and Abundance Tables for I Mass Spectrometry*, Elsevier Publishing Company, Amsterdam, 570 pp.

K. Biemann, *Mass Spectrometry: Applications to Organic Chemistry* Graw-Hill Book Company, New York, 1962, 370 pp.

K. Biemann, "Mass Spectrometry," in *Annual Reviews of Biochemistry*

Photoionization Detector Sensitivity of Organic Compounds*

Marsha L. Langhorst
The Dow Chemical Company, USA, Analytical Laboratory, 574 Building, Midland, Michigan 48640

Abstract

Using a gas chromatograph equipped with a high temperature photoionization detector, a wide variety of organic compounds was analyzed. Relative detector sensitivities were determined on a molar basis and on a weight basis and were normalized against the detector response for benzene. By analyzing sets of organic compounds of like functionality but different numbers of carbons, several conclusions were derived relating PID sensitivity to molecular structure. In general, relative PID sensitivities should be compared on a molar basis rather than on a weight basis. PID sensitivity depends primarily upon carbon number, functional groups, and bonding type.

Introduction

The photoionization detector (PID) is designed to detect species in the effluent from a gas chromatograph by utilizing the principle of photoionization. Photoionization occurs when the absorption of a photon by a molecule leads to ionization via the reaction:

$$RH + h\nu \rightarrow RH^+ + e^-$$

where RH is an ionizable molecule and hν is a photon with an energy ≥ the ionization potential (IP) of the molecule.

With the development of a stable PID with a sealed UV source (HNU Systems, Inc., Newton Upper Falls, Massachusetts), interest in the detector has increased. The development and performance of the detector have been documented (1-5), as well as a number of diverse applications (6-12). By utilizing UV lamps with different photon energies, the detector can be easily modified for almost universal or quite select detection of compounds.

If the ionization potential of the compound is less than the lamp energy, then the photoionization detector will respond to that molecule. As a result, tables of IPs can be used to determine whether or not the detector may be useful (6). However, these parameters of lamp energy and IP do not indicate the relative detector sensitivity for various compounds. This lack of information for concisely defining the factors affecting PID sensitivity has limited its acceptance.

Some instrumental parameters effecting PID sensitivity include: (A) lamp intensity, (B) lamp seal, and (C) flow rate through the detector. The lamp intensity is adjustable with a dial on the HNU Systems electrometer/power supply unit. The intensity can be diminished if the detector window becomes dirty or coated with material from column bleed or samples. The lamp seal is optimized at the time the UV lamp is installed in the detector. The sensitivity increases (almost exponentially) as flow rate decreases (5). With high efficiency, packed gas chromatography columns' flow rates between 8-12 cc/min can be normally used for high sensitivity.

Logically, the detector sensitivity also depends upon ionization efficiency, a parameter related to the tightness with which electrons are held to a molecule. By investigating detector response for a wide variety of organic compounds, general rules have been derived for predicting PID sensitivity based upon organic compound structure.

Experimental

The HNU Systems, Inc. high-temperature photoionization detector, Model PI-51-02, was installed on a Hewlett-Packard (Palo Alto, California) 5700 gas chromatograph (GC). Using a 10.2 eV lamp, a wide variety of organic compounds was analyzed on several different GC columns. Peak areas were integrated with a Spectra-Physics (Arlington Heights, Illinois) Systems I computing integrator. Relative detector sensitivities were determined on a molar basis and on a weight basis and were normalized against the detector response for benzene. Using the data obtained from analyzing sets of compounds of like functionality but different numbers of carbons, conclusions were derived that related PID sensitivity to molecular structure.

The chemical standards were obtained from Supelco, Inc., (Bellefonte, Pennsylvania) (PolyScience Corp. analytical standards kits, Niles, Illinois). The chemical purities were all > 95%.

*This paper was presented at the 1980 Pittsburgh Conference on March 12, 1980, in Atlantic City, New Jersey (paper number 415).

Calculations

The molar sensitivity relative to benzene is calculated using the following equation:

$$SM = \frac{A}{A_{(BZ)}} \times \frac{B_{(BZ)}}{B} \qquad \text{Eq. 1}$$

where A is the peak area of compound of interest, $A_{(BZ)}$ is the peak area of the benzene peak, B is the molar concentration of the compound of interest (nmoles/ml), and $B_{(BZ)}$ is the molar concentration of the benzene standard solution (nmoles/ml).

The relative sensitivity normalized to benzene on a weight basis is calculated using the following equation:

$$S = \frac{A}{A_{(BZ)}} \times \frac{C_{(BZ)}}{C} \qquad \text{Eq. 2}$$

where C is the concentration of compound of interest (μg/ml) and $C_{(BZ)}$ is the concentration of benzene in standard solution (μg/ml).

Results and Discussion

The detector response relative to benzene on a molar basis for a large number of organic compounds is detailed in Table I. From these data, it can be concluded that PID sensitivity depends upon the following chemical structure parameters: (A) carbon number, (B) functional groups (e.g., -OH, -COOR, etc.), and (C) bonding type (e.g., double bonds, aromatic, etc.). More specific conclusions are listed in Table II.

Table I. Sensitivity of Compound Relative to Benzene on a Molar Basis (Benzene = 1.0)

Compound	SM (Bz)	Compound	SM (Bz)	Compound	SM (Bz)
n-ALKANES		1-Hexadecene	0.99	**ALDEHYDES**	
Heptane	0.032	1-Heptadecene	1.06	Butanal	0.30
Octane	0.080	1-Octadecene	1.10	Pentanal	0.36
n-Nonane	0.14	1-Nonadecene	1.17	Hexanal	0.41
n-Decane	0.23			Heptanal	0.45
Undecane	0.30	**ALKENES, DIENES, ALKYNES**		Octanal	0.49
decane	0.37			Nonanal	0.53
decane	0.46	2-Heptene	0.51		
n-Tetradecane	0.53	3-Heptene	0.58	**ALCOHOLS**	
Pentadecane	0.59	3-Methyl-1-butene	0.52	1-Butanol	0.023
Hexadecane	0.71	1,9-Decadiene	1.07	1-Pentanol	0.053
Heptadecane	0.72	2-Octyne	2.75	1-Hexanol	0.086
n-Octadecane	0.79			1-Heptanol	0.12
n-Nonadecane	0.86	**KETONES**		1-Octanol	0.16
Eicosane	0.93			1-Nonanol	0.20
Heneicosane	1.03	Acetone	0.35	1-Decanol	0.25
n-Docosane	1.13	2-Butanone	0.40	1-Undecanol	0.29
		2-Pentanone	0.45	1-Dodecanol	0.36
ALKANES: BRANCHED & CYCLIC		2-Hexanone	0.52	Isobutanol	0.029
		2-Heptanone	0.59		
2-Dimethylbutane	0.037	2-Octanone	0.71	**ESTERS**	
2,3-Dimethylbutane	0.032	2-Nonanone	0.78		
2-Methylpentane	0.011	3-Pentanone	0.54	Methyl propionate	0.010
Methylpentane	0.027	3-Heptanone	0.68	Methyl butanoate	0.039
4-Dimethylpentane	0.080	3-Octanone	0.73	Methyl pentanoate	0.082
Methylhexane	0.075	4-Heptanone	0.70	Methyl hexanoate	0.096
2,3-Dimethylpentane	0.10	5-Nonanone	0.82	Methyl heptanoate	0.14
2,2,4-Trimethylpentane	0.21			Methyl octanoate	0.15
4- & 2,5-Dimethylhexane	0.15	**KETONES: BRANCHED & CYCLIC**		Methyl nonanoate	0.26
3,4-Trimethylpentane	0.22			Methyl decanoate	0.33
3-Methylheptane	0.13	3-Methyl-2-butanone	0.58	Methyl dodecanoate	0.48
2,2,5-Trimethylhexane	0.26	3-Methyl-2-pentanone	0.60	Methyl tetradecanoate	0.66
yclohexane	0.18	4-Methyl-2-Hexanone	0.62	Methyl hexadecanoate	0.82
lethylcyclohexane	0.28	3-Methyl-2-heptanone	0.72	Ethyl acetate	0.020
ecahydronaphthalene	1.04	2-Methyl-3-pentanone	0.62	Ethyl butanoate	0.15
		5-Methyl-2-hexanone	0.65	Ethyl hexanoate	0.24
1-ALKENES		5-Methyl-3-heptanone	0.75	Ethyl octanoate	0.32
		3,3-Dimethyl-2-butanone	0.65	Ethyl decanoate	0.51
Heptene	0.54	2,4-Dimethyl-3-pentanone	0.70	Ethyl dodecanoate	0.70
1-Octene	0.55	2,6-Dimethyl-4-heptanone	0.81	Propyl acetate	0.025
nene	0.58	Cyclopentanone	0.57	Propyl butanoate	0.21
cene	0.67	Cyclohexanone	0.62	Butyl acetate	0.044
Undecene	0.70	2-Methylcyclohexanone	0.66		
Dodecene	0.73	3-Methylcyclohexanone	0.66	**AROMATIC HYDROCARBONS**	
1-Tridecene	0.81	4-Methylcyclohexanone	0.63		
1-Tetradecene	0.87	2,3-Butanedione	0.45	Toluene	1.09
Pentadecene	0.92				

(continued on next page)

Table I. (continued)

Compound	SM (Bz)
(Aromatic Hydrocarbons)	
Ethylbenzene	1.16
n-Propylbenzene	1.21
n-Butylbenzene	1.27
n-Hexylbenzene	1.29
n-Octylbenzene	1.52
n-Decylbenzene	1.69
o-Xylene	1.14
m-Xylene	1.15
p-Xylene	1.20
Cumene	1.22
p-Cymene	1.27
Mesitylene	1.27
PAHs/PNAs	
Naphthalene	1.97
Anthracene	2.44
Phenanthrene	2.50
1,2-Benzanthracene	2.46
Chrysene	2.96
Pyrene	3.02
Triphenylene	3.08
Fluorene	2.08
Fluoranthene	2.85
Acenaphthene	3.06
Biphenyl	1.88
p-Terphenyl	2.20
SUBSTITUTED BENZENES	
Ring Activators	
Phenol	1.05
Aniline	1.13
1,2-Dimethoxybenzene	1.19
Ring Deactivators	
Nitrobenzene	0.29
Benzoic acid	0.50
Benzaldehyde	0.96
Acetophenone	0.94
Chlorobenzenes	
1,3-Dichlorobenzene	1.42
1,4-Dichlorobenzene	1.39
1,2-Dichlorobenzene	1.30
1,3,5-Trichlorobenzene	1.26
1,2,4-Trichlorobenzene	1.20
1,2,3-Trichlorobenzene	1.44
1,2,4,5-Tetrachlorobenzene	1.28
1,2,3,4-Tetrachlorobenzene	1.40
Pentachlorobenzene	1.32
Hexachlorobenzene	1.25
Chlorobenzenes average =	1.30
Chlorophenols	
2-Chlorophenol	1.19
3-Chlorophenol	1.32
4-Chlorophenol	1.30
2,3-Dichlorophenol	1.34
2,4-Dichlorophenol	1.34
2,5-Dichlorophenol	1.34
2,6-Dichlorophenol	1.33
3,4-Dichlorophenol	1.37
3,5-Dichlorophenol	1.35
2,3,4-Trichlorophenol	1.28
2,3,5-Trichlorophenol	1.28
2,3,6-Trichlorophenol	1.47
2,4,5-Trichlorophenol	1.32
2,4,6-Trichlorophenol	1.30
3,4,5-Trichlorophenol	1.20
2,3,4,5-Tetrachlorophenol	1.14
2,3,4,6-Tetrachlorophenol	1.43
2,3,5,6-Tetrachlorophenol	1.38
Pentachlorophenol	1.18
Chlorophenols average =	1.32
Polychlorinated Biphenyls	
2,3-Dichlorobiphenyl	2.18
4,4'-Dichlorobiphenyl	2.47
2',3,4-Trichlorobiphenyl	2.40
2,2',5,5'-Tetrachlorobiphenyl	2.43
2,3',4',5-Tetrachlorobiphenyl	2.39
3,3',4,4'-Tetrachlorobiphenyl	2.96
2,2',4,5,5'-Pentachlorobiphenyl	2.45
2,2',3,4,5'-Pentachlorobiphenyl	2.80
2,2',3,4,5,6'-Hexachlorobiphenyl	2.55
2,2',4,4',5,5'-Hexachlorbiphenyl	2.60
PCBs average =	2.53
Phthalates	
bis(Methyl)phthalate	0.56
bis(Ethyl)phthalate	0.87
bis(n-Butyl)phthalate	1.06
bis(2-Ethylhexyl)phthalate	1.78
Butylbenzylphthalate	1.78
Halogenated	
Monochlorobenzene	1.30
Bromobenzene	1.82
Iodobenzene	2.50
1-Chloro-2-fluorobenzene	0.98
1-Fluoro-4-nitrobenzene	0.15
Mixed Functionality	
p-Cresol	1.07
2,4-Dimethylphenol	1.10
2-Chloro-5-hydroxy toluene	1.20
2,4-Dinitrotoluene	0.062
4-Nitrophenol	0.29
2,4-Dinitrophenol	0.094
Diphenyloxide	2.10
Dibenzofuran	0.86
Dibenzo-p-dioxin	0.93
Dibenzothiophene	1.31
4-Bromodiphenyloxide	3.30
2-Chloronaphthalene	2.04
MISCELLANEOUS	
3-Hexene-1-ol	0.46
Hexachlorocyclohexane	0.027
Hexachlorocyclopentadiene	0.88
Hexachloro-1,3-butadiene	1.34
Mesityloxide	0.611
1-Bromobutane	0.066
1-Iodobutane	1.93
1,2-Dibromobutane	0.081
Diethyl ether	0.36
Tetrahydrofuran	0.39
Pyridine	0.50
Isopentanol	0.057
tert-Pentanol	0.054
1,4-Butanediol	0.10

Table II. Conclusions on a Molar Basis

- Sensitivity increases as carbon number increases.
- For n-alkanes, SM = 0.0715n - 0.457 where SM = molar sensitivity relative to benzene (Benzene = 1.0) and n = carbon number
- Sensitivity for alkanes < alkenes < aromatics.
- Sensitivity of alkanes < alcohols ≤ esters < aldehydes < ketones
- Sensitivity of cyclic compounds > noncyclic compounds
- Sensitivity of branched compounds > nonbranched compounds.
- Sensitivity of fluorine-substituted < chlorine-substituted < bromine-substituted < iodine-substituted compounds
- For substituted benzenes, ring activators (electron-releasing groups), increase sensitivity and ring deactivators (electron-withdrawing groups) decrease sensitivity (exception: halogenated benzenes)

In general, sensitivity increases as carbon number increases. For *n*-alkanes, molar sensitivity is linearly related to carbon number by the relationship:

$$SM = 0.715n - 0.475$$

where *SM* is the molar sensitivity relative to benzene and *n* is the carbon number (see Figure 1). This line was drawn for C_7 through C_{22} *n*-alkanes. C_1 through C_6 alkanes were excluded because they have ionization potentials greater than or equal to 10.2 eV and therefore give little or no response when the PID is equipped with a 10.2-eV lamp. Figure 2 shows relative sensitivities normalized to benzene on a *weight* basis for *n*-alkanes and 1-alkenes. For alkanes, the relationship is nearly linear at low carbon numbers. It was concluded that PID sensitivities could be better compared on a molar basis

rather than on a weight basis.

Series of 1-alkenes, alcohols, aldehydes, ketones, and esters were also analyzed. For these compounds, functional groups and bonding structure also affect detector sensitivity as well as carbon number (see Figures 1 and 3-4). At low carbon numbers, the bonding type or functional group is the primary

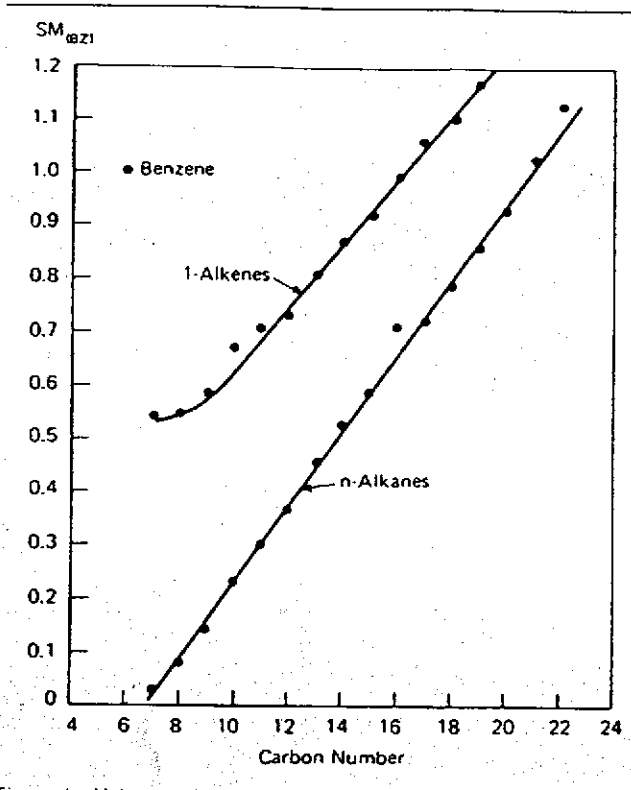


Figure 1. Molar sensitivity relative to benzene vs. carbon number for n-alkanes and 1-alkenes.

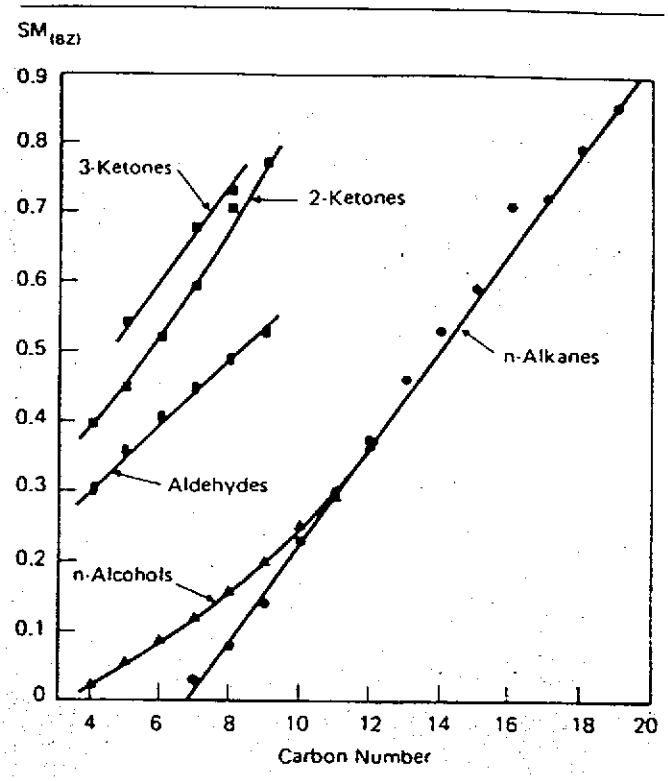


Figure 3. Molar sensitivity relative to benzene vs carbon number for 1-alcohols, aldehydes, and ketones.

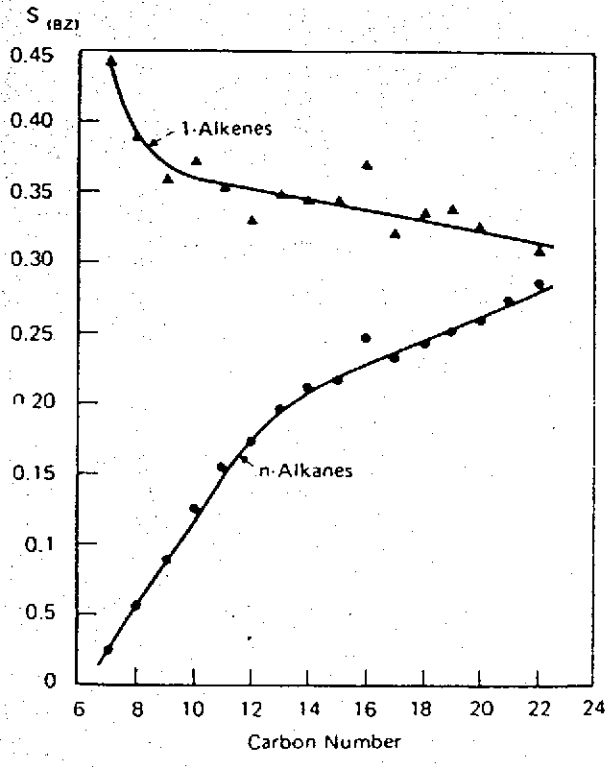


Figure 2. Sensitivity relative to benzene on a weight basis vs. carbon number for n-alkanes and 1-alkenes.

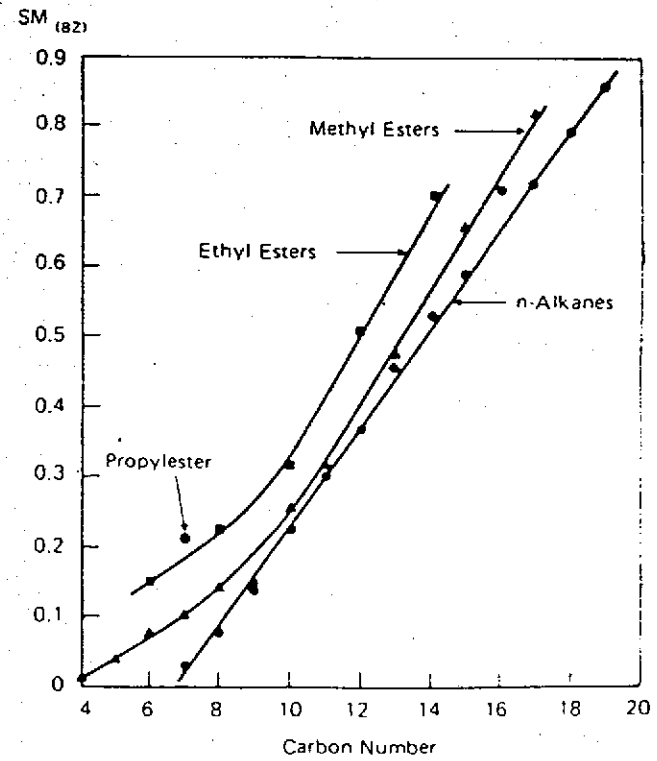


Figure 4. Molar sensitivity relative to benzene vs. carbon number for methyl, ethyl, and propyl esters.

factor affecting sensitivity. At high carbon number, the plot of *SM* vs. carbon number tends to parallel or meet the line for *n*-alkanes. That is, carbon number is then the predominant factor affecting response. In general, the sensitivity of *n*-alkanes < 1-alcohols < esters < aldehydes < ketones of the same carbon number.

From the data in Table I a number of other conclusions can be drawn. Sensitivity of alkanes < alkenes < aromatics. Figure 5 shows that branched compounds are generally more sensitive than nonbranched compounds. This figure compares alkanes with one, two, or three branching methyl groups attached.

Table III shows data to support the conclusion that cyclic compounds are more sensitive than their noncyclic analogs. For halogenated compounds, sensitivity increases in the order fluorine-substituted compounds < chlorine-substituted compounds < bromine-substituted compounds < iodine-substituted compounds. This is illustrated in Figure 6 with halogenated benzenes.

For substituted benzenes, electron-releasing groups (ring activators) increase sensitivity, and electron-withdrawing groups (ring deactivators) decrease sensitivity relative to benzene itself. Figure 7 lists activating and deactivating groups and shows how these substituents affect molar sensitivity relative to benzene. For alkyl benzenes and phthalates sensitivity increases as the carbon number of the alkyl chain increases (see Figure 8).

These general conclusions should increase the utility of the PID by giving the analyst a better understanding of its applicability and performance.

References

1. J.N. Driscoll and F.F. Spaziani. PID development gives new performance levels. *Res./Dev.* 27: 50-54 (1976).
2. J.N. Driscoll. Applications of a photoionization detector in gas chromatography. *Am. Lab.* 9: 71-74 (1976).

Table III. Comparison of Molar Sensitivity of Cyclic and Noncyclic Compounds

Noncyclic Compound	SM (Bz)	Cyclic Compound	SM (Bz)
Hexane	<0.032	Cyclohexane	0.18
3-Methylhexane	0.075	Methylcyclohexane	0.18
2-Pentanone	0.45	Cyclopentanone	0.57
3-Pentanone	0.54		
2-Hexanone	0.52	Cyclohexanone	0.62
4-Methylhexanone	0.62	2-Methylcyclohexanone	0.66
		3-Methylcyclohexanone	0.66
		4-Methylcyclohexanone	0.63
Decane	0.23	Decahydronaphthalene	1.04
Diethyl ether	0.36	Tetrahydrofuran	0.39

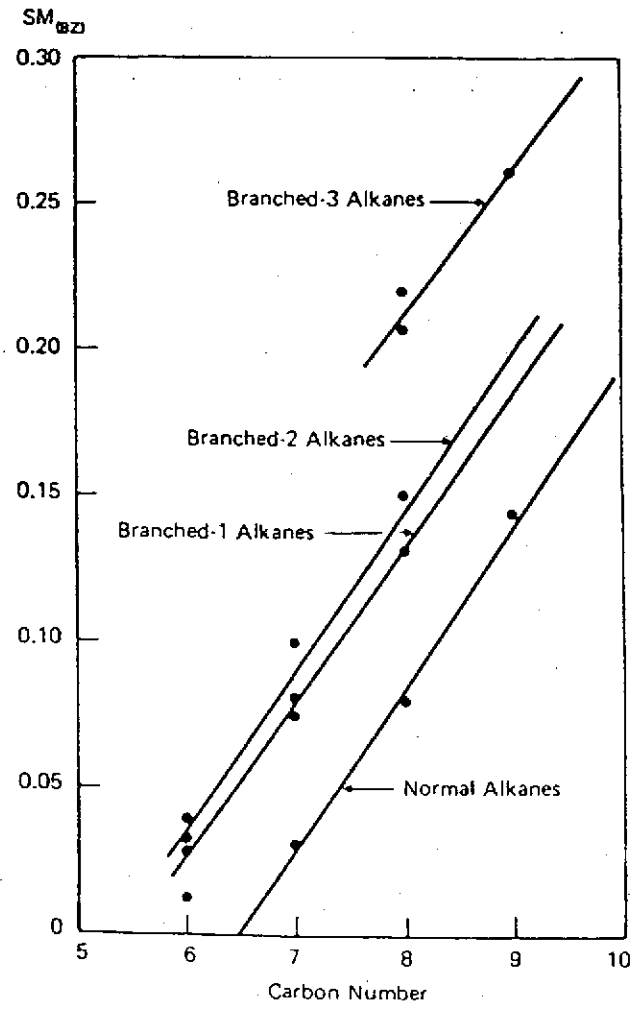


Figure 5. SM vs. carbon number for straight chain vs. branched hydrocarbons.

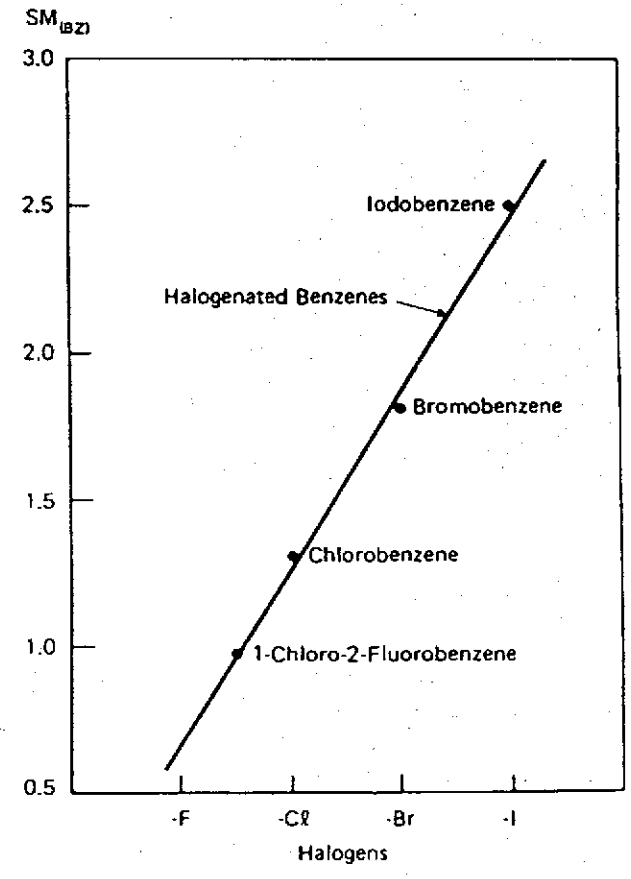


Figure 6. SM vs. halogen for halogenated benzenes.

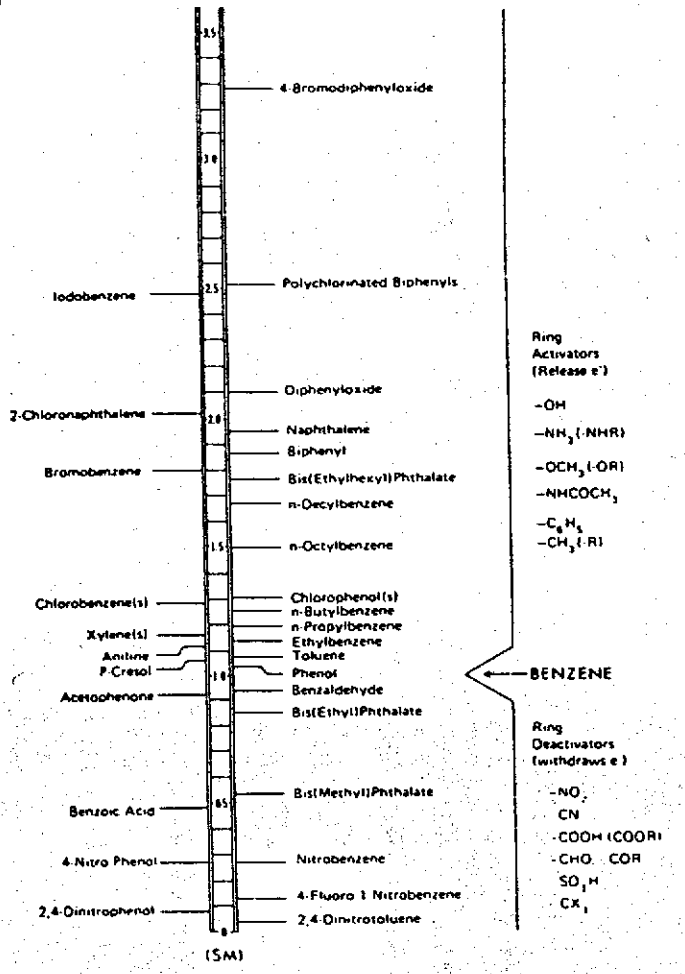


Figure 7. Molar sensitivity relative to benzene for substituted benzenes.

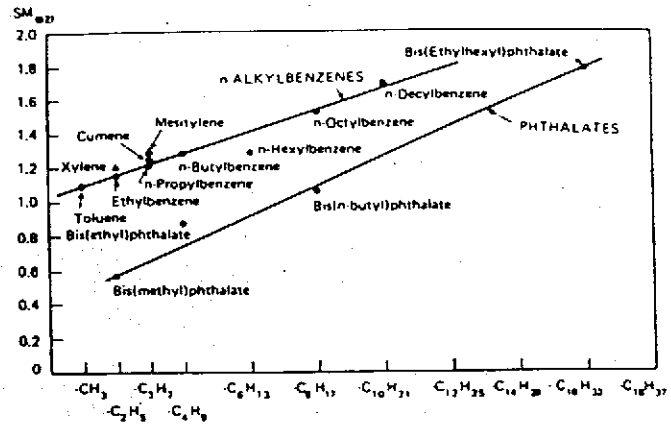


Figure 8. SM vs. carbon number of alkyl group for alkylbenzenes and phthalates.

3. J.N. Driscoll. Evaluation of a new photoionization detector for organic compounds. *J. Chromatogr.* 134: 49-55 (1977).
4. J.N. Driscoll, F. Ford, L.F. Jaramillo, J.H. Becker, G. Hewitt, J.K. Marshall, and F. Onishuk. Developments and applications of the photoionization detector in gas chromatography. *Am. Lab.* 10: 137-44 (1978).
5. *Instruction Manual for PI-51-02 Photoionization Detector.* HNU Systems, Inc., Newton Upper Falls, Massachusetts, 1976.
6. J.N. Driscoll, J. Ford, L.F. Jaramillo, and E.T. Gruber. Gas chromatographic detection and identification of aromatic and aliphatic hydrocarbons in complex mixtures by coupling photoionization and flame ionization detectors. *J. Chromatogr.* 158: 171-80 (1978).
7. A.R. Oyler, D.L. Bodenner, K.J. Welch, R.J. Llukkonen, R.M. Carlson, H.L. Kopperman, and R. Caple. Determination of aqueous chlorination reaction products of polynuclear aromatic hydrocarbons by reversed phase high performance liquid chromatography-gas chromatography. *Anal. Chem.* 50: 837 (1978).
8. D.B. Smith and L.A. Krause. Analysis of charcoal tube samples for carbon disulfide using a photoionization detector. *Am. Ind. Hyg. Assoc. J.* 39: 939-44 (1978).
9. N.E. Hester and R.A. Meyer. A sensitive technique for measurement of benzene and alkylbenzenes in air. *Environ. Sci. Technol.* 13: 107-09 (1979).
10. W.G. Jennings, S.G. Wyllie, and S. Alves. Photoionization detection in a high resolution glass capillary system. *Chromatographia.* 10: 426-29 (1977).
11. R.S. Mehta, M.S. Dresselhaus, G. Dresselhaus, and J.K. Zeiger. On the possible magnetic field dependence of the nickel carbonylation rate. *Surface Sci.* 78: L681-88 (1978).
12. M.L. Langhorst and T.J. Nestrick. Determination of chlorobenzenes in air and biological samples by gas chromatography with photoionization detection. *Anal. Chem.* 51: 2018-25 (1979).

Manuscript received April 18, 1980;
revision received August 18, 1980.

APPENDIX D

NIOSH METHOD 5503

FORMULA: mixture: $C_{12}H_{10-x}Cl_x$
[where x = 1 to 10]
M.W.: ca. 258 (42% Cl ; $C_{12}H_7Cl_2$);
ca. 326 (54% Cl ; $C_{12}H_5Cl_5$)

POLYCHLOROBIPHENYLS

METHOD: 5503
ISSUED: 2/15/84
REVISION #1: 8/15/87

OSHA: 1 mg/m³ (42% Cl);
0.5 mg/m³ (54% Cl)
NIOSH: 0.001 mg/m³ [1,2]
ACGIH: 1 mg/m³ (42% Cl); STEL 2 mg/m³
0.5 mg/m³ (54% Cl); STEL 1 mg/m³
(skin)

PROPERTIES:
42% Cl: BP 325 to 366 °C; MP -19 °C;
d 1.38 g/mL @ 25 °C;
VP 0.01 Pa (8 x 10^{-5} mm Hg;
1 mg/m³) @ 20 °C [3]
54% Cl: BP 365 to 390 °C; MP 10 °C;
d 1.54 g/mL @ 25 °C;
VP 0.0004 Pa (3 x 10^{-6} mm Hg;
0.05 mg/m³) @ 20 °C [3,4]

SYNONYMS: PCB; CAS #1336-36-3; 1,1'-biphenyl chloro (CAS #27323-18-8); chlorodiphenyl, 42% Cl (Aroclor 1242; CAS #53469-21-9), and 54% Cl (Aroclor 1254; CAS #11097-69-1)

SAMPLING

SAMPLER: FILTER + SOLID SORBENT
(13-mm glass fiber + Florisil,
100 mg/50 mg)

FLOW RATE: 0.05 to 0.2 L/min or less

VOL-MIN: 1 L @ 0.5 mg/m³
-MAX: 50 L

SHIPMENT: transfer filters to
glass vials after sampling

SAMPLE STABILITY: unknown for filters;
2 months for Florisil
tubes [5]

BLANKS: 10% of samples

ACCURACY

RANGE STUDIED: not studied

BIAS: none identified

OVERALL PRECISION (s_r): not evaluated

MEASUREMENT

!
!TECHNIQUE: GAS CHROMATOGRAPHY, ECD (^{63}Ni)
!
!ANALYTE: polychlorobiphenyls
!
!DESORPTION: filter + front section, 5 mL hexane;
! back section, 2 mL hexane
!
!INJECTION VOLUME: 4 µL with 1-µL backflush
!
!TEMPERATURE-INJECTION: 250 - 300 °C
! -DETECTOR: 300 - 325 °C
! -COLUMN: 180 °C
!
!CARRIER GAS: N_2, 40 mL/min
!
!COLUMN: glass, 1.8 m x 2 mm ID, 1.5% OV-17/1.95%
! QF-1 on 80/100 mesh Chromosorb WHP
!
!CALIBRATION: standard PCB mixture in hexane
!
!RANGE: 0.4 to 4 µg per sample [6]
!
!ESTIMATED LOD: 0.03 µg per sample [6]
!
!PRECISION (s_r): 0.044 [5]
!

APPLICABILITY: The working range is 0.01 to 10 mg/m³ for a 40-L air sample [5]. With modifications, surface wipe samples may be analyzed [7,8].

INTERFERENCES: Chlorinated pesticides, such as DDT and DDE, may interfere with quantitation of PCB. Sulfur-containing compounds in petroleum products also interfere [9].

OTHER METHODS: This method revises Methods S120 [10], 5503 (dated 2/15/84), and P&CAM 244 [5]. Methods S121 [11] and P&CAM 253 [12] for PCB have not been revised.

CALIBRATION AND QUALITY CONTROL:

8. Calibrate daily with at least five working standards over the range 10 to 500 ng PCB/mL.
   a. Add known amounts of stock standard solution to hexane in 10-mL volumetric flasks and dilute to the mark.
   b. Analyze together with samples and blanks (steps 11 and 12).
   c. Prepare calibration graph (sum of areas of selected peaks vs. ng PCB/mL).
9. Determine desorption efficiency (DE) at least once for each lot of glass fiber filters and Florisil used for sampling in the calibration range (step 8). Prepare three tubes at each of five levels plus three media blanks.
   a. Remove and discard back sorbent section of a media blank Florisil tube.
   b. Inject known amounts of stock standard solution directly onto front sorbent section and onto a media blank filter with a microliter syringe.
   c. Cap the tube. Allow to stand overnight.
   d. Desorb (steps 5 through 7) and analyze together with working standards (steps 11 and 12).
   e. Prepare a graph of DE vs. µg PCB recovered.
10. Analyze three quality control blind spikes and three analyst spikes to ensure that the calibration graph and DE graph are in control.

MEASUREMENT:

11. Set gas chromatograph according to manufacturer's recommendations and to conditions given on page 5503-1. Inject sample aliquot manually using solvent flush technique or with autosampler.
    NOTE 1: Where individual identification of PCB is needed, a procedure using a capillary column may be used [14].
    NOTE 2: If peak area is above the linear range of the working standards, dilute with hexane, reanalyze and apply the appropriate dilution factor in calculations.
12. Sum the areas for five or more selected peaks.

CALCULATIONS:

13. Determine the mass, ng (corrected for DE) of PCB found on the glass fiber filter (w) and in the Florisil front (W_f) and back (W_b) sorbent sections, and in the average media blank filter (B) and front (B_f) and back (B_b) sorbent sections.
    NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.
14. Calculate concentration, C, of PCB in the air volume sampled, V (L):

$$C = \frac{(W + W_f + W_b - B - B_f - B_b) \cdot 10^{-3}}{V}, \text{ mg/m}^3.$$

EVALUATION OF METHOD:

This method uses 13-mm glass fiber filters which have not been evaluated for collecting PCB. In Method S120, however, Aroclor 1242 was completely recovered from 37-mm glass fiber filters using 15 mL isooctane [12,15,16]. With 5 mL of hexane, Aroclor 1016 was also completely recovered from 100-mg Florisil beds after one-day storage [5]. Thus, with no adsorption effect likely on glass fiber filters for PCB, 5 mL hexane should be adequate to completely extract PCB from combined filters and front sorbent sections. Sample stability on glass fiber filters has not been investigated. Breakthrough volume was >48 L for the Florisil tube at 75% RH in an atmosphere containing 10 mg/m³ Aroclor 1016 [5].

REFERENCES:

[1] Criteria for a Recommended Standard...Occupational Exposure to Polychlorinated Biphenyls, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-225 (1977).

SAFEWAY/LUCKY'S

Dear Manager,

We the Directors of the Helping Hands Ministry of the Berkeley Mt. Zion Missionary Baptist Church are trying to continually meet the needs of our Community in the form of providing the following programs to the homeless and those less fortunate than ourselves: We are Feeding, Clothing, Educating, Job Training for employment, Providing Health resources and some Training for CPR with certificates of completion, and Legal Assistance Referrals.

Our intent is to reclaim, retrain and prepare people for a renewed productive life. If we give a man a plate of food only we feed him for a day, but, if we train a man to be productive we feed that same man for life. With this concept in mind and reflecting on out past progress this year, we now need the help of the Businesses in our neighborhoods and City to lend a helping hand.

It is our request of your store/company that you give us donations of turkeys and or hams to feed the needy on Christmas Day. We intend to feed 600 plus people not this one day meal but individuals special day.

We currently are feeding bimonthly on the second and forth Saturdays of each month. We prepare lunches and deliver them to the Parks and shelters where people are living and trying to acquire a place to rest for a period of time. We also feed the home bound elderly that inform us of their situations. On these occasions we feed 175 each time, at times as many as 225 people. Our intent is to become endowed enough to feed daily and fulfill all of the other entities of our ministries on a full time basis.

Your donations will be greatly appreciated. If you have any

concerns that have not been addressed in this letter please give us a telephone call as soon as possible. We can be reached at (510) 524-1204, if no one answers please leave a message or respond in writing to Helping Hands Ministry, Food Pantry, Ms. Trina R. Johnson or Rev. Geary Miller, 1400 Eighth Street, Berkeley, CA. 94710.

Thank you for your donations.

Servants to our Community,

Ms. Trina R. Johnson, Director

Rev. Geary Miller, Director

M. T. Thompson, Pastor

P. S. MAKE ALL CHECK PAYABLE TO "HELPING HANDS MINISTRIES-BMZMBC". This is a income tax deduction.

TRJ/GM.jdsb

ALAMEDA COUNTY HEALTH CARE SERVICES
ENVIRONMENTAL HEALTH SERVICES
HAZARDOUS MATERIALS UNIT
80 Swan Way, Suite 200
Oakland, CA 94621
(510) 271-4320

October 29, 1993

TO: All Environmental Health Service Staff

From: Juliette D. Blake, HAZMAT
December Holiday Chairperson

Subj: DECEMBER HOLIDAY CELEBRATION

The HAZMAT Division have the responsibility of hosting the December Holiday Celebration for 1993. I have been granted the privilege of chairing this function.

In order for our DHC to be successful, we the committee need your participation as follows:

Each staff member of EHS is asked to bring a dish (20 servings) or give a donation of $7.00 to defray the cost of our expense.

The style will be a buffet POT LUCK: attached is a suggestive menu for your work site. Each work site will receive a copy of the same.

We are expecting each staff member to participate in some form of food or money donations.

Please sign up we have a preset deadline of Friday, December 3, 1993 for receiving money for this function. Make any and all checks payable to Juliette D. Blake, your notimesfellowship with your coworkers in the labor of providing a healthier environment for us to breath, sleep, celebrate and enjoy one another.

ALAMEDA COUNTY HEALTH CARE SERVICES
ENVIRONMENTAL HEALTH SERVICES
HAZARDOUS MATERIALS UNIT
80 Swan Way, Suite 200
Oakland, CA 94621
(510) 271-4320

October 29, 1993

TO: All Environmental Health Service Staff

From: Juliette D. Blake, HAZMAT
December Holiday Chairperson

Subj: DECEMBER HOLIDAY CELEBRATION

The HAZMAT Division have the responsibility of hosting the December Holiday Celebration for 1993. I have been granted the privilege of chairing this function.

In order for our DHC to be successful, we the committee need your participation as follows:

Each staff member of EHS is asked to bring a dish (20 servings) or give a donation of $7.00 to defray the cost of our expense.

The style will be a buffet POT LUCK: attached is a suggestive menu for your work site. Each work site will receive a copy of the same.

We are expecting each staff member to participate in some form of food or money donations.

Please sign up we have a preset deadline of Friday, December 3, 1993 for receiving money for this function. Make any and all checks payable to Juliette D. Blake Foundation Fund.

Oakland, CA 94619
TIME: 12:00 Noon until 2:00 PM

Come one, come all and have a wonderful time fellowship with your coworkers in the labor of providing a healthier environment for us to breath, sleep, celebrate and enjoy one another.

If there are questions or concerns not addressed in this memo feel free to call me (Juliette Blake) at 217-4320 (ext. 43420) to discuss them as soon as possible.

Thank you.

Voice Mail

97128 — Don

DP 0354

34555

271-4555

*

Box #

97128

*

pass code

1993

Cyn 97129

Chris 97130

D/P 0325 (667-3200)

Juliette 97131

Leroy — Vacant 97132

Star 1

0

Redial

LAST # called.

memory 11.