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THE MEMPHIS DEPOT
TENNESSEE

ADMINISTRATIVE RECORD
COVER SHEET

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JOB No. 11-8531-01
CONTRACT No. DACA 87-88-C-0082

LAW ENVIRONMENTAL

DEFENSE DEPOT MEMPHIS, TENNESSEE (DDMT)

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)

FINAL WORK PLANS

- INTRODUCTION - VOL. 1
- SOIL BORING AND MONITORING WELL INSTALLATION PLAN - VOL. II
- SAMPLING AND ANALYSIS PLAN - VOL. III
- SAFETY HEALTH AND EMERGENCY RESPONSE PLAN - VOL. IV

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS HUNTSVILLE, ALABAMA

JANUARY, 1989

LAW ENVIRONMENTAL, INC.

112 TOWNPARK DRIVE
KENNESAW, GEORGIA 30144-5599
404-421-3400

Correspondence No. OT8-420

February 1, 1989

U.S. Army Corps of Engineers
Huntsville Division
P.O. Box 1600
Huntsville, AL 35807-4301

Attention: Mr. Tim Smith
Project Manager

Dear Mr. Smith:

Subject: Final Work Plans
RI/FS at Defense Depot Memphis, TN
LEGS Job. No. 11-8531-01
Contract No. DACA87-88-C-0082

Law Environmental, Inc., Government Services Division is pleased to submit the final Work Plan for the DDMT project. Only Volumes I through IV are attached as no comments relative to Volume V have been received by this office.

In accordance with the Statement of Work, we are submitting copies of the final Work Plan to the Agencies listed on the attached sheet.

Should you have any questions concerning the final plans or other aspects of the project, please do not hesitate to call.

Sincerely,

Thomas L. Richardson, P.E.
Project Principal

John R. Absalon, P.G.
Project Manager

FWT/cb

cc: see attached list

8531.11

Commander
U.S. Army Corps of Engineers
Attention: CEHND-ED-PM
Tim Smith, Project Manager
P.O. Box 1600
Huntsville, AL 35807-4301

4 copies

Commander Defense Logistics Agency
Attention: DLA-WS/Depot Bill Randall
Cameron Station
Alexandria, VA 22304

2 copies

Commander
U.S. Army Environmental
Hygiene Agency
Attention: HSHB-ME-SG
Aberdeen Proving Ground, MD 21010-5422

2 copies

Commander
Defense Depot Memphis, TN
Attention: Danny Chumney
2163 Airways Blvd.
Memphis, TN 38114-5000

2 copies

Michael J. Hartnett, Chief
Federal Facilities Unit
U.S. EPA Region IV
345 Courtland St., NE
Atlanta, GA 30365

1 copy

Paul Patterson, Environmental Specialist
Tennessee Department of Health and Environment
Division of Solid Waste Management
170 Mid America Mall North
1101 State Office Bldg.
Memphis, TN 38103

1 copy

DDMT WORK PLAN - VOLUME I

INTRODUCTION

FOR

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)

AT

DEFENSE DEPOT MEMPHIS, TENNESSEE (DDMT)
CONTRACT NO. DACA87-88-C-0092

Prepared for:

U.S. Army Corps of Engineers
Huntsville Division
P.O. Box 1600
Huntsville, Alabama 35807

Prepared by:

Law Environmental, Inc.
Government Services Division
112 TownPark Drive
Kennesaw, Georgia 30144-5599

January, 1989

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1.0 INTRODUCTION

The Work Plan has been prepared as the scoping document for the remedial investigation/feasibility study (RI/FS) at Defense Depot Memphis, Tennessee (DDMT). The purpose of the Work Plan submittal is threefold: (1) to provide a consolidated report on site history, current site activities, and resulting environmental impacts; (2) to familiarize personnel working on the project with site conditions; and (3) to provide project plans for conducting the RI/FS (reference the DDMT Project SOW). This document, Volume I of the Work Plan, fulfills the first two objectives previously stated. Field investigations plans (i.e., Volume II - Soil Boring/Monitoring Well Plan; Volume III - Sampling/Analysis and QA/QC Plan; Volume IV - Safety Plan) will be submitted at a later date along with a Data Management Plan (Volume V) in order to fulfill the third objective above.

Volume I covers the following areas:

- Site location, history, mission and organization (1.0)
- Environmental setting (2.0)
- Past and current hazardous materials use, storage and disposal (3.0)
- Past environmental studies (4.0)
- Findings (5.0)
- Conceptual Site Model (6.0)
- Proposed ARARs (7.0)
- Potential remedial alternatives (8.0)

Location

Defense Depot Memphis is located in Memphis, Tennessee, in the extreme southwestern portion of the state. The Depot lies approximately five miles east of the Mississippi River near the junction of Interstate 40 and 55.

The Depot is located in the south central section of Memphis approximately five miles southeast of the Central Business District and three miles northwest of Memphis International Airport. Airways Boulevard borders the Depot on the east and provides primary access to the installation. Dunn Avenue, Ball Road, and Perry Road serve as the northern, southern, and western boundaries, respectively. Figure 1-1 shows a layout of the DDMT facility.

History, Mission and Organization

Construction of the Defense Depot Memphis began in June 1941 and was completed in May 1942 on land which was previously used as a cotton field. Operation of the DDMT began January, 1942.

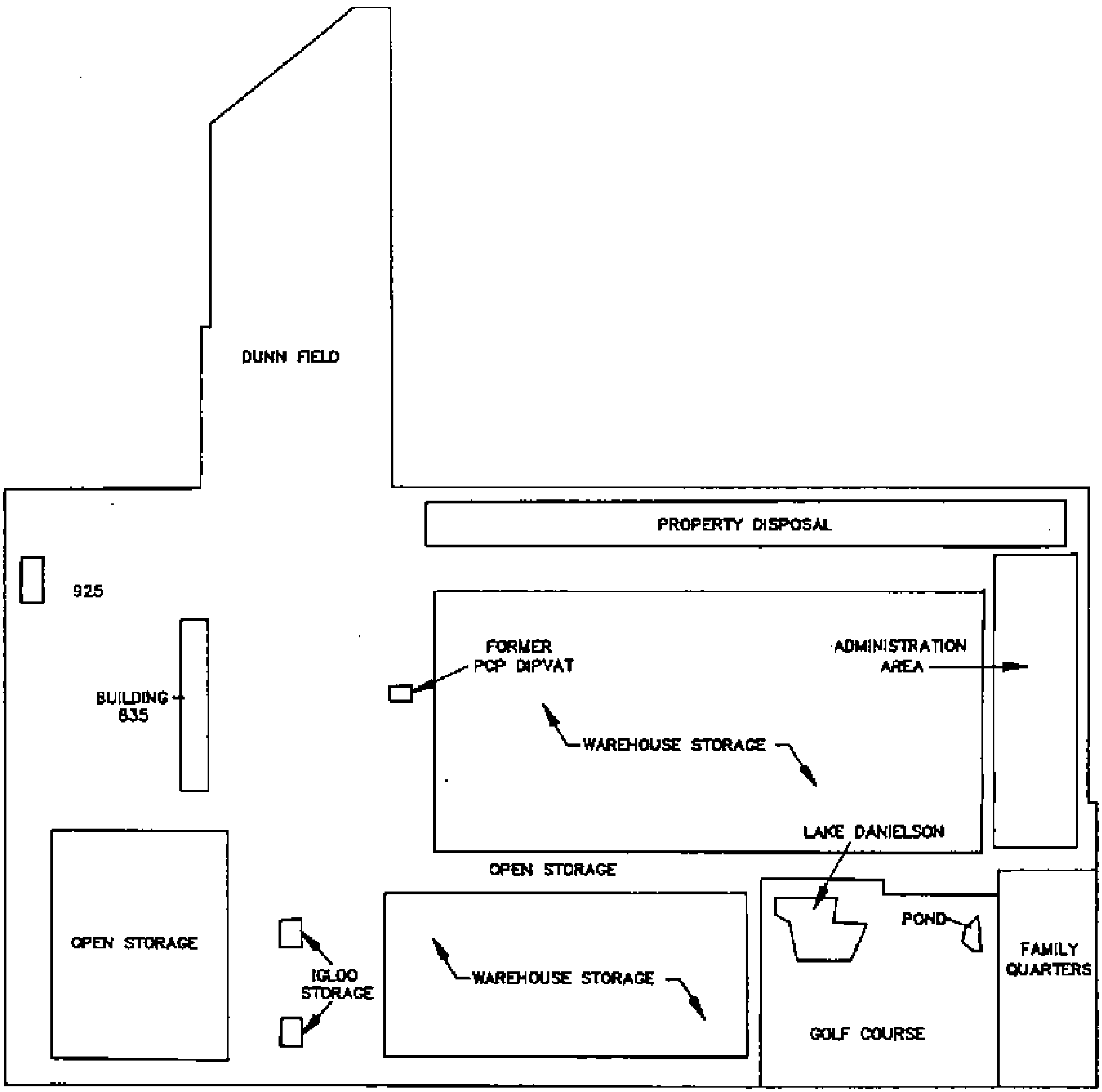
The initial mission and functions of the DDMT were to supply, provide stock control, and storage and maintenance services for the Army Engineer, Chemical, Quartermaster Services. During World War II, the Depot served as a prisoner of war camp for 800 prisoners. The Depot also performed supply missions for the signal and ordnance technical services.

In 1963 the installation was chosen by the Defense Supply Agency (DSA), currently the Defense Logistics Agency (DLA), to be a principal distribution center for a complete range of DSA commodities. On January 1, 1964, the U.S. Army released the installation to DSA and the installation became the Defense Depot Memphis. The DDMT's current mission, as a major DLA field element, is to store and distribute Department of Defense commodities within the south-central United States.

The installation consists of 642 acres of land and 127 structures.

FIGURE 1-1

SITE LAYOUT OF DDMT



SOURCE: GEOHYDROLOGIC STUDY NO. 38-26-0195-83, DDM, MEMPHIS, TN, 21 JUNE - 2 JULY, 1982.

SCALE: 1"~1000'

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Interface with Headquarters and Other DOD Agencies

DDMT is under the direction of the Defense Logistics Agency (DLA). DLA is responsible to the Secretary of Defense for providing services and supplies used in common by all the military services. Several other organizations are co-located at DDMT and report directly to DLA. These include Defense Industrial Plant Equipment Center (DIPEC), Defense Reutilization Marketing Region (DRMR), Defense Reutilization Marketing Organization (DRMO), Defense Logistics Agency (DLA), Customer Supply Assistance Center, Defense Contract Administrative Services (DCAS), and Defense Systems Automation Command (DSAC).

As host activity, DDMT provides administrative support to the DLA co-located activities. Services include accounting, personnel, and travel arrangements.

2.0 REVIEW OF INSTALLATION ENVIRONMENTAL SETTING

Geology

The majority of Memphis is located in the Gulf Coastal Plain Province, locally referred to as the West Tennessee Plain. Memphis is near the center of the Mississippi Embayment, a large trough-shaped depression extending from southern Illinois to Jackson, Mississippi. Underlying geologic formations consist primarily of unconsolidated sand, clay, and gravel. Well-consolidated rocks occur at depths greater than approximately 2,000 feet.

Surficial Soils

According to the U.S. Department of Agriculture Soil Conservation Service Soil Survey for Shelby County, the predominant surface soil association found on the DDMT site prior to construction of the Depot was the Memphis-Granada-Loring Association. Characteristics of this association include yellow brown to dark brown, sloping, well-drained to moderately well-drained, silt soil deposits varying in thickness from 6 to 8 inches. Construction activities for the Depot have altered the soil on the majority of the site to such an extent that the soil type is now classified as graded land, with silty materials.

Two areas on the site which have not been significantly altered include the northeast corner of Dunn Field and the southeast corner of the golf course. The predominant soil type in these areas is the Memphis Association, a clay, sandy, silt loam which is good for pasture lands and crops. The Memphis soil type is well drained; however, it is subject to erosion if unprotected.

Topography

The majority of the DDMT site is fairly level with an average elevation of 300 feet, National Geodetic Vertical Datum of 1929

(NGVD). Areas where elevation changes are fairly significant include the area south of Dunn Avenue in the vicinity of the railroad switch yard where elevations range from 297 to 317 feet NGVD. The area in the vicinity of the golf course was not extensively altered during construction of the DDMT, and elevations there range from 267 to 301 feet. Elevations in the southwest portion of the DDMT site, north of Ball Road and east of Perry Road in the vicinity of Building 995, range from 297 to 308 feet. A concrete paved slope, which ranges in elevation from 291 feet to 301 feet separates the bulk storage buildings from the binnable storage buildings. North of Dunn Road, elevations range from 269 to 311 feet.

Hydrogeology

The Gulf Coastal Plain is characterized by gently rolling to steep topography formed by erosion and covered by loess deposits during Pleistocene glaciation. The gently rolling to steep topography is broken in many places by flat lying alluvial deposits of streams that cross the area. In descending order Quaternary and Tertiary geologic formations of importance include: alluvium, loess, fluvial deposits, Jackson Formation and upper part of Claiborne Group (undifferentiated), Memphis Sand, Flour Island Formation, Fort Pillow Sand and Old Breastworks Formation. The principal freshwater aquifers are the alluvium/fluvial deposits which make up the surficial unconfined aquifer, and the Memphis Sand and the Fort Pillow Sand, which are confined aquifers. The Memphis Sand is considered to be an aquifer of regional significance. Most of the water used for municipal and industrial supplies in the Memphis area is drawn from the Memphis Sand (97%) and the Fort Pillow Sand (3%). (USGS WRI Report No. 85-4295).

Seven monitoring wells have been drilled at DDMT in the Dunn Field area. Soil samples collected during drilling range from inorganic clays of high plasticity to well-graded gravels/gravel-sand mixtures with little or no fines, silty gravels or gravel-sand-silt mixtures. The data suggests that the upper zone (less than 30 feet) is less permeable than the lower zone. Water was encountered at two levels in the subsurface - a perched zone about 20 feet below ground surface (bgs), and the regional water table 59 to 73 feet bgs. Ground-water flow appears to be toward the west or southwest.

Drainage

Surface drainage on the DDMT site is accomplished by an effective storm drainage system. Dunn Field and the area along the site's northern boundary drain into a storm water outfall which discharges into the city ditches and small unnamed creeks. The creeks flow northerly into Cane Creek and then southwesterly into Nonconnah Creek which lies approximately three-fourths of a mile south of the DDMT. Drainage along the eastern, western and southern boundaries of the Depot site is also into city ditches and small creeks which flow southerly into Nonconnah Creek. Nonconnah Creek flows westerly into Lake McKellar which empties directly into the Mississippi River.

Lake Danielson, a four-acre surface storm water storage area available for fire fighting, and a small pond on the Depot golf course are the only surface waters located on the DDMT site. Lake Danielson collects surface water runoff from the golf course and discharge from an on-site storm sewer. Overflow from the lake discharges into storm drains which eventually empty into Nonconnah Creek. The pond located on the golf course collects runoff from the golf course and adjacent developed areas and discharges into the drainage system on the south side of the DDMT site.

Vegetation and Wildlife

The majority of the DDMT site is developed with urban uses. Vegetative resources are limited to Bermuda grass, a few deciduous black oaks, and several species of decorative shrubs and trees. Landscaping programs have concentrated decorative species around the lake and golf course and in the housing area.

Very little natural habitat is available for wildlife on DDMT property. Dunn Field is the only undisturbed open area on the site. Animals which have been observed at Dunn Field include squirrels, red foxes, quail, mourning doves, and turtles. Rats and mice occupy the developed portions of the site, attracted by subsistence stocks.

Lake Danielson (Fire Reservoir) has been periodically stocked with bluegill and bass. Catfish are also found in the lake. The lake is a closed ecosystem which is directly impacted by installation operations. A fish kill in the lake occurred in 1976 and to a lesser extent in 1988. Although the source of the fish kills have not been officially identified, speculation points to pesticide treatment of the golf course. A small goldfish pond is also located on the golf course.

No threatened or endangered species are known to inhabit or utilize the DDMT site.

3.0 REVIEW OF PAST INSTALLATION HAZARDOUS MATERIAL USE, STORAGE AND DISPOSAL

The information evaluated under Task 1 of this project indicates that as a result of DDMT's complex site utilization history, large quantities of potentially hazardous materials have been stored, repackaged, shipped or disposed on installation property. In addition, leaks or spills of stored goods or substances used on site have been reported. Past and recent facility use conditions were reviewed to determine the following:

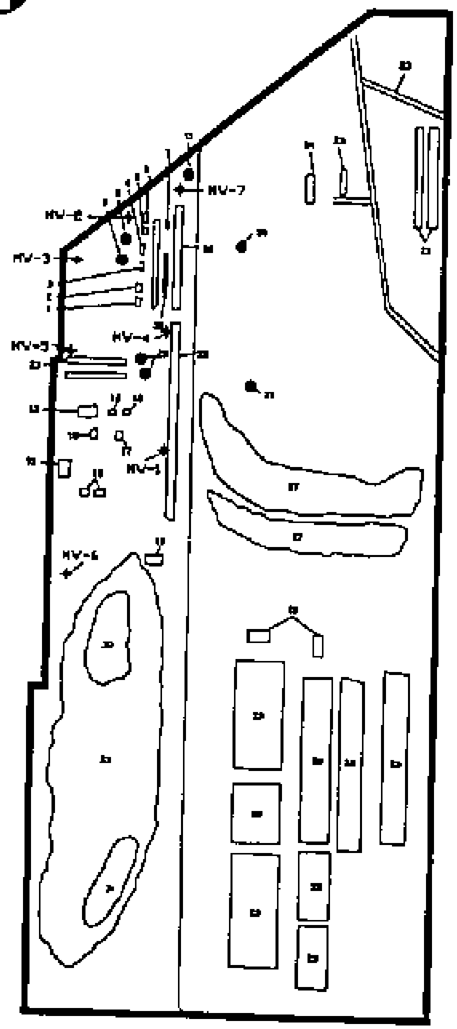
1) What impact, if any, past/current conditions might affect RI/FS project goals.
2) What constraints, if any, conditions of concern could place on planned facility monitoring and sampling efforts.
3) What effects, if any, conditions of concern could exert on the interpretation of project monitoring and analytical data.

The examination of available facility utilization information commenced with the review of Dunn Field material storage and disposal records. A total of 33 individual sites were identified at Dunn Field. Descriptive information is summarized on Table 3-1. The individual site locations are illustrated on Figure 3-1.

Available facility utilization information included some U.S. Army Environmental Hygiene Agency (USAEHA) and U.S. army Toxic and Hazardous Materials Agency (USATHAMA) records describing past conditions on the main installation. A total of forty specific locations or conditions of potential environmental concern were noted. This information is listed on Table 3-2. The locations of individual sites are illustrated on Figure 3-2.

FIGURE 3-1

DUNN FIELD DISPOSAL & STORAGE SITES



SCALE: 1"~350'

LOCATION	
BURIAL SITES	
1	TRAINING SETS, NINE EACH, MUSTARD AND LEWISITE, 1955.
2	7 POUNDS (LBS) AMMONIUM HYDROXIDE, 1 GAL GLACIAL ACETIC ACID, 1955.
3	3,000 QUARTS (QT) CHEMICALS, 5 CUBIC FEET (FT(3)) ORTHO-TOLIDINE DIHYDROCHLORIDE, 1955.
4	THIRTEEN 55-GAL DRUMS OIL, GREASE AND PAINT, DATE UNKNOWN.
5	THIRTY-TWO 55-GAL DRUMS OIL, GREASE, AND THINNER, 1955.
6	3 FT(3) METHYL BROMIDE, 1955.
7	40,037 UNITS OINTMENT (EYE), 1955.
8	1,700 BOTTLES FUMING NITRIC ACID, 1954.
9	3,768 1-GAL CANS METHYL BROMIDE, 1954.
10	ASHES AND METAL REFUSE FROM BURNING PIT, 1955.
11	1,433 1-OUNCE (OZ) BOTTLES TRICHLOROACETIC ACID, 1965.
12	SULPHURIC/HYDROCHLORIC ACIDS, 1967.
13	32 CUBIC YARDS MIXED CHEMICALS AND ACID, 900 LBS DETERGENT, 7,000 LBS ALUMINUM SULPHATE, 200 LBS SODIUM.
14	SODIUM, 1968.
15	SODIUM PHOSPHATE, 1968.
16	ACID, 1969.
17	HERBICIDE, CLEANING COMPOUND, MEDICAL SUPPLIES, 1969.
18	ACID, DATE UNKNOWN.
19	HARDWARE (NUTS AND BOLTS).
22	XXCC3 IMPREGNITE.
29	FOOD SUPPLIES.
30	BURIAL SITE PRIOR TO BAUXITE STORAGE; FOODS, CONSTRUCTION DEBRIS BURNED, 1946.
33	14 BURIAL PITS CONTAINING SODIUM PHOSPHATE, SODIUM, ACID, MEDICAL SUPPLIES, CHLORINATED LIME, 1970.
BURN SITES	
21	SANITARY WASTE, SMOKE POTS, CN CANISTERS.
31	OLD BURN AREA, 1946.
STORAGE SITES	
25	PESTICIDE STORAGE
27	BAUXITE
28	FLUORSPAR
32	BAUXITE, 1942-72.
OTHER SITES	
20	ASPHALT DUMP
23	OPEN DRAIN DITCHES
24	PISTOL RANGE
26	BURIED DRAINPIPE

SOURCE: GEOHYDROLOGIC STUDY NO. 38-26-0195-83, DDM, MEMPHIS, TN, 21 JUNE ~ 2 JULY, 1982

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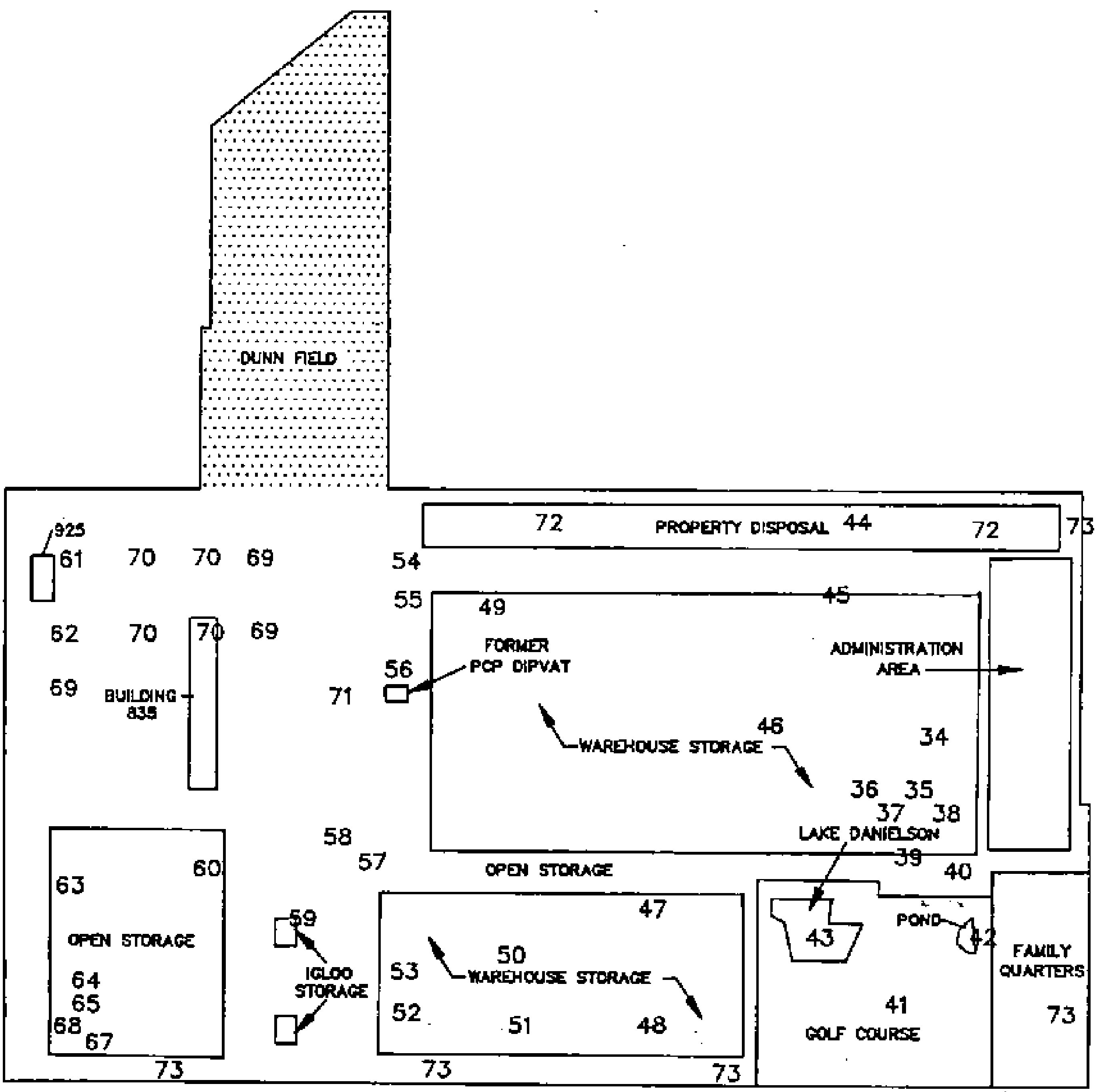
FIGURE 3-2

MAIN INSTALLATION DISPOSAL & STORAGE SITES



SEE TABLE 3-2 FOR EXPLANATION OF LOCATION NUMBERS.

SCALE: 1"~1000'

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TABLE 3-1

DEFENSE DEPOT MEMPHIS TENNESSEE

DUNN FIELD SITES

SUMMARY OF HAZARDOUS MATERIAL USE, STORAGE, AND DISPOSAL SITES

MAP NO.	ZONE	LOCATION	MATERIALS/WASTE	QUANTITY, DIMENSIONS OR SIZE	REMARKS
1	DUNN FIELD	NW QUADRANT	MUSTARD AND LEWISITE	NINE TRAINING SETS	DISPOSED IN 1955
2	DUNN FIELD	NW QUADRANT	AMMONIUM HYDROXIDE & GLACIAL ACETIC ACID	7 POUNDS SOLID, 1 GAL. LIQUID	DISPOSED IN 1955
3	DUNN FIELD	NW QUADRANT	VARIOUS CHEMICALS;ORTHO-TOLIDINE DIHYDROCHLORIDE	3,000 QUARTS/5 CU.FT OTD	DISPOSED IN 1955
4	DUNN FIELD	NW QUADRANT	POL AND PAINT	13-55 GAL.DRUMS	---
5	DUNN FIELD	NW QUADRANT	POL AND THINNER	32-55 GAL DRUMS	DISPOSED IN 1955
6	DUNN FIELD	NW QUADRANT	METHYL BROMIDE	3 CUBIC FEET	DISPOSED IN 1955
7	DUNN FIELD	NW QUADRANT	EYE OINTMENT	40,037 UNITS	DISPOSED IN 1955
8	DUNN FIELD	NW QUADRANT	FUMING NITRIC ACID	1,700 BOTTLES	DISPOSED IN 1955
9	DUNN FIELD	NW QUADRANT	METHYL BROMIDE	3,768 ONE-GALLON CANS	DISPOSED IN 1954
10	DUNN FIELD	NW QUADRANT	ASHES AND METAL WASTE	UNCERTAIN	DISPOSED IN 1954
11	DUNN FIELD	NW QUADRANT	TRICHLOROACETIC ACID	1,433 ONE-OUNCE BOTTLES	DISPOSED IN 1955
12	DUNN FIELD	NW QUADRANT	SULPHYRIC AND HYDROCHLORIC ACIDS	30 PALLETS	DISPOSED IN 1965
13	DUNN FIELD	NW QUADRANT	MIXED CHEMICAL & ACID, DETERGENT, ALUMINUM SULPHATE & SODIUM	32 CUBIC YARDS MIXED CHEMICALS & ACID, 8,100 POUNDS SOLIDS	DISPOSED IN 1967
14	DUNN FIELD	NW QUADRANT	SODIUM	ONE PALLET	---
15	DUNN FIELD	NW QUADRANT	SODIUM PHOSPHATE	ONE PALLET	---
16	DUNN FIELD	NW QUADRANT	ACID	ONE PALLET	DISPOSED IN 1968
17	DUNN FIELD	NW QUADRANT	HERBICIDE, MEDICAL SUPPLIES & CLEANING COMPOUND	UNCERTAIN	DISPOSED IN 1969
					DISPOSED IN 1969
18	DUNN FIELD	NW QUADRANT	ACID	UNCERTAIN	---
19	DUNN FIELD	NW QUADRANT	HARDWARE (NUTS & BOLTS)	UNCERTAIN	---
20	DUNN FIELD	NE QUADRANT	ASPHALT	UNCERTAIN	---
21	DUNN FIELD	NE QUADRANT	SANITARY WASTE, CN CANISTERS, & SMOKE POTS	UNCERTAIN	UTILIZED FROM 1955-60
22	DUNN FIELD	NE QUADRANT	XXCC-3 IMPREGNITE	UNCERTAIN	---
23	DUNN FIELD	NE QUADRANT	DRAINAGE DITCHES	---	MAY HAVE REC'D RUNOFF FROM STORAGE & DISPOSAL AREAS
24	DUNN FIELD	BUILDING 1184	HERBICIDES & PESTICIDES	UNCERTAIN	---
25	DUNN FIELD	NE QUADRANT	PESTICIDES	UNCERTAIN	---
26	DUNN FIELD	NE QUADRANT	DRAIN PIPE	UNCERTAIN	---
27	DUNN FIELD	NE QUADRANT	BAUXITE	TWO SEMI-CONTAINED PILES	---

TABLE 3-1

DEFENSE DEPOT MEMPHIS TENNESSEE

DUNN FIELD SITES

SUMMARY OF HAZARDOUS MATERIAL USE, STORAGE, AND DISPOSAL SITES

MAP NO.	ZONE	LOCATION	MATERIALS/WASTE	QUANTITY, DIMENSIONS OR SIZE	REMARKS
28	DUNN FIELD	SE QUADRANT	FLUORSPAR	TEN BINS	---
29	DUNN FIELD	NW QUADRANT	FOOD SUPPLIES	UNCERTAIN	---
30	DUNN FIELD	SW QUADRANT	FOODS, BURNED CONSTRUCTION DEBRIS	UNCERTAIN	DISPOSED IN 1948
31	DUNN FIELD	SW QUADRANT	VARIOUS COMBUSTIBLES	UNCERTAIN	UTILIZED IN 1946
32	DUNN FIELD	SW QUADRANT	BAUXITE	ONE SEMI-CONTAINED PILE	UTILIZED FROM 1942-72
33	DUNN FIELD	NW QUADRANT	SODIUM, SODIUM PHOSPHATE, ACID, CHLORINATED LIME&MEDICAL SUPPLIES	UNCERTAIN	DISPOSED IN 1970

9 18

TABLE 3-2
DEFENSE DEPOT MEMPHIS TENNESSEE
MAIN INSTALLATION
SUMMARY OF HAZARDOUS AND NON-HAZARDOUS MATERIAL USE, STORAGE, AND DISPOSAL SITES

MAP NO.	ZONE	LOCATION	MATERIALS/WASTE	QUANTITY, DIMENSIONS OR SIZE	REMARKS
34	MAIN INSTAL.	BUILDING 249	XXCC-3	UNCERTAIN	STORAGE/HANDLING UNCERTAIN
35	MAIN INSTAL.	BUILDING 253	POL	50 X 125 FEET	SMALL CONTAINERS
36	MAIN INSTAL.	BUILDING 257	MOGAS	47,700 GALLONS	TANKS NOT TESTED
37	MAIN INSTAL.	BUILDING 263	POL	20 X 40 FEET	SMALL CONTAINERS
38	MAIN INSTAL.	PAD 267	PESTICIDES, HERBICIDES	150 X 200 FEET	BULK LOTS USED ON POST
39	MAIN INSTAL.	AREA 272	PCBS	100 X 225 FEET	TRANSFORMER LEAKS SUSPECTED
40	MAIN INSTAL.	BUILDING 273	PESTICIDES, CLEANERS	10 X 50 FEET	---
41	MAIN INSTAL.	GOLF COURSE	2,4,D. M2A1&M4 FLAMETHROWER LIQUID FUELS	22 ACRES	SURFACE APPLICATION
42	MAIN INSTAL.	POND	2,40	0.5 ACRE	SURFACE APPLICATION
43	MAIN INSTAL.	LAKE DANIELSON	2,40	4 ACRES	SURFACE APPLICATION
44	MAIN INSTAL.	BUILDING 308	DDT	11,000 - 12,000 GALLONS	SPILLS SUSPECTED
45	MAIN INSTAL.	BUILDING 319	FLAMMABLES, TOXICS,ETC.	UNCERTAIN	RADIOACTIVE ITEMS REPACKED IN WEST END OF BLDG.
46	MAIN INSTAL.	BUILDING 359	MEDICAL SUPPLIES & WASTE	30 X 60 FEET	---
47	MAIN INSTAL.	VICINITY BLDG. 470	UNKNOWN	UNCERTAIN	---
48	MAIN INSTAL.	VICINITY BLDG. 490	UNKNOWN	200 X 400 FEET	---
49	MAIN INSTAL.	BUILDING 629	DDT, HERBICIDES, SOLVENTS, OXIDIZER,CORROSIVE,REACTIVE,ETC.	DDT-70 TONS, LARGE QUANTITIES OF BULK LIQUIDS	HYDROFLUORIC ACID SPILL
50	MAIN INSTAL.	VICINITY BLDG. 689	UNKNOWN	UNCERTAIN	---
51	MAIN INSTAL.	VICINITY BLDG. 690	UNKNOWN	UNCERTAIN	---
52	MAIN INSTAL.	VICINITY BLDGS.689-690	UNKNOWN	UNCERTAIN	---
53	MAIN INSTAL.	BUILDING 689	ALCOHOL, ACETONE, TOLUENE, NAPHTHA, HF	3,000 GALLONS	HYDROFLUORIC ACID SPILL
54	MAIN INSTAL.	VICINITY S702	FUELS, MISC.LIQUIDS, WOOD,PAPER	UNKNOWN	UTILIZED 1968-72
55	MAIN INSTAL.	BUILDING 720	FUEL & CLEANERS DISPENSING	POL-12,000 GALLONS	---
56	MAIN INSTAL.	BUILDING 737	PCP, DIOXIN, FURAN	≅ 600 CUBIC YARDS	BUILDING,DIPVAT,PUMPHOUSE & UST REMOVED. SOIL CONTAMINATION REMAINS
57	MAIN INSTAL.	BUILDING 765	FUEL OIL	---	---
58	MAIN INSTAL.	BUILDING 770	WASTE OIL AND FUEL OIL	---	---
59	MAIN INSTAL.	BUILDING 783	FLAMMABLES	---	---
60	MAIN INSTAL.	BUILDING 873	POL	500,000 GALLONS	CONFIRMED DDE,DDT & ALDRIN CONTAM. EAST OF BLDG.
61/62	MAIN INSTAL.	BLDGS. 925 & 949	POL	VARIES	REPLACES X-25

9 19

TABLE 3-2

DEFENSE DEPOT MEMPHIS TENNESSEE

MAIN INSTALLATION

SUMMARY OF HAZARDOUS AND NON-HAZARDOUS MATERIAL USE, STORAGE, AND DISPOSAL SITES

MAP NO.	ZONE	LOCATION	MATERIALS/WASTE	QUANTITY, DIMENSIONS OR SIZE	REMARKS
63	MAIN INSTAL.	BUILDING 972	FLAMMABLES, SOLVENTS, WASTE OIL, ETC.	UNCERTAIN	LEAKERS" RECOUPED IN 1981 - UNDERGROUND TANK USED
64	MAIN INSTAL.	BUILDING 1084	DDT, "BANNED PESTICIDES"	---	---
65	MAIN INSTAL.	BUILDING 1085	POL	SMALL QUANTITIES	VEHICLE GREASE RACK
66	MAIN INSTAL.	BUILDING 1086	VARIOUS WASTES	UNCERTAIN	---
67	MAIN INSTAL.	BUILDING 1088	ZINC CHROMATE PRIMER	UNCERTAIN	---
68	MAIN INSTAL.	BUILDING 1089	ACIDS	UNCERTAIN	ACID LEAKS SUSPECTED
69	MAIN INSTAL.	AREAS X-13, X-15, X-25	POL, ISOOCTANE, TOLUENE, ACETONE, MEK, NAPHTHA	UNCERTAIN	A FEW LEAKS SUSPECTED
70	MAIN INSTAL.	RR TRACKS 1,2,3,4,5,6	POL, VARIOUS CHEMICALS	UNCERTAIN	A FEW LEAKS SUSPECTED
71	MAIN INSTAL.	ALL RR TRACKS	HERBICIDE	UNCERTAIN	HERBICIDE USED TO CLEAR TRACKS
72	MAIN INSTAL.	POD YARD	WASTE OIL	UNCERTAIN	USED FOR DUST CONTROL
73	MAIN INSTAL.	ALL GRASSED AREAS	2,4 D	UNCERTAIN	---

4.0 REVIEW OF INSTALLATION ENVIRONMENTAL STUDIES

In conformance with DOD policies, a number of pesticide/ herbicides, waste management environmental quality, land use and industrial hygiene studies have been performed by government agencies and private consultants. A number of outside information sources have also been identified. The studies and related supporting information known to Law Environmental, Inc., includes the following:

- City of Memphis, Memphis Light, Gas and Water Division, Miscellaneous file data, October 18, 1988 (Contact: F.P. Von Hofe) Memphis Tennessee.
- Harland Bartholomew & Associates, Inc. Master Plan Defense Depot Memphis, Tennessee, July 1988
- O.H. Materials Company, Summary Report: On-Site Remedial Activities at Defense Depot Memphis, Feb. 1986
- Phoenix Environmental Consultants, Inc., Environmental Assessment for Hazardous Materials Mission Expansion, January, 1984
- U.S. Department of Agriculture, Soil Conservation Service Soil Survey, Shelby County, Tennessee. November 1970. Washington, D.C.
- U.S. Environmental Protection Agency Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Draft document). March, 1988, Washington, D.C.
- U.S. Army, Environmental Hygiene Agency Ground-Water Consultation No. 38-26-0815-87. December, 1986. Aberdeen Proving Ground, MD 21010.
- U.S. Army, Environmental Hygiene Agency - Water Quality Biological Study No. 32-24-0733-86. March, 1986. Aberdeen Proving Ground, MD 21010.
- U.S. Army, Environmental Hygiene Agency. Geohydrologic Study No.38-26-0195-83. July 1982. Aberdeen Proving Ground, MD 21010
- U.S. Army, Toxic and Hazardous Materials Agency.

Installation Assessment of Defense Depot Memphis Tennessee. March, 1981, Aberdeen Proving Ground, MD 21010.

- U.S. Geological Survey, Ground-Water Resources of Western Tennessee, Water Supply Paper 656, 1933, Washington, D.C.
- U.S. Geological Survey, Predicted Hydrologic Effects of Pumping the Lichterman Well Field in the Memphis Area, TN. Water Supply Paper 1819-B. 1965. Washington, D.C.
- U.S. Geological Survey, Geology and Hydrology of the Claiborne Group in Western Tennessee. Water Supply Paper 1809-F. 1965. Washington, D.C.
- U.S. Geological Survey, Potential for Leakage Among Principal Aquifers in the Memphis Area, Tennessee. Water Resources Investigations Report 85-4295. 1986. Washington, D.C.
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- U.S. Army, Environmental Hygiene Agency. Environmental Impact Assessment. Consultation Visit No. 21-1443-78, Defense Depot Memphis, Memphis, TN, 29-31 August 1977.
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- U.S. Army, Environmental Hygiene Agency. Environmental Assessments of Existing Operations at DLA Installations. Survey No. 24-1443-78. 18 January 1978.
- Defense Supply Agency. Defense Depot Memphis. Safety & Health Office (DDMT-GE) Industrial Hygiene Survey No. 78-002: Asbestos Rebagging & Rewarehousing by Kennedy Contracting Company.
- U.S. Army, Environmental Hygiene Agency. Waste

Management Consultation No. 26-1443-78, Defense Depot Memphis, Memphis, Tennessee, 9-11 August 1977. Aberdeen Proving Ground, MD 21010. 1977.

- U.S. Army, Environmental Hygiene Agency. Hazardous Waste Management Survey No. 26-0020-78. Defense Depot Memphis, Memphis, Tennessee. 9-13 May 1977. Aberdeen Proving Ground, MD 21010.
- U.S. Army, Environmental Hygiene Agency. Industrial Hygiene Special Study No. 55-35-0127-80, Evaluation of Hazardous Material Warehouse, Defense Depot Memphis, TN, 10-12 September 1979. Aberdeen Proving Ground, MD 21010. 1979.
- U.S. Army, Environmental Hygiene Agency. Waste Management Consultation No. 26-1443-78, Defense Depot Memphis, Memphis, Tennessee, 9-11 August 1977. Aberdeen Proving Ground, MD 21010. 1977.
- U.S. Army Environmental Hygiene Agency. Hazardous Waste Management Survey No. 26-0020-78. Defense Depot Memphis, Memphis, Tennessee. 9-13 May 1977. Aberdeen Proving Ground, MD 21010.
- U.S. Army, Environmental Hygiene Agency. Hazardous Waste Management Consultation No. 37-26-0113-81. Defense Depot Memphis, Memphis, Tennessee. 5-9 May 1980. Aberdeen Proving Ground, MD 21010. 1980.
- U.S. Army, Environmental Hygiene Agency. Industrial Hygiene Survey No. 62-0228-77, Defense Depot Memphis, Memphis, Tennessee. 13-15 June 1977.
- U.S. Army, Environmental Hygiene Agency. Industrial Hygiene Survey No. 23-022-70. Defense Depot Memphis, Memphis, Tennessee. 27-30 October 1969. Edgewood Arsenal, MD 21010. 1969.
- U.S. Army, Environmental Hygiene Agency. Industrial Hygiene Survey No. 35-049-73/74. Defense Depot Memphis, Memphis, Tennessee. 19-22 June 1973. Aberdeen Proving Ground, MD. 21010. 1973.
- U.S. Army, Environmental Hygiene Agency. Radiation protection Survey No. 62-0431-77, Defense Depot

Memphis, Memphis, Tennessee. 8 June 1977.

- U.S. Army, Environmental Hygiene Agency. Entomological Survey No. 44-P09-75. Defense Depot Memphis, Memphis, Tennessee. 21-25 October 1974.
- U.S. Army, Environmental Hygiene Agency. Installation Pest Management Program Review No. 16-62-0589-80. Defense Depot Memphis, Memphis, Tennessee. 22-24 October 1979. Aberdeen Proving Ground, MD 21010.
- U.S. Army, Environmental Hygiene Agency. Installation Pest Management Program Review No. 16-62-0541-79. Defense Depot Memphis. Memphis, Tennessee. 13-15 November 1978. Aberdeen Proving Ground, MD 21010.
- U.S. Army, Environmental Hygiene Agency. Installation Pest Management Program Survey No. 62-0577-78, Defense Depot Memphis, Memphis, Tennessee. 6-9 September 1977. 1977.
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- U.S. Army, Environmental Hygiene Agency. Entomological Survey No. 44-015-74, Defense Depot Memphis, Memphis, Tennessee, 6-9 November 1973. 1974.
- U.S. Army, Environmental Hygiene Agency. Installation Pest Management Program Review No. 62-0544-77, Defense Depot Memphis, Memphis, Tennessee. 7-9 September 1976. 1977.

5.0 REVIEW OF CURRENT HAZARDOUS MATERIAL/WASTE MANAGEMENT

This section is based on the Master Plan Report: Defense Depot Memphis, Tennessee, prepared by Harland Bartholomew and Associates, Inc., July, 1988.

DDMT routinely receives and ships hazardous materials. The amount of materials handled was estimated to be 37,000 tons in FY 1987. In February 1986, the position of Environmental Coordinator was created. Responsibilities of the position include overseeing all operations involving hazardous material and assuring compliance with appropriate guidelines.

The current utilization of DDMT land resources is illustrated on Figure 1-1.

The following hazardous materials are warehoused and issued at DDMT:

1) Flammable Liquids
2) Flammable Solids
3) Corrosives (Acids and Bases)
4) Poisons (A&B) including insecticides
5) Compressed Gases (non-flammable)
6) Compressed Gases (flammable)
7) Class C Explosives
8) Oxidizers
9) Radioactive Materials
10) Other Regulated Material (ORM)

These materials are received as packaged commodities from manufacturers in containers that range in size up to 55-gallon drum quantities. While in storage, these materials are segregated by hazardous storage compatibility groups to assure optimum safety conditions are met.

Storage

Existing locations of hazardous materials storage at DDMT are summarized below (see Figures 3-1 and 3-2, Tables 3-1 and 3-2).

Location	Item
Building 629	Various chemicals (toxics, corrosives, oxidizers)
Building 319	Flammable materials, toxics
Area X-25	Flammable materials
Building 835	Anti-Freeze
Building S-873	POL products and overflow chemicals from 629
Building 689	Short-term storage of flammable liquids, for shipping and receiving

The majority of chemical stock items are stored in Building 629. This building is constructed on a concrete foundation without floor drains and contains five bays separated by concrete walls and fire doors. Spill booths containing absorbent materials and cleanup equipment are located in each separate area. These booths are marked to preclude incompatible chemicals being placed in the same booth. The capacity of Building 629 is currently inadequate, and overflow chemicals are stored in Building S-873.

Building 319 is the flammable materials storage area and contains mostly alcohols with lesser amounts of other items (ether, pesticides, and solvents). Hazardous materials requiring temperature-controlled environments are also stored in this warehouse, as are pilferable hazardous materials. The building is concrete-bermed and is on a concrete foundation with no floor drains. One mechanically ventilated, separately bermed room in the west end of the building contains cyanide compounds. The building is equipped with explosion-proof lighting and spill booths similar to those in Building 629. Security restrictions at Building 319 are tight. Building 319 storage will be replaced by the proposed new hazardous materials warehouse.

The X-25 area is a bermed, concrete pad in the open storage area on the northwest side of the installation, where only Class 1 flammable liquids are stored. These liquids are normally stored in 55-gallon drums and include a wide range of industrial grade organic solvents. Three tension fabric roof structures have recently been constructed over the area, however, the northernmost structure fell in January 1988 and has not been replaced.

Building S-873 is an open-sided shed for POL products storage. Overflow chemicals, which would normally be stored in Warehouse 629, are also stored at Building S-873. The new recoupment facility, Building 865, is adjacent to the new hazardous materials warehouse, Building 835. The recoupment facility is used for repackaging of selected materials that are damaged in transport. Any material that cannot be repackaged must be classified as hazardous material excess and turned over to DRMO.

The drums which are now stored in areas X-13 and X-15 will then be moved into the free space in S-873. In this manner, all open storage of drummed products, except at X-25, will be eliminated. Building 529 is partially utilized for non-compliance storage. An additional 20,000 square feet of material will be relocated from Building 529 to the new warehouse.

The Flammable Liquids Holding Area, also known as the "hot house", is where flammable materials are temporarily stored (less than 24 hours), after receipt or before shipping. Typical items in this area include alcohols, ketones, aromatics, and ethers. The "hot house" is located at the northwest corner of Building 689.

A new hazardous materials warehouse is presently under construction in the northwest quadrant of DDMT. The total area of the building is 141,100 square feet. The building will provide 138,000 square feet of storage area for hazardous materials with the remainder being used for general office and ancillary activities. Sources of DDMT hazardous wastes include spill cleanup residue, mission stock which has reached expired shelf life, and satellite generation areas. Hazardous materials operations at DDMT are increasing. In 1984, DDMT was responsible for 30,000 tons of hazardous material, while in 1987, the amount was about 37,000 tons.

Hazardous Waste Generation and Disposal

DDMT is a RCRA generator of hazardous wastes in the State of Tennessee, under generator number TN 42100205780. DDMT is a small quantity generator, because less than 220 pounds of hazardous wastes are generated per month. The only source of DDMT hazardous wastes result from the cleanup of small hazardous materials spills. Of the approximately 100,000 hazardous material transfers per year at DDMT, only an estimated 50 per year results in an out-of-container event. More than 90 percent of these events result from packaging failures in transport. The remaining events are attributed to handling at DDMT.

Defense Reutilization and Marketing Region (DRMR) is a tenant activity of DDMT. DRMR supports several installations in the region and is responsible for providing disposal of hazardous material through contractors. The old Defense Property Disposal Office has been redesignated Defense Reutilization and Marketing Office (DRMO). DRMO provides property disposal services and conforming storage facilities for hazardous materials and hazardous wastes generated by DDMT, Memphis Naval Air Station and Air Force Air National Guard. Under the present permit, the time limit for hazardous waste storage is 90 days. The installation is seeking a Part B permit from EPA which would allow storage up to 180 days.

Building 308 is where hazardous materials in DRMO's possession are stored. It is a wood-framed tin structure with a concrete floor. A two-foot concrete foundation surrounds the floor to provide secondary containment, except for two doorways. Spill containment and cleanup materials are kept in the building. Building 308 will be replaced by the planned DRMO Conforming Storage Facility. The project was planned for FY 1987. It will provide a 14,000 square foot storage facility with auxiliary facilities required to accomplish the hazardous materials disposal mission. Recoupment is used as much as possible to minimize losses and to keep waste quantity to a minimum. Cleanup residuals are transferred to DRMO for resale or disposal.

Sampling investigation of the PCP DIP Tank Building commenced in August, 1985 when U.S. Army Environmental Hygiene Agency personnel obtained analytical results arranged by O.H. Materials which revealed the presence of high levels of highly chlorinated isomers of dioxins and furans.

Samples taken of soil under the dip vat showed the presence of contamination. O.H. Materials used a portable drill rig to systematically depth sample the area. O.H. Material in conjunction with state and federal authorities determined a target clean-up criteria figure of 200 ppb total dioxins and furans.

Although contaminants exceeding the 200 ppb were found at a depth of 27 feet, the U. S. Army, Region IV EPA, and the State of Tennessee Department of Health and Environment determined a 10 foot removal depth.

The contaminated soil was stored on roll-off containers near Building 670. The roll-off containers have been removed and the soil has been disposed at an approved facility. The Dioxin was removed to an approved hazardous waste disposal facility in spring 1988.

Traces of zinc have been found in the bottom sludge of Lake Danielson. This is believed to have been caused by drainage from cooling towers. Many cooling towers are constructed of hot-dipped galvanized metal parts. Prior to assembly, the metal parts are dipped in a vat of molten zinc to obtain a coating for protection against corrosion. At present, the contaminant level of the sludge is within compliance limits and is not considered to be a significant problem. However, monitoring of the sludge should be continued, and should the sludge approach the maximum allowable contaminant level, it should be dredged out and disposed of in a manner prescribed by the governing environmental agency.

DDMT has instituted spill response and control measures which avoid significant releases of spilled hazardous material to the environment. The following programs have been implemented to mitigate adverse impacts.

(1) Spill Prevention, Control, and Countermeasures (SPCC) Plan. The plan is designed to improve responses to and decrease the potential for hazardous materials spills.

(2) Installation Spill Contingency Plan (ISCP). The Plan provides specific steps to follow for reporting of a spill, mobilization of the spill response team, and cleanup of a spill. Also included are telephone numbers for emergency services (police, fire department, hospitals, etc.), reportable quantities of hazardous materials, and the responsibilities of the spill response team members.

(3) Personal Training. The training includes courses for hazardous materials warehouse personnel, spill team members, and management. The training program includes initial orientation; an in-house course, "Introduction to Hazardous Materials--Handling and Storage, Packing and Marketing"; certification training for packers, "Defense Packaging of Hazardous Materials for Transportation," which is conducted

by the Joint Military Packaging Training Center; and opportunities to take technical courses and attend appropriate seminars outside the DLA system for certain personnel. Safety meetings are conducted once per week. Unannounced drills on safe work practices are conducted monthly by the Safety and Health Office.

(4) Spill Response Vehicle. The vehicle has a variety of spill response equipment for personnel protection (chemical-resistant coveralls, boots, hard-hats, face shields, gloves, respirators, first aid kits, fire extinguishers, etc.), spill control (shovels, absorbents, neutralizing chemicals, etc.), communications, and analysis (explosimeter, oxygen meter, pH paper, etc.) plus other safety gear. In addition to the DDMT vehicle, the City of Memphis Fire Department Hazardous React Team is on call for emergencies at the installation. This team has a national reputation for its hazardous spills response expertise.

Prior to 1976, the north end of Dunn Field was used for burial of toxic and carcinogenic compounds, ID sets, pesticides, and foodstuff. Burning sites were also formerly located there. The Resource Conservation Recovery Act, Code Federal Regulation 40 was enacted in 1976, and since then, burial and incineration of hazardous wastes at the site has not been practiced. The area is monitored for ground-water contamination.

Explosives. DDMT does not handle significant quantities of ammunition. There are small quantities of ammunition confiscated by the FBI that are stored in an igloo on the west side of 9th Street. The storage of these materials is not considered to be a significant hazard to personnel or facilities.

The only other explosives on the Depot are flammable materials stored in temporary structures on the west side of the installation. An adequate safety distance is maintained.

6.0 CONCEPTUAL SITE MODEL

Background information gathered during the initial site visit to the Defense Depot, Memphis, Tennessee (DDMT) were utilized in developing a conceptual site model which evaluates potential risks to human health and the environment. As suggested in the SPA guidance documents, the conceptual model includes all known and suspected sources of contamination, types of contaminants and affected media, known and potential routes of migration, and all known or potential human and environmental receptors. Thus the model may be considered a worst case analysis. In addition to assisting the identification of sampling sites, the model will also assist in the identification of appropriate remedial technologies.

A preliminary conceptual model of exposure pathways at the DDMT is included as an aid in evaluating areas which need investigation at the depot (Table 6-1). Potential receptors include employees of the depot, inhabitants of the surrounding area and the entire population of Memphis. A schematic presentation of the model is found in Figure 6-1.

6.1 POTENTIAL SOURCES

Dunn Field is identified as the area with highest potential for ground water contamination. Dunn Field has served as a burial site for many hazardous waste materials including mustard and Lewisite gas, oil and grease, paint and thinner, methyl bromide, pesticides and herbicides. According to Lt. Marks at Edgewood Arsenal, the M-1 War Gas Set (which is believed to be the identity of the mustard/Lewsite training sets which are buried at Dunn Field) consists of 48 hermetleally sealed pyrex glass tubes, each containing 40 cc of agent. Each kit contains 12 tubes each of mustard, Lewsite, phosgene and chloropickrin. The Mustard and Lewsite are in concentrations of 5% solution in chloroform. Twelve tubes, each enclosed in an outer cardboard tube, were

TABLE 6-1

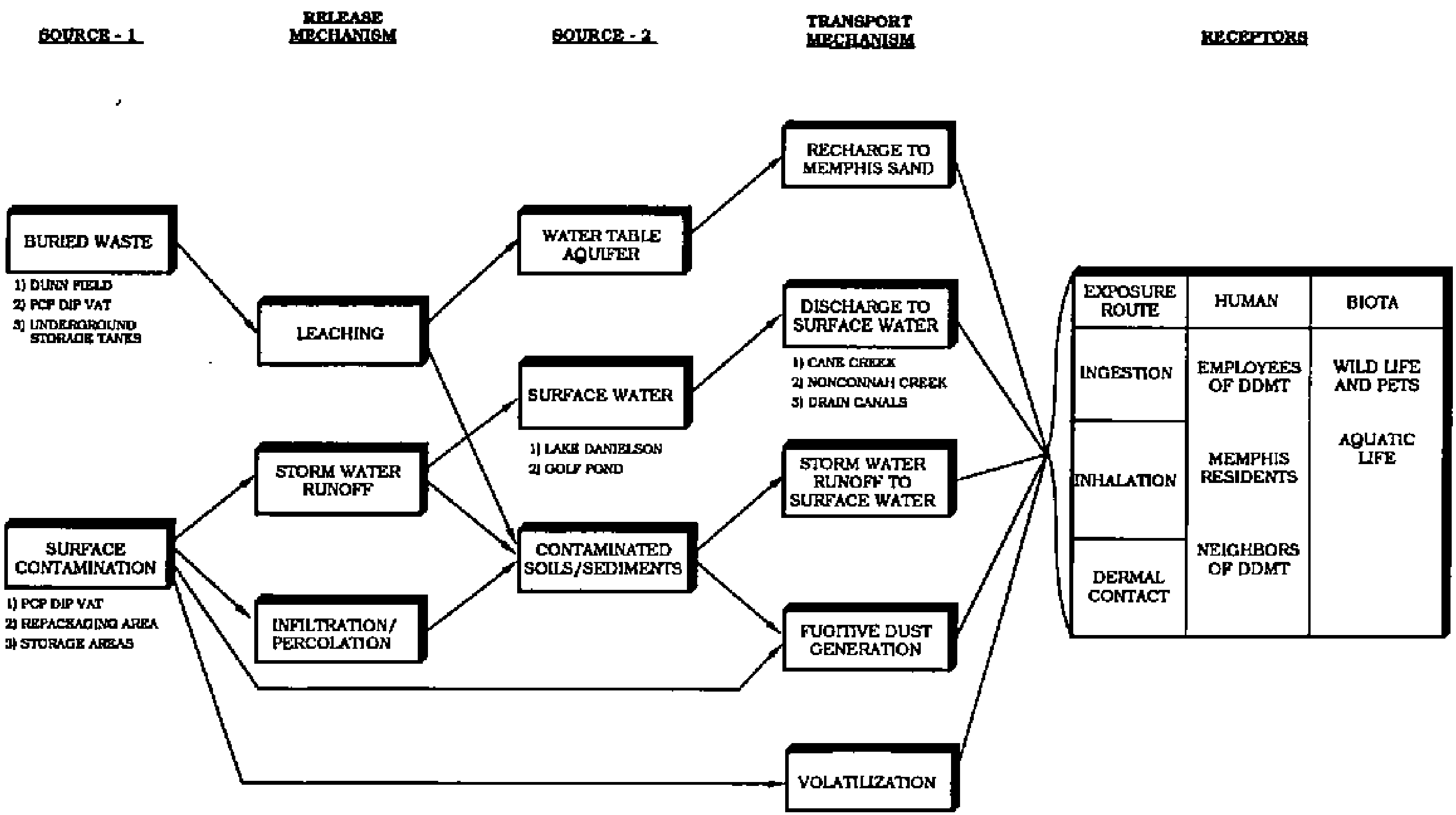
POTENTIAL EXPOSURE PATHWAYS

SOURCE/RELEASE	TRANSPORT MECHANISM	EXPOSURE POINT/ROUTE
1. MIGRATION OF CONTAMINANTS FROM DUNN FIELD	SHALLOW AQUIFER RECHARGE OF MEMPHIS SAND	WATER SUPPLY WELLS FOR MEMPHIS (WELL NO. 115 IN ALLEN FIELD)
	SHALLOW AQUIFER DISCHARGE TO SURFACE WATER (CANE CREEK)	RECREATIONAL USES OF CANE CREEK AQUATIC LIFE IMPACTS TO CANE CREEK INGESTION OF FISH FROM CANE CREEK
2. SURFACE RUNOFF OF CONTAMINANTS FROM STORAGE AREAS	STORMWATER DISCHARGE TO GOLF COURSE POND AND LAKE DANIELSON	AQUATIC LIFE IMPACTS IN POND/LAKE
	DISCHARGE FROM POND/LAKE TO NONCONNAH CREEK	AQUATIC LIFE IMPACTS IN NONCONNAH CREEK RECREATIONAL USES OF NONCONNAH CREEK INGESTION OF FISH FROM NONCONNAH CREEK
3. MIGRATION OF CONTAMINANTS FROM PCP-DIP TANK	SHALLOW AQUIFER RECHARGE OF MEMPHIS SAND	WATER SUPPLY WELLS FOR MEMPHIS (WELL NO. 115 IN ALLEN FIELD)
	SHALLOW AQUIFER DISCHARGE TO SURFACE WATER (POND/LAKE/ NONCONNAH CREEK)	AQUATIC LIFE IMPACT IN SURFACE WATERS RECREATIONAL USES OF SURFACE WATERS INGESTION OF FISH FROM SURFACE WATERS
	FUGITIVE DUST-GENERATION IN CONTAMINATED AREAS	INHALATION OF CONTAMINATED DUSTS BY ON-SITE PERSONNEL

FIGURE 6-1

CONCEPTUAL SITE MODEL

DEFENSE DEPOT MEMPHIS, TENNESSEE



BASED ON E.P.A. GUIDANCE FOR CONDUCTING RI/FS UNDER CERCLA, MARCH 1988

LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION

packed in a metal container of dimensions 5.75" x 9.5". The record indicates that only nine of these sets were buried in Dunn Field. The listing of contaminants of concern will be based on substances found during this investigation. The current listing found in Table 6-2 indicates those substances already found in the ground water at DDMT. Thiodigycol, a by-product formed when mustard reacts with water, has not been found in previous ground water studies. It has been included in Table 6-2 due to the possible presence.

The former PCP dip vat area is another potential source of contamination. Although the area was remediated in 1986 it is possible that some contamination of the subsurface still exists. According to the 1986 O.H. Materials report "Soil containing contamination exceeding the targeted 200 ppb clean-up level for total dioxins and furans currently remains below the 10 foot level to which excavation in Building 737 reached." The migration of PCP and its contaminants from contaminated subsurface soils which remain on sight may eventually reach the water table aquifer. The soils at DDMT are low to moderately permeable and are low in organic matter.

Underground storage tanks are also potential sources of contamination to surrounding soils with contaminants potentially migrating to ground water. At least nineteen underground storage tanks are located at DDMT and have contained fuel, waste oil, and pesticide rinse water. Most of the UST's at DDMT were leak tested and replaced by fiberglass tanks. No leaks were detected.

Storage areas on the east side of the depot drain into Lake Danielson. A pesticide storage area was previously placed upgradient to Lake Danielson, but the original building has been removed, a new concrete foundation poured and a new fabric building installed. Pesticide storage has been moved to another area. Pesticide and PCB residues have been found in fish tissues and in sediment samples from Lake Danielson and the golf course pond (USAEHA, 1986). Lake Danielson and, possibly, the

TABLE 6-2

CONTAMINANTS OF CONCERN

POTENTIAL SOURCE	CONTAMINANTS OF CONCERN
MUSTARD/LEWISITE	THIODIGLYCOL
PAINTS	CADMIUM CHROMIUM LEAD
THINNERS/SOLVENTS	CARBON TETRACHLORIDE CHLOROFORM 1,1-DICHLOROETHANE t-1,2-DICHLOROETHYLENE 1,1,2,2-TETRACHLOROETHANE TETRACHLOROETHYLENE 1,1,2-TRICHLOROETHANE TRICHLOROETHYLENE
PESTICIDES/HERBICIDES	DDT CHLORDANE
PCP DIP TANK	PENTACHLOROPHENOL DIOXIN FURAN
TRANSFORMERS	PCBs

DEFENSE DEPOT MEMPHIS

golf course pond must now be considered potential sources of contamination. Storm runoff and overflow from Lake Danielson and the golf course pond are directed into drainage canals.

Many outdoor areas with gravel bases have served as repackaging or recoupment areas at DDMT. These areas which include the corner of 21st and E streets, the DRMO storage yard and areas surrounding Bldg. S873 were exposed to infrequent ground spills (USAEHA, 1985). Tables 3-1 and 3-2, and Figures 3-1 and 3-2, respectively, list and show areas at the installation where potential waste sources may be located. It should be noted that most repackaging was done in areas with concrete floors.

6.2 EXPOSURE PATHWAYS

The DDMT is located within the city limits of Memphis and is east of the Allen Well Field, one of six well fields owned by the Memphis Light, Gas and Water Division. The Allen Well Field draws water from the Memphis Sand aquifer which is the water source for all the City of Memphis and most of Shelby County. Studies have shown that "windows" occur in the confining layer of the Memphis Sand aquifer which may allow leakage of contaminants from water table aquifers (USGS,1988). It has been documented that contaminants from the DDMT have contaminated the water table aquifer (U.S. Army Environ. Hygiene Agency Ground-water Consultation No. 38-26-0815-87 DDMT, 1986). Although this aquifer is not used as a source of drinking water, contaminants could potentially reach the Memphis Sand aquifer if "windows" exist in the confirming unit in the vicinity of DDMT.

A preliminary well survey of the area within a one mile radius of the depot did not reveal the existence of any residential wells. Two industrial wells are located within a one mile radius, but are not used as a potable water source (Memphis and Shelby County HD,1988). The State of Tennessee and the local health department track the number of wells in the area by requiring drilling permits and annual permit renewals for continuous well operation.

The land uses surrounding DDMT are a mixture of residences and commercial or manufacturing establishments. The area is well populated. Storm water runoff from the depot travels by open concrete-lined canals through residential sections surrounding DDMT until reaching either Cane Creek on the north side or Nonconnah Creek to the south and west. Cane Creek eventually drains into Nonconnah Creek. Nonconnah Creek is a tributary of the Mississippi River.

Inhalation exposures to fugitive dust or volatile organic vapors from areas with surface contamination are release mechanisms to be considered in the potential exposure of employees and neighbors of DDMT. Highly permeable, non-compacted surface soil aids the migration of surface contaminants to subsurface soils and eventually to the water table and groundwater aquifers. It should be noted, however, that the installation as a whole is well vegated or concreted leaving very small areas susceptible to wind erosion.

It was noted during the initial site investigation that storm water runoff leaves the depot via several open storm canals. These canals could serve as a contact point for inhabitants of the areas surrounding the DDMT. Therefore, sampling of storm drain waters will be valuable in discerning whether contaminants are leaving DDMT via storm water runoff and surface water drainage.

The majority of DDMT employees are civilians working during two shifts per work day. The number of employees is estimated to be 2,700 (Chumney, 1988). Employees are potentially exposed via inhalation, ingestion and dermal contact to contaminated surface soils and waters. Inhabitants of areas surrounding DDMT may be exposed to contaminated dusts or volatile vapors escaping from the DDMT or by contact with storm water runoff and drainage from DDMT.

The entire population of Memphis, which uses groundwater from the Memphis Sand as a drinking water source, must be considered as potential receptors. The population of Memphis is estimated at 700,000 for the city and 800,000 for all of Shelby County.

Most of the DDMT contains structures or paved surfaces. The limited unsurfaced areas (i.e., Dunn Field and the golf course) support native Bermuda grass and deciduous black oaks (Quercus velutina). Some shrubbery is located in previously landscaped areas such as the housing area, golf course and lake. Small, urban-living animals such as squirrels, birds, snakes and turtles are the potential residents of "natural" areas in Dunn Field and the golf course. Game fish such as bluegill, bass and catfish have been previously stocked in Lake Danielson. Goldfish inhabit the golf course pond. Fishing is currently prohibited in the lake and golf course pond.

Aquatic life is potentially impacted by contamination of surface waters such as Lake Danielson, the golf course pond, Cane Creek and Nonconnah Creek. Wildlife and area pets may be exposed via contact with contaminated soil or surface waters.

The conceptual site model highlights several areas deserving investigation. Because the Allen Well Field is less than one mile downgradient of DDMT, buried wastes from Dunn Field, the former PCP Dip Vat, and underground storage tanks may impact these water supply wells. Buried wastes may leach into surrounding soils and be transported by surface water discharge, storm water runoff and fugitive dust generation. Surface contamination from the depot must be assessed as contaminants from this source can be transported by surface water, storm water runoff, fugitive dusts and volatilization. Populations potentially impacted are employees and neighbors of DDMT, residents of Memphis, wildlife, pets and aquatic life.

7.0 PROPOSED ARARS

CERCLA guidelines specify that remedial actions meet any Federal standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate requirements (ARARS). State ARARS must be met if they are more stringent than Federal requirements.

Charles Pietrosewicz of the Agency for Toxic Substances and Disease Registry (ATSDR), Liaison-EPA IV, was consulted concerning the proposed ARARS for the DDMT sites. Mr. Pietrosewicz agreed that the ARARS listed on Table 7-1 were appropriate for the public health and environmental assessment of the DDMT sites.

TABLE 7-1

PROPOSED ARARs

AREA OF CONCERN	ARARs*
1. MEMPHIS SAND AQUIFER	MAXIMUM CONTAMINANT LEVELS (MCLs) TENNESSEE DRINKING WATER STANDARDS
2. CANE CREEK LAKE DANIELSON GOLF COURSE POND NONCONNAH CREEK	AMBIENT WATER QUALITY CRITERIA TENNESSEE WATER QUALITY CRITERIA TENNESSEE EFFLUENT LIMITATIONS

* (1) TENN. H_20 QUALITY CRITERIA:
RULES & REGULATIONS OF THE STATE OF TENN., CHAPTER 1200-4, DEPARTMENT OF HEALTH, BUREAU OF ENV. HEALTH SERVICES, DIV. OF WATER QUALITY, RULE 3

(2) TENN. EFFLUENT LIMITATIONS & STANDARDS:
TENN. WATER QUALITY CONTROL BOARD CHAPTER 1200-4-5

(3) TENN. DRINKING WATER STANDARDS:
TENN. DEPT. OF HEALTH, BUREAU OF ENV. HEALTH SERVICES, DIV. OF WATER SUPPLY, RULE 1

(4) SAFE DRINKING WATER ACT:
(MCLs) E.P.A. NAT. PRIMARY DRINKING WATER REGULATION : 40 CFR 141

(5) AMBIENT H_20 QUALITY:
CLEAN WATER OF 1977 SECT 304 (a) AND 307

8.0 PRELIMINARY EVALUATION OF REMEDIAL ALTERNATIVES

8.1 INTRODUCTION

The purpose of this section is to discuss potential remedial approaches and associated data that may be needed to evaluate alternatives during the Feasibility Study. The following discussion considers alternatives potentially suitable for the mitigation of site conditions at DDMT. This section has been prepared in response to the Statement of Work, Section 1, General Statement of Services and the Subtask 3.2.1.3 description. As information is gathered during the Remedial Investigation, potential remedial approaches will be reconsidered.

Under SARA, remedy selection is based upon four generalized concepts which are:

1. The remedy must protect human health and the environment;
2. The remedy must be cost-effective;
3. The remedy must utilize treatment technologies to the maximum extent practicable; and
4. The remedy must meet applicable or relevant and appropriate requirements (ARAR's).

A detailed Risk and/or Health Assessment must be conducted for any remedy selected.

8.2 IDENTIFICATION OF REMEDIAL ALTERNATIVES

For each affected media, a remedial alternative will be identified as necessary in each of the broad categories:

- No action
- Containment
- Treatment with walk-away potential

- Treatment reducing contaminant toxicity, mobility, and volume

A brief overview of each broad category is provided in the following subsections.

8.2.1 No Action Alternative

Under the No Action Alternative, the site would not receive any further remedial action. Before this alternative can be selected, the extent and rate of migration of contamination must be determined and projected into the future. The No Action Alternative could be viable if health factors can be addressed and rates of migration and impact on potential receptors can be adequately determined. A detailed Risk Assessment must be conducted before this alternative could be chosen.

8.2.2 Containment

Containment usually consists of site capping and the installation of barrier walls to preclude surface water infiltration, leachate generation, ground-water underflow and waste contaminant migration into the receiving environment. Containment may be synonymous with isolation, as the site is theoretically separated from its environmental setting by the barrier system. Containment may also be employed to channel leachate or ground water to collection points for subsequent treatment.

The data required to evaluate this alternative might include a description of disposed waste materials, the delineation of site-related contamination in the adjacent receiving environment and a characterization of the concentrated wastes present in the landfill. The waste characterization data would be required to determine contaminant compatibility with potential containment systems.

8.2.3 Treatment With Walk-Away Potential

Treatment with walk-away potential may involve several technologies. A few technologies identified here may also be applicable, with some differences, to a discussion of treatment reducing contaminant toxicity, mobility or volume, described in the following subsection. This type of treatment may be performed on site, or off site. A possible approach is to apply conventional processes such as biological treatment, physical/chemical treatment or solidification/stabilization. All of these approaches require that site waste materials be mixed with agents that render them harmless or inert, preferably in-situ. Biological and physical/chemical treatment processes may reduce toxicity, but not mobility or volume. Solidification/stabilization techniques may reduce mobility, but usually will not address toxicity. Fixation techniques may also increase contaminant volumes by the addition of the stabilization material(s) to the waste materials.

The site data required to evaluate these candidate methodologies include landfill environmental setting, contaminant concentrations and extent, waste characterization and treatability studies.

8.2.4 Treatment Reducing Contaminant Toxicity, Mobility or Volume

Thermal destruction and incineration are two potential remedial alternatives that could possibly reduce contaminant toxicity, mobility or volume. Thermal destruction methods may be utilized to destroy organic contaminants in gaseous, liquid and solid waste. The purpose is to degrade a substance into relatively inert or easily managed materials. Technologies associated with thermal destruction include molten salt, wet air oxidation, plasma arc, circulating bed, high temperature fluid wall, pyrolysis, etc. Incineration technologies generally considered applicable include liquid injection, rotary kiln, fluidized bed and multiple hearth (Remedial Action at Waste Disposal Sites, USEPA, 1985). Incinerators require combustion temperatures on the order of 1300°F to 3000°F; residence times are highly variable.

In addition to thermal destruction and incineration, more conventional approaches such as biological treatment, physical/chemical treatment or solidification/stabilization may be utilized. These techniques may be applied singly or in conjunction with other techniques to obtain the desired results.

The site data required to evaluate this candidate methodology include site environmental setting, waste characterization, BTU content, water content, viscosity, halogen content and ash content. Pilot-scale tests may be needed to establish start-up conditions, maintenance requirements and operating parameters.

8.3 PRELIMINARY IDENTIFICATION AND SCREENING OF GENERAL RESPONSE ACTIONS

This subsection provides a preliminary identification and screening of general response actions and associated technologies potentially useful for Defense Depot Memphis Tennessee. The actions and technologies considered address site remediation with respect to suspected site conditions and anticipated contaminant migration pathways. Each action and associated technology is briefly described in Table 8-1. Significant capabilities and limitations are listed, based upon the incomplete data presently available and numerous assumptions. This procedure is used to begin the process of technology screening so that remedial alternatives can be developed, as the RI/FS process proceeds.

A total of eight general response actions have been initially recognized for application at DDMT. These actions were selected in accordance with USEPA guidance documents and our experience on similar projects.

TABLE 8-1
DEFENSE DEPOT MEMPHIS, TENNESSEE
SUMMARY OF POTENTIAL GENERAL RESPONSE ACTIONS AND ASSOCIATED REMEDIAL TECHNOLOGIES

GENERAL RESPONSE ACTIONS	ASSOCIATED TECHNOLOGY	DESCRIPTION	BENEFITS	LIMITATIONS	WASTE	SOILS & SEDIMENTS	SURFACE WATER	GROUND WATER	REMARKS
No Action	Site Monitoring	A no action alternative. Monitor site by periodic environmental sampling and analysis, per SARA.	Simplest, least costly option.	May not adequately address site problems. Potential for contaminant migration. May be objectionable to the community.	X	X	X	X	Retain option
Containment	Capping and barrier walls	Isolates the site from its environs, precluding leachate generation and migration. Capping controls infiltration, while barriers prevent leachate leakage and underflow. In some scenarios, containment can be designed to facilitate leachate collection and treatment.	A demonstrated, conventional procedure.	Contaminants remain in place. Dependent on site geology. Dependent on climate. Dependent on waste compatibility. Not a long-term solution.		X		X	Retain option for possible conjunctive use with others. Generally not applicable at DDMT, could be used with others at Dunn Field.
Selected Waste Removal	Remove drums, soils, sediments, liquid wastes, etc.	Remove selected wastes based on contaminant levels, degree of risk to humans and the environment,etc. Technology may be applied to ground water, when combined with treatment.	More cost effective than complete removal. May be more favorable to the community than no action alternative.	Waste character is not known. May not be possible to segregate wastes to allow selective removal. Landfill excavation to remove wastes may be difficult and potentially dangerous. Does not address ground-water contamination.	X	X			Potentially applicable for buried wastes at Dunn Field and sediments in Lake Danielson.

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TABLE 8-1

DEFENSE DEPOT MEMPHIS, TENNESSEE

SUMMARY OF POTENTIAL GENERAL RESPONSE ACTIONS AND ASSOCIATED REMEDIAL TECHNOLOGIES

GENERAL RESPONSE ACTIONS	ASSOCIATED TECHNOLOGY	DESCRIPTION	BENEFITS	LIMITATIONS	WASTE	SOILS & SEDIMENTS	SURFACE WATER	GROUND WATER	REMARKS
Pumping	Ground-water withdrawal and/ or liquid waste removal.	Remove contaminated ground water or liquid wastes by pumping to treatment systems.	A demonstrated, conventional approach.	Dependent on site geology. Dependent on waste character. Long term operation and maintenance required. Existing aquifer will be affected.	X			X	Possible for use in any area where water table aquifer has been contaminated.
On-Site Treatment	Incineration, solidification, biological, chemical and/or physical treatment.	Indicates some form of treatment performed at the site which renders the material non-hazardous. Includes on-site incineration, biological, chemical and physical treatment and solidification	Avoids transportation hazards. Treatment helps ensure reduction in future liability. Chemical/ physical on-site treatment would be lower cost options suitable for inorganic contaminants found on the site. On-site treatment of ground water by physical/ chemical means is a practical alternative.	Incineration is a more costly alternative. Solidification and/or on-site landfill could result in future contamination. On-site solidification with subsequent off-site disposal may be acceptable. Biological treatment would not be effective on inorganics.	X	X	X	X	Retain option for further consideration. Possible for use in any area of soil, sediment, or ground-water contamination.

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TABLE 8-1
DEFENSE DEPOT MEMPHIS, TENNESSEE
SUMMARY OF POTENTIAL GENERAL RESPONSE ACTIONS AND ASSOCIATED REMEDIAL TECHNOLOGIES

GENERAL RESPONSE ACTIONS	ASSOCIATED TECHNOLOGY	DESCRIPTION	BENEFITS	LIMITATIONS	WASTE	SOILS & SEDIMENTS	SURFACE WATER	GROUND WATER	REMARKS
Off-Site Treatment	Incineration, biological, chemical and/or physical treatment.	Same as above, except that wastes are excavated and transported to an off-site facility.	Same as above.	Same as above.	X	X	X	X	Retain option for further consideration. Does not appear seriously applicable.
On-Site Disposal	Landfill and land treatment for some contaminants.	Refers to the construction of a landfill and/or a land application facility on site.	Avoids transportation hazards. A demonstrated conventional approach. Very cost effective when compared to removal/resiting schemes.	Not a viable long-term solution, as contaminants remain on site. May result in increased risk. Perpetual care required.	X	X			Probably not apply as would require a permitted landfill.
Off-Site Disposal	Remove wastes to a secure landfill. Use land treatment for selected contaminants. Withdraw contaminated water for treatment.	Includes the excavation of contaminated soils/sediments and removal of drums with subsequent landfill in a secure landfill. Land application is applicable to contaminated soils and sediments. It involves the mixing of contaminated materials with the soil-plant sorption, and immobilization.	Landfill presents a proven, economic means of safely disposing of hazardous special solid wastes containing no free liquid.	Land treatment is useful only for organic materials, and is thus not entirely applicable to this waste. Landfill of contaminated wastes could result in future contamination at the new site. May result in increased risk.	X	X	X	X	Potential for removal of contaminated soils or sediments or buried wastes.

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8.4 PERFORMANCE CRITERIA AND STANDARDS FOR GENERAL RESPONSE ACTIONS

The performance criteria and standards which must be considered for the previously described actions are outlined below, based on ARARs, environmental, public health, institutional, and cost considerations.

8.4.1 Environmental Protection

Alternatives posing significant adverse environmental effects will be excluded from further consideration. Only those alternatives that satisfy the RI objectives and contribute to the protection of the environment will be considered further. Environmental criteria which must be considered include:

- Impact of construction on flora, fauna, and the natural drainage system
- Impact of treatment systems operation on ambient air quality
- Destruction of flora and wildlife habitat or natural drainage systems during contaminated soils excavation process
- Impact of pollutant release to downgradient surface waters, ground waters, and/or sensitive habitats
- Criteria for effluent discharge to surface waters, through off-site disposal of contaminated ground water options
- Potential for offsite contaminant spills during transportation of soils or ground water, for off-site treatment and disposal options.

8.4.2 Public Health

Only those alternatives which will minimize or mitigate the threat of harm to public health and the environment will be considered. Specific consideration will be given to:

- o Guidelines for allowable chemical concentrations in an underground source of drinking water for migration management options
- o Assessment of long-term risk to downgradient receptors for migration management options
- o The potential for continued release of pollutants from the source into the ground water for all options
- o The potential for contaminated ground-water interaction with surface water, and potential surface water receptors, for the no action alternative
- o Assessment of risk through air emissions from on-site treatment options and excavation of contaminated soils
- o Assessment of risk through off-site transport options

8.4.3 Institutional

An alternative that does not meet technical requirements of the applicable environmental laws (e.g., RCRA, CWA, CAA, TSCA, Safe Drinking Water Act, UIC) will usually be excluded from further evaluation. Specific consideration will be given to:

- o Department of Transportation (State and Federal) requirements and restrictions for hazardous waste transport for off-site treatment and disposal options

- Pretreatment standards for discharge into publicly owned treatment works, for off-site treatment and disposal options

- NPDES permitting requirements for off-site discharge of ground water or effluent options

- Clean Air Act permitting requirements for on-site treatment options

- State and local land use zoning restrictions for construction and operation of on-site treatment systems, pipelines, and wells.

8.4.4 Cost

An alternative whose cost significantly exceeds that of other alternatives and does not provide substantially greater public health or environmental benefits will be eliminated. Total cost of an alternative should be considered and will include the cost of implementing the alternative and the cost of operation and maintenance. Costs will be presented in terms of present worth to provide for comparison among alternatives having different useful lives. Specific considerations could include:

- Transportation costs for off-site disposal or treatment options

- Disposal fees for hazardous waste landfilling for off-site disposal options

- Treatment costs and/or acceptance fees for off-site treatment options

- Pipeline costs based on size, length and construction constraints for off-site discharge of contaminated ground water

- Well construction costs for contaminated ground-water recovery systems and deep well injection options

- Operation and maintenance costs for ground-water recovery and treatment options

- Facilities construction and operating costs for on-site treatment options

- Excavation, filling and grading costs for source removal options

- Permitting fees for off-site discharge (NPDES) and deep well disposal (RCRA) options

- Engineering design fees for recovery, treatment, and off-site discharge options

8.5 APPROACH TO ALTERNATIVE EVALUATION

The results of the screening of remedial alternatives will depend on factors selected for making comparisons and how they are applied. Alternatives will be evaluated and ranked in terms of cost-effectiveness, technological feasibility and reliability, and ability to provide adequate protection of human health, and the environment. The detailed evaluation of selected alternatives will consider, at a minimum, the following factors:

- Special engineering considerations required to implement the alternatives (e.g., pilot treatment facilities, additional studies needed to proceed with final remedial design)

- Environmental impacts and proposed methods and costs for mitigating any adverse effects

- Operation, maintenance, and monitoring requirements of the remedy

- Off-site disposal needs and transportation plans

- Temporary storage requirements

- Safety requirements for remedial implementation, including both on-site and off-site health and safety considerations

- A description of how the alternatives could be phased into operable units, including a discussion of how various operable units of the total remedy could be implemented individually or in groups, resulting in a significant improvement in the environmental protection or savings in costs

- A review of any national off-site treatment and disposal facilities to consider compliance with applicable RCRA requirements, both current and proposed. In addition, the capacity of such facilities should be examined.

8.6 IDENTIFICATION OF DATA REQUIREMENTS

Additional data are required to formulate cost effective remediation concepts. These data requirements are based on a review of existing data, possible remedial alternatives, and predicted performance. The requirements are as follows:

- Source Control

  - Volume (area and depth) of material to be considered
  - Chemical nature of the material
  - Soil and subsoil characteristics

- o Ground-Water Related Migration

  - Volume of water involved (area, depth)
  - Aquifer characteristics
  - Background information
  - Current ground-water use

- o Surface Water Related Migration

  - Degree and extent of surface water involvement
  - Identification of surface drainage channels

8.7 FEASIBILITY STUDY

Following the data collection phases of the Remedial Investigation, the information obtained will be used in the FS to evaluate and cost those remedial alternatives deemed appropriate.

DDMT WORK PLAN - VOLUME II

FINAL SOIL BORING AND

MONITORING WELL INSTALLATION PROGRAM

For

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)

At

DEFENSE DEPOT MEMPHIS, TENNESSEE (DDMT)
CONTRACT NO. DACA87-88-C-0092

Prepared for:

U.S. Army Corps of Engineers
Huntsville Division
P. O. Box 1600
Huntsville, Alabama 35807

Prepared by:

Law Environmental, Incorporated
Government Services Division
112 TownPark Drive
Kennesaw, Georgia 30144-5599

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1.0 INTRODUCTION

Because of potential contamination at the Defense Depot Memphis, Tennessee (DDMT), the Defense Logistics Agency (DLA) has initiated this investigative program through the Huntsville Division, Corps of Engineers. The purpose is to determine if contamination has occurred and assess feasible alternatives for clean-up. To accomplish these objectives, ground-water, surface water, soil and sediment samples will be collected at DDMT. This plan describes the soil boring and monitoring well installation program and is Volume II of the DDMT Work Plan.

Soil borings drilled for the purpose of soil sample collection for analytical testing must be advanced in a manner which allows the collection of representative soil samples. Similarly, monitoring wells must be properly installed in order to accomplish the following objectives: to collect representative groundwater samples; to prevent contamination of the aquifer by the drilling activities; to prevent inter-aquifer contamination; and to prevent vertical seepage of surface water into the monitoring well water-intake zone. The soil sampling and well installation plan discusses the equipment, procedures and personnel that will be used at DDMT to accomplish these objectives.

DDMT is located in Memphis, Tennessee and is currently managed by the DLA. The mission of the Depot is to stockpile and distribute material goods. Background information about the depot history, environmental setting and past waste disposal practices is discussed in Volume I of the Work Plan. As previously mentioned, Volume II is the Soil Boring and Monitoring Well Installation Plan. This plan covers soil boring and monitoring well locations and depths, drilling equipment and materials, drilling procedures, decontamination procedures, well design and installation, well development, permeability testing, and project assignments and responsibilities. This plan was prepared to meet the requirements of the DDMT statement of work.

2.0 SOIL BORING LOCATIONS AND DEPTHS

Law will install five soil borings during the RI/FS at DDMT as specified in the project scope of work. The purpose of the soil borings will be to characterize the subsurface geology and to collect soil samples for chemical analysis. To accomplish these objectives, both geotechnical samples and soil samples for chemical analysis will be collected from the soil borings. The soil borings will be drilled using hollow stem augering techniques. Borings will be sampled continuously from the ground surface to a depth of 10 feet. After a depth of 10 feet is reached, samples will be taken at a minimum of 5 foot intervals. The soil borings will be backfilled with a grout bentonite mixture.

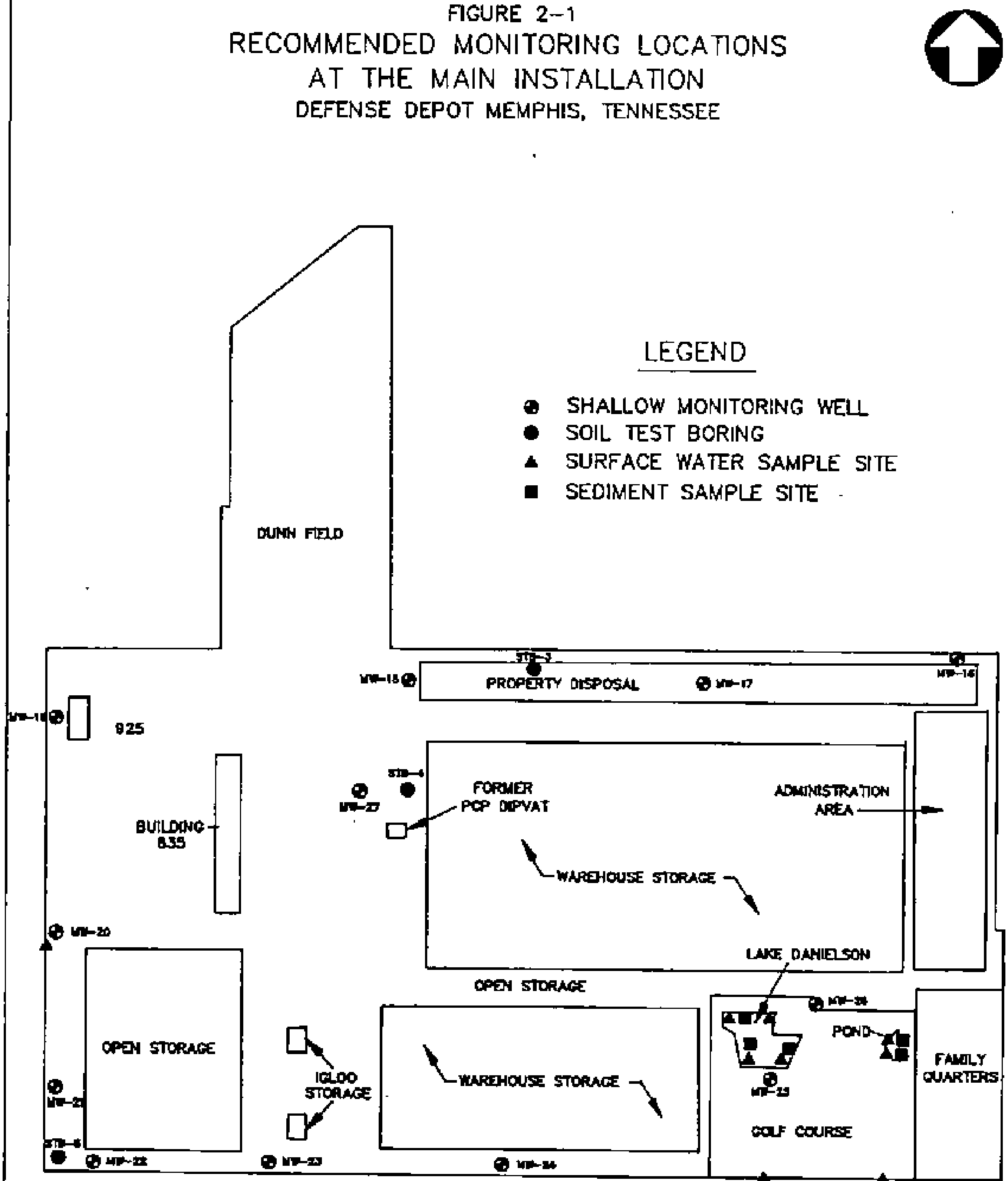
This section of the plan discusses the location, depth and sampling of the borings.

2.1 SOIL BORING LOCATIONS

As stated previously, the purpose of the soil borings is to collect samples for chemical analysis and to obtain geologic information on the site. Therefore, the soil borings have been located to optimize both objectives. Figures 2-1 and 2-2, respectively, show the proposed sampling locations for the main installation and Dunn Field. As shown on the figures, the five borings form a north-south transect of the entire site. Two borings (Figure 2-1) will be on the main part of the installation and three will be in Dunn Field (Figure 2-2). These locations will provide chemical samples and geology data for the installation.

It should be noted that these locations are well away from the mustard/lewisite burial site (reference Figure 3-1, Work Plan, Volume I). No sampling will occur at this burial site except by the U.S. Army Technical Escort Unit (TEU).

FIGURE 2-1
RECOMMENDED MONITORING LOCATIONS
AT THE MAIN INSTALLATION
DEFENSE DEPOT MEMPHIS, TENNESSEE



SOURCE: GEOHYDROLOGIC STUDY NO. 38-26-0195-83, DDM, MEMPHIS, TN, 21 JUNE - 2 JULY, 1982.

SCALE: 1"~1000'

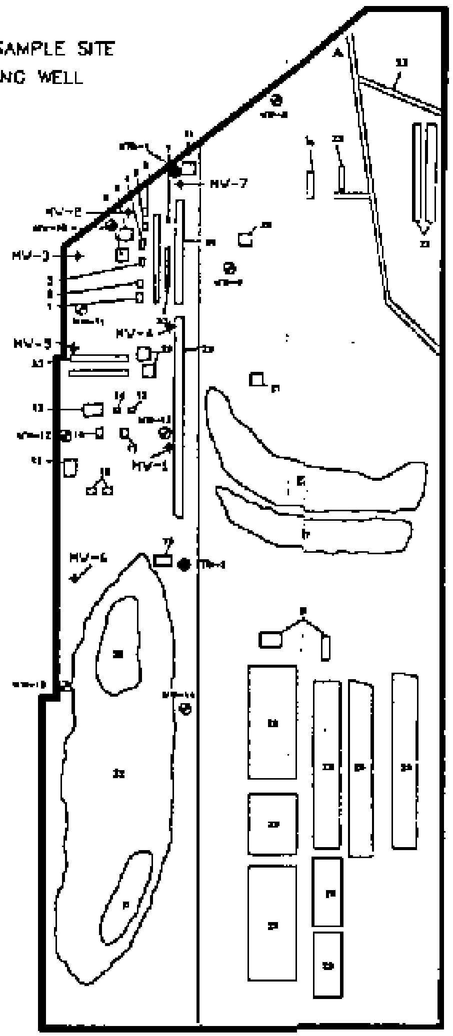
FIGURE 2-2

RECOMMENDED MONITORING LOCATIONS AT DUNN FIELD

DEFENSE DEPOT MEMPHIS, TENNESSEE

LEGEND

- ⊕ SHALLOW MONITORING WELL
- ● SOIL TEST BORING
- ▲ SURFACE WATER SAMPLE SITE
- ✦ EXISTING MONITORING WELL



LOCATION	
BURIAL SITES	
1	TRAINING SETS, NINE EACH MUSTARD AND LEWISITE, 1955.
2	7 POUNDS (LBS) AMMONIUM HYDROXIDE, 1 GAL GLACIAL ACETIC ACID, 1955.
3	3,000 QUARTS (QT) CHEMICALS, 5 CUBIC FEET (FT(3)) ORTHO-TOLIDINE DIHYDROCHLORIDE, 1955.
4	THIRTEEN 55-GAL DRUMS OIL, GREASE, AND PAINT, DATE UNKNOWN.
5	THIRTY-TWO 55-GAL DRUMS OIL, GREASE, AND THINNER, 1955.
6	3 FT(3) METHYL BROMIDE, 1955.
7	40,037 UNITS OINTMENT (EYE), 1955.
8	1,700 BOTTLES FUMING NITRIC ACID, 1954.
9	3,768 1-GAL CANS METHYL BROMIDE, 1954.
10	ASHES AND METAL REFUSE FROM BURNING PIT, 1955.
11	1,433 1-OUNCE (OZ) BOTTLES TRICHLOROACETIC ACID, 1965.
12	SULPHURIC/HYDROCHLORIC ACIDS, 1967.
13	32 CUBIC YARDS MIXED CHEMICALS AND ACID, 900 LBS DETERGENT, 7,000 LBS ALUMINUM SULPHATE, 200 LBS SODIUM.
14	SODIUM, 1968.
15	SODIUM PHOSPHATE, 1968.
16	ACID, 1969.
17	HERBICIDE, CLEANING COMPOUND, MEDICAL SUPPLIES, 1969.
18	ACID, DATE UNKNOWN.
19	HARDWARE (NUTS AND BOLTS).
22	XXCC3 IMPREGNITE.
29	FOOD SUPPLIES.
30	BURIAL SITE PRIOR TO BAUXITE STORAGE; FOODS, CONSTRUCTION DEBRIS BURNED, 1948.
33	14 BURIAL PITS CONTAINING SODIUM PHOSPHATE, SODIUM, ACID, MEDICAL SUPPLIES, CHLORINATED LIME, 1970.
BURN SITES	
21	SANITARY WASTE, SMOKE POTS, CN CANISTERS.
31	OLD BURN AREA, 1946.
STORAGE SITES	
25	PESTICIDE STORAGE
27	BAUXITE
28	FLUORSPAR
32	BAUXITE, 1942-72.
OTHER SITES	
20	ASPHALT DUMP
23	OPEN DRAIN DITCHES
24	PISTOL RANGE
26	BURIED DRAINPIPE

SOURCE: GEOHYDROLOGIC STUDY NO. 38-26-0195-83, DDM, MEMPHIS, TN, 21 JUNE - 2 JULY, 1982

SCALE: 1"~350'

LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION

2.2 SOIL BORING DEPTHS

The statement of work (SOW) for the DDMT RI/FS provides for five soil test borings with a total footage not to exceed 400 feet of drilling. Therefore, it is estimated that each soil test boring will average 80 feet in depth. Based on a review of background information, an 80 foot soil boring will provide adequate geologic data on the unsaturated zone and the water table aquifer beneath DDMT. Some of the borings may reach the confining unit beneath the water table aquifer, but that will not be known until actual borings are installed.

2.3 SOIL BORING JUSTIFICATION

BORINGS STB-1 and STB-2
LOCATION - DUNN FIELD
JUSTIFICATION - Borings in Dunn Field will serve two purposes, i.e., for collection of soil samples for chemical analysis and to describe the geology beneath Dunn Field. Previous borings installed at Dunn Field were sampled by collecting auger cuttings during the drilling operation. While this method is adequate to provide a general description of the subsurface, it is not adequate to provide the site specific detail that can be obtained using continuous sampling procedures. A continuous soil profile will provide the detail necessary to understand the subsurface environment at Dunn Field.

BORING STB-3
LOCATION - PDO YARD, MAIN INSTALLATION
JUSTIFICATION - Collection of soil samples for chemical analysis and to describe the subsurface stratigraphy in the vicinity of the PDO yard. No soil test borings have been installed in the vicinity of the PDO yard.

BORING STB-4

LOCATION - FORMER PCP VAT AREA, MAIN INSTALLATION

JUSTIFICATION - Although the area has been remediated, the contractor only removed soil to a depth of ten feet. STB-4 will test the soil at depths below ten feet and indicate the effectiveness of the remediation efforts.

BORING STB-5

LOCATION - SOUTHWEST CORNER, MAIN INSTALLATION

JUSTIFICATION - The location, on the edge of the open storage area, will help to describe the subsurface stratigraphy of the area as well as allow the collection of soil samples for chemical analysis in an area of known chemical spills.

2.4 SOIL BORING SAMPLING

Soil samples for chemical and geotechnical analysis will be collected from the 5 soil test borings. Two potential sampling protocols will be either using a split spoon sampler collecting samples with the standard penetration test (ASTM-D- 1586-67) or with a CME continuous sampling device (or equivalent continuous sampler). Subsurface conditions will dictate the most reasonable sampling procedures.

For chemical analysis, three samples will be taken from each boring. The depth of each chemical sample will be based on photoionization detector (PID) readings during drilling. If PID readings indicate organic contamination, the chemical samples will be collected from the zone with the highest readings. If no PID readings register above zero, then samples will be obtained at depths judged by the field manager to represent the greatest potential for contamination (i.e., low permeability layers in the unsaturated zone, at the water table, etc.).

Besides soil for chemical analysis, samples for strata identification and geotechnical analysis will be obtained from the soil borings. Two samples will be selected from each boring to analyze for grain size, Atterberg Limits and moisture content.

A geologist or engineer will be assigned to each drilling rig to assure that samples are properly collected and that geologic strata are adequately identified and mapped.

3.0 MONITORING WELL LOCATIONS AND DEPTHS

As specified in the Scope of Work, 20 shallow monitoring wells will be installed during the RI/FS. The monitoring well locations and depths for each site are discussed below.

3.1 MONITORING WELL LOCATIONS

Monitoring wells will be drilled in the main installation and at Dunn Field. The proposed locations are shown in Figures 2-1 and 2-2. These locations have been selected based upon reviews of background data regarding geology, geohydrology, and past waste practices at DDMT (reference Figure 3-1, Work Plan, Volume I). Twelve wells are proposed for the main installation and eight wells at Dunn Field. Each location is near a potential waste source, or downgradient of waste sources. Ground water within the Memphis Sand formation flows predominantly toward the Mississippi River west of the installation. Data from the AEHA installed wells indicate a westerly direction of ground water flow in the surficial aquifer.

As with the soil borings in Section 2.0, no wells will be drilled near the mustard/lewisite burial location. Monitoring wells have been selected to avoid this type of chemical contact. If monitoring wells are necessary near the mustard/lewisite burial site, the U.S. Army TEU will have sole responsibility for installing these wells.

3.2 MONITORING WELL DEPTHS

The DDMT SOW states that 20 wells will be installed with a total footage not to exceed 1700 feet of drilling. Previous monitoring wells installed at DDMT have shown that the water table occurs at a depth of approximately 70 feet below land surface. Each new monitoring well and soil test boring will terminate approximately

15 feet into the water table aquifer as per the SOW. However if the confining unit is reached then drilling will terminate. Therefore, it is estimated that each well will average 85 feet in depth.

3.3 MONITORING WELL JUSTIFICATION

MONITORING WELL MW-8
LOCATION - NORTH CENTRAL DUNN FIELD
JUSTIFICATION - This well will be located up-gradient to MW-7 which has shown significant ground water contamination. The new well will define the extent of the contaminate plume in this direction.

MONITORING WELL MW-9
LOCATION - NORTH CENTRAL DUNN FIELD
JUSTIFICATION - This well will be located up gradient to known burial sites of hazardous wastes as well as ground water monitoring wells (MW-2, MW-3, and MW-5) which have shown significant ground water contamination. The new well will define the extent of the contaminate plume in this direction.

MONITORING WELL MW-10
LOCATION - NORTH WEST DUNN FIELD
JUSTIFICATION - This well will be located near MW-2 which is screened at 30 feet and was unable to produce enough water for analysis during the last sampling event. MW-2 is thought to be screened in a perched zone that may or may not produce water. Therefore no water samples have been obtained from the water table aquifer in the vicinity of MW-2.

MONITORING WELL MW-11
LOCATION - NORTH WEST DUNN FIELD
JUSTIFICATION - This well will be located midway between MW-3 and MW-5 both of which indicated ground water contamination. The new

well will further delineate the extent of the contamination plume immediately down-gradient of the burial sites.

MONITORING WELL MW-12
LOCATION - WEST DUNN FIELD
JUSTIFICATION - This well will be located midway between MW-5 and MW-6 both of which indicated ground water contamination. The new well will further delineate the extent of the contamination plume.

MONITORING WELL MW-13
LOCATION - CENTRAL DUNN FIELD
JUSTIFICATION - This well will be located adjacent to an area where hazardous wastes were buried. It is also up gradient to MW-4 and MW-6 which both indicated ground water contamination. This well will define the extent of the plume of ground water contamination in this direction. It replaces monitoring well MW-1 which was previously destroyed.

MONITORING WELL MW-14
LOCATION - CENTRAL DUNN FIELD
JUSTIFICATION - This well will be located up-gradient to an area where various wastes were buried or burned. It is also up gradient to MW-6 which had the highest levels of ground water contamination of any well at DDMT. The well will further delineate the extent of the plume of ground water contamination in this area.

MONITORING WELL MW-15
LOCATION - WEST DUNN FIELD
JUSTIFICATION - This well will be located adjacent to MW-6 which had the highest levels of contamination of any ground water well at DDMT. It will further delineate the plume of ground water contamination indicated by MW-6.

MONITORING WELL MW-16

LOCATION - NORTHEAST EDGE OF MAIN INSTALLATION

JUSTIFICATION - Based on the suspected regional hydraulic gradient it is anticipated that MW-16 will function as an upgradient or background monitoring location. Therefore, this well should provide information on the background water quality.

MONITORING WELL MW-17

LOCATION - PDO YARD, MAIN INSTALLATION

JUSTIFICATION - This well will be located in the Property Disposal Yard which in the past has handled large amounts of hazardous materials. Data from the well should indicate whether past hazardous material handling practices have affected the surficial aquifer.

MONITORING WELL MW-18

LOCATION - PDO YARD, MAIN INSTALLATION

JUSTIFICATION - Same as MW-17 above.

MONITORING WELL MW-19

LOCATION - WESTERN EDGE OF MAIN INSTALLATION

JUSTIFICATION -MW-19 is located on the downgradient boundary of DDMT. It is in the vicinity of the flammable storage yard (X-13, X-25) and other storage activities. It should provide water quality in the surficial aquifer leaving DDMT.

MONITORING WELL MW-20

LOCATION - SOUTHWESTERN EDGE OF MAIN INSTALLATION

JUSTIFICATION - This well will be located downgradient of the Open Storage Area. Numerous hazardous wastes are known to have contacted the environment in this area which necessitates monitoring. Potential contamination on the western boundary includes paints, solvents, pesticides, hydrocarbons and others.

MONITORING WELL MW-21

LOCATION - SOUTHWESTERN EDGE OF MAIN INSTALLATION

JUSTIFICATION - Same as MW-20 above.

MONITORING WELL MW-22

LOCATION - SOUTHWESTERN EDGE OF MAIN INSTALLATION

JUSTIFICATION - Same as MW-20 above.

MONITORING WELL MW-23

LOCATION - SOUTHERN EDGE OF MAIN INSTALLATION

JUSTIFICATION - This well will be located near an area which underwent a remediation effort in 1985. Numerous damaged containers of acids, bases, solvents and cleaners were repackaged or disposed of and a substantial quantity of contaminated soil was removed. A ground water monitoring well inn this area will indicate if the surficial aquifer was impacted by past material handling practices.

MONITORING WELL MW-24

LOCATION - SOUTHERN EDGE OF MAIN INSTALLATION

JUSTIFICATION - This well will be located near a former drum storage area. Records indicate that from time to time leaks were discovered in some of the drums stored in this area. A ground water monitoring well should indicate if the surficial aquifer was impacted by the leaking drums.

MONITORING WELL MW-25

LOCATION - LAKE DANIELSON/GOLF COURSE POND AREA, MAIN INSTALLATION

JUSTIFICATION - Past herbicide or pesticide releases in this area have affected the aquatic life in these surface waters. A ground water monitoring well in this area will indicate if the surficial aquifer was impacted by these chemicals.

MONITORING WELL MW-26

LOCATION - LAKE DANIELSON/GOLF COURSE POND AREA, MAIN INSTALLATION - Same as MW-25 above.

MONITORING WELL MW-27

LOCATION - FORMER PCP DIPVAT DRIP AREA

JUSTIFICATION - This well will be located down gradient of the former PCP dipvat drip area, which was remediated in 1985. A ground water monitoring well will indicate what affect activities at the dipvat area had on the surficial aquifer.

3.4 Surface Soil Sample Locations

A total of 40 shallow (less than 18 inches in depth) surface soil samples will be collected. Past waste management practices and hazardous materials handling locations will be the quiding factors in choosing locations for the samples. The following table lists areas where samples will be obtained:

- Dunn Field Area
- Property Disposal Area
- Former PCP Dipvat Area
- Open Storage Area
- Lake Danielson/Pond Area
- Former Recoupment Area
- Paint Shop/Sand Blast Area

The exact locations of the sample points will be determined in the field by the Field Manager based upon visual inspection of the area and using best engineering judgment.

3.5 OPTIONAL WORK

Additional ground-water monitoring wells have been included as optional tasks to the basic contract. All of the optional tasks are listed below. Those necessary for completion of the RI/FS will be exercised at the discretion of the Contracting Officer.

Option 1 - Install two deep wells
Option 2 - Install three deep wells

Option 3 - Install three shallow wells
Option 4 - Install seven shallow wells
Option 5 - Additional ground water sampling
Option 6 - Additional surface water sampling
Option 7 - Additional soil/sediment sampling
Option 8 - Additional soil borings
Option 9 - Treatability Plans
Option 10 - Community Relations assistance
Option 11 - Feasibility Study

We recommend exercising Option 1 to install two deep wells at DDMT. Contamination has been identified in the water table aquifer at Dunn Field. However, the major concern is whether this contamination is penetrating the Jackson - Upper Claiborne confining units and affecting the Memphis Sand.

The Memphis Sand and the overlying water table aquifer are separated by approximately 110 feet of clay in the Allen field area. Low levels of contamination (below drinking water standards) have been detected in the Memphis Sand. The installation of two deep wells would allow a direct indication of the presence or absence of contamination of this aquifer, along with providing geologic information about the confining unit. One well each would be located on the downgradient side of the site in Dunn Field and in the main part of the installation. The wells would be drilled through the confining unit and into the Memphis Sand aquifer. To prevent vertical leakage from the water table aquifer into the Memphis Sand, Type III wells would be used instead of Type II wells.

4.0 DRILLING EQUIPMENT AND MATERIALS

4.1 DRILLING TECHNIQUES

The DDMT soil borings will be installed utilizing hollow stem auger (HSA) drilling techniques. The monitoring wells at the site will be installed utilizing one of the following drilling techniques:

- Hollow Stem Auger (HSA)
- Wash Rotary (WR)

It is acknowledged that the Hollow Stem Auger technique is preferable for installation of the monitoring wells, and will be used if possible at DDMT. The drill rigs will install a minimum 7-inch diameter borehole in order to facilitate installation of 2-inch (ID) ground-water monitoring wells. For installation of deep wells a larger diameter boring will be drilled for installation of the surface casing and four inch well. The drill rig will have the capability to collect split spoon samples according to ASTM procedures. At a minimum, the rig will be equipped with a cathead operated, 140-pound hammer with a 30-inch draw. Continuous sampling may be utilized at the discretion of the Site Manager. Augers and drill rods will be free from oil and grease, and will be cleaned with steam prior to initiating drilling on each well. Toxic and/or contaminating substances will not be used during any part of the drilling, well development processes. All drilling activities and methods will be sufficient to prohibit the introduction of contaminants from one water bearing stratum to another via the well bore.

4.2 WELL CASING AND SCREEN MATERIALS

The nature of the geologic material and the location of the water bearing zone to be monitored will dictate the selection of the appropriate monitoring well type. At DDMT, both Type II and Type III monitoring wells may be installed. The design and installation of these wells is discussed in Section 7.0. Figure 4-1 and 4-2 show Type II and Type III wells, respectively.

4.2.1 Surface Casing

All surface casing used in the construction of Type III wells will consist of minimum 8-inch PVC or steel metal pipe. No glue joints will be used in the surface casing. The pipe will be of sufficient strength to ensure structural integrity during the installation process.

4.2.2 Well Casing (Riser)

Well riser pipe will consist of new, threaded, flush-joint PVC pipe. For deep wells the riser will be of Schedule 80 and of 4 inches minimum inside diameter (ID). Risers for the shallow wells will consist of 2 inch minimum ID, Schedule 40 PVC pipe. The risers will conform to the requirements of ASTM-D 2241 for PVC pipe and will bear markings that will identify the material as that which is specified. No solvents or glue of any kind will be used in the well bore. Upon completion of the well, a vented PVC cap will be installed to prevent material from entering the well.

4.2.3 Well Screen

The well screen will consist of 15 to 20 feet of PVC material similar in specification to the well riser. The screen will be new, noncontaminating, commercially fabricated and of continuous wrap or mill slot, #10 slot size (0.010 inch). The screen will be placed in an appropriate location in the borehole to accommodate fluctuations in the water table.

FIGURE 4-1

TYPE II MONITORING WELL INSTALLATION DIAGRAM

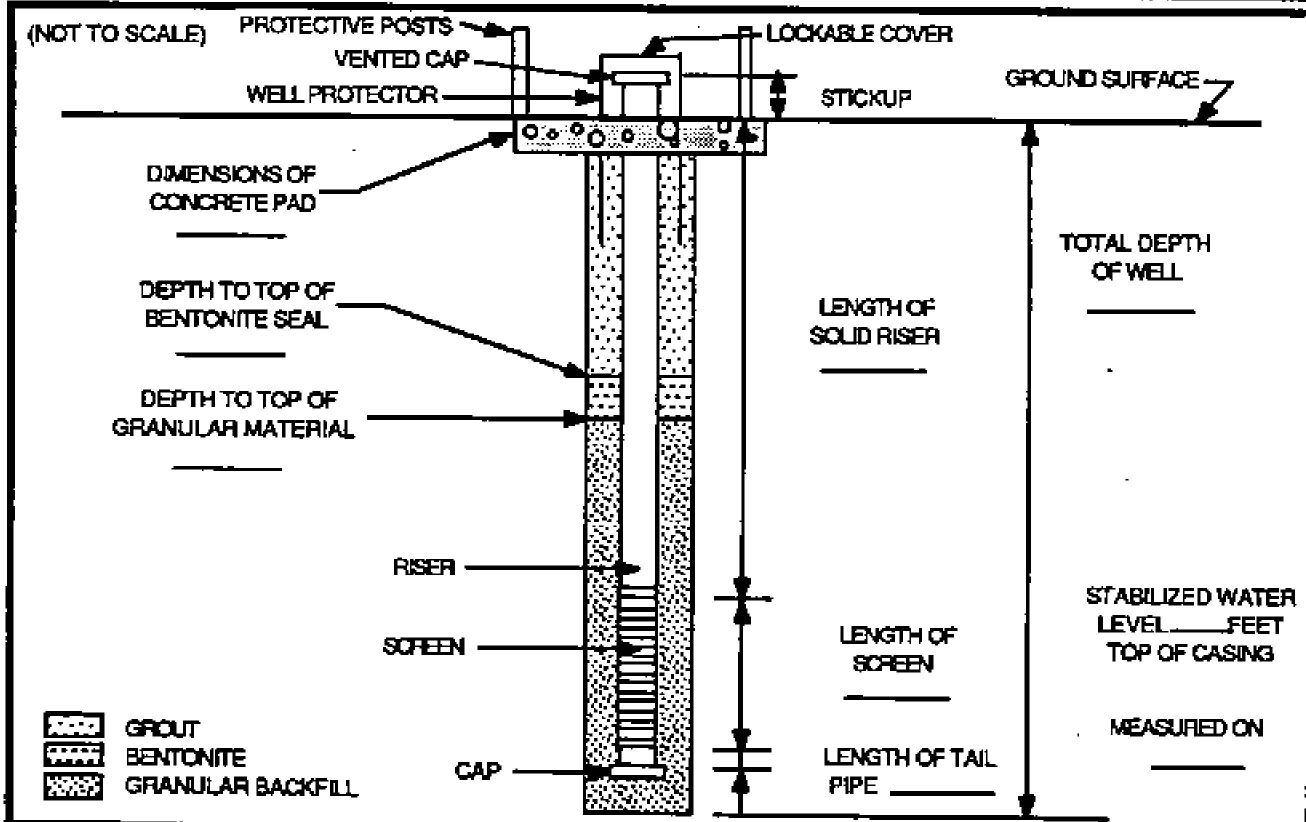
LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION
KENNESAW, GEORGIA

JOB NAME ______
WELL NO. ______ JOB NO. ______
DATE ______ TIME ______
WELL LOCATION ______

GROUND SURFACE ELEVATION ______
TOP OF SCREEN ELEVATION ______
REFERENCE POINT ELEVATION ______
TYPE SAND PACK ______ GRADATION ______
SAND PACK MANUFACTURER ______
SCREEN MATERIAL ______
MANUFACTURER ______
RISER MATERIAL ______
MANUFACTURER ______
RISER DIAMETER ______
DRILLING TECHNIQUE ______
BIT SIZE AND TYPE ______
AUGER SIZE AND TYPE ______
STRATUM DEPTH ______

BENTONITE TYPE ______
MANUFACTURER ______
CEMENT TYPE ______
MANUFACTURER ______
BOREHOLE DIAMETER ______
SCREEN DIAMETER ______ SLOT SIZE ______
LAW ENVIRONMENTAL, INC.
FIELD REPRESENTATIVE ______
DRILLING CONTRACTOR ______
AMOUNT BENTONITE USED ______
AMOUNT CEMENT USED ______
AMOUNT SAND USED ______
STATIC WATER DEPTH (after dev.) ______
STRATUM DESCRIPTION ______

(NOT TO SCALE)



QA / QC	INSTALLED BY: ______ INSTALLATION OBSERVED BY: ______ DISCREPANCIES: ______

FIGURE 4-2

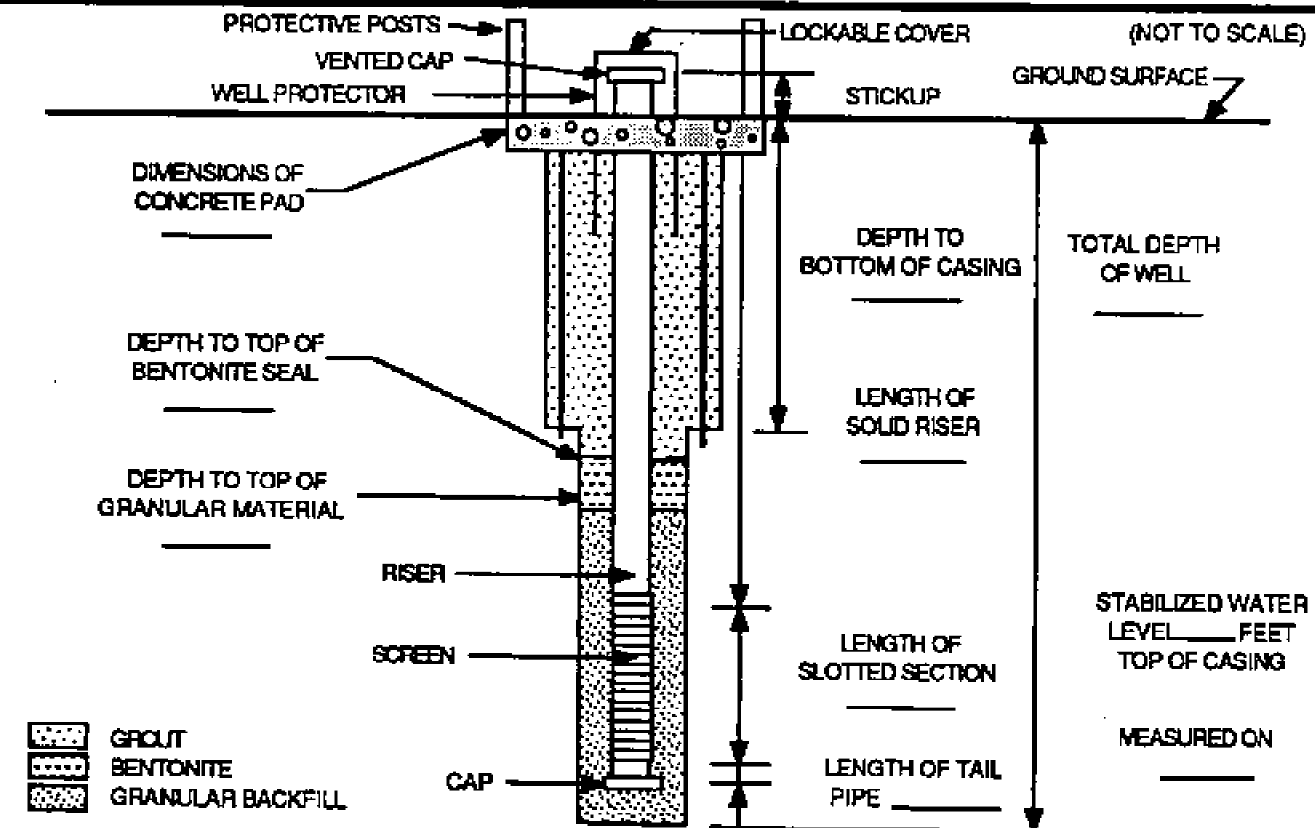
TYPE III MONITORING WELL INSTALLATION DIAGRAM

LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION
KENNESAW, GEORGIA

WELL NO. ______
JOB NO. ______
DATE ______ TIME ______
WELL LOCATION ______

GROUND SURFACE ELEVATION ______
TOP OF SCREEN ELEVATION ______
REFERENCE POINT ELEVATION ______
TYPE SAND PACK ______ GRADATION ______
SAND PACK MANUFACTURER ______
SCREEN MATERIAL ______
MANUFACTURER ______
RISER MATERIAL ______
MANUFACTURER ______
RISER DIAMETER ______
DRILLING TECHNIQUE (above casing) ______
BIT SIZE AND TYPE ______
DRILLING TECHNIQUE (below casing) ______
BIT SIZE AND TYPE ______

BENTONITE TYPE ______
MANUFACTURER ______
CEMENT TYPE ______
MANUFACTURER ______
BOREHOLE DIAMETER ______
SCREEN DIAMETER ______ SLOT SIZE ______
LAW ENVIRONMENTAL, INC.
FIELD REPRESENTATIVE ______
DRILLING CONTRACTOR ______
AMOUNT BENTONITE USED ______
AMOUNT CEMENT USED ______
AMOUNT SAND USED ______
STATIC WATER DEPTH (after dev.) ______
TYPE OF CASING ______



QA / QC

INSTALLED BY: ______ INSTALLATION OBSERVED BY: ______
DISCREPANCIES: ______

4.2.4 Sand Sump

A 2-foot minimum length sand-sump constructed of PVC similar in specifications to the well riser will be placed below the base of the screen. The sand-sump will be installed only if the screen can be placed at the appropriate interval without the sand-sump penetrating through the aquitard. The bottom of the deepest screen or casing section will be sealed with a threaded PVC plug.

4.2.5 Centralizers

Depending upon the type of drilling technique and the well depth, centralizers may be necessary to maintain the well casing and screen in the center of the boring. Centralizers will only be installed on the solid riser pipe and not on the screen. When hollow stem augering is used centralizers will not be necessary.

4.3 SAND PACK FILTER

A continuous sand pack will be installed as a filter in the annulus between the boring well and the well screen. The sand pack will consist of clean, inert, non-carbonate materials. The sand pack will be placed from the bottom of the well to at least 2 feet above the top of the screen. A tremie pipe will be used, if appropriate, to place the sand pack in the well.

4.4 BENTONITE SEAL

A minimum 2 foot bentonite seal will be placed into the annular space between the riser and the boring wall at the top of the sand pack. The bentonite will be wetted and at least 30 minutes will be allowed to expire prior to grouting to allow for swelling of the bentonite pellets.

4.5 GROUT MIXTURE

A non-shrinking, cement-bentonite grout mixture will be placed in the annular space between the well casing and boring from the top of the bentonite seal to the ground surface. The cement mixture will consist of Portland cement (ASTM--C150), and water added in the proportion of not more than 7 gallons per 94 pound bag of cement. Additionally, 3 percent by weight of bentonite powder will be added to the mixture to help reduce shrinkage.

4.6 DRILLING FLUIDS

4.6.1 Water

Clean, non-chlorinated potable water or formation water from the well being drilled is recommended in the SOW for use as a drilling fluid. However, the acquisition of non-chlorinated water is typically not feasible, and local water supplies containing chlorine are generally acceptable for use. A sample of the drilling water will be collected and analyzed according to approved protocols. Any proposed use and source of water will be approved by the Contracting Officer prior to use in drilling.

4.6.2 Drilling Mud

It is currently anticipated that the wells will be installed without the need for drilling mud. However, in the event that drilling mud is necessary, bentonite is the only approved drilling fluid additive. No organic additives will be used. Data on the bentonite will be provided including: brand name, manufacturer, manufacturer's address, product description, and mixing ratios.

4.7 WELL COMPLETION DETAILS

4.7.1 Concrete Pad

A minimum 3 foot by 3 foot by 4 inch concrete pad will be installed around each of the monitoring wells at the site. The pads will consist of ready-mix concrete mixed in appropriate proportions (i.e. ready-mix and water). The pad will be sloped slightly from the well to the edges of the pad to facilitate surface run off. A 3 foot by 3 foot form will be constructed (out of 2x4 lumber) to pour the pad. The form may remain in-place. A survey marker shall be permanently placed in each pad.

4.7.2 Steel Security Cap

A round, or square, steel security cap will be installed over the PVC well stick-up. It is anticipated that the steel security cap will extend above the ground approximately 24 to 36 inches. The security cap will have a hinged locking cap feature. The diameter of the security cap will allow easy access to the PVC well stick-up and will be installed in the concrete pad. There will be no openings in the protective casing well below its top. Key-alike locks will be provided for each of the wells.

4.7.3 Protective Posts

Three protective posts consisting of nominal 2 inch diameter steel will be embedded into the concrete pad equally spaced around the well and to a sufficient height (30 - 36 inches) to protect the well pipe from being damaged.

4.7.4 Well Painting

The steel security cap and the protective posts will be painted with a bright, (yellow or orange) rust-inhibiting paint (i.e., Krylon, or equal).

4.7.5 Well Identification

A permanent marking or tag will be affixed to the outer steel protective casing of each well. The well number, a U.S. Army Corps of Engineers identification, and the top of casing elevation will be identified on each tag.

4.7.6 Temporary Capping

Any well that is temporarily removed from service, or left incomplete during installation will be capped with a watertight cap and equipped with a "vandal proof" cover satisfying state or local regulations.

5.0 DRILLING PROCEDURES

5.1 INITIAL ACTIVITIES

The drill rig head assembly, table, and tools will be steam cleaned prior to setting up on a sampling location. Prior to setting up the drilling rig on a boring location, written permission will be obtained from DDMT for approval of the drilling location. Drilling will only proceed in areas free of service lines. All drilling will proceed under strict compliance with the Safety Plan (Volume IV).

5.2 DRILLING PROCEDURES

Drilling with both hollow-stem augers and rotary wash methods may be required. Hollow-stem auger drilling is to be given first preference for both the soil test borings and the shallow monitoring wells (Type II Wells). Wash drilling may be required if hollow-stem augering does not provide a stable borehole for sampling or well installation. Rotary wash drilling will probably be required to install the Type III wells.

5.3 SOIL BORING LOG

A field soil boring log will be completed during the drilling operation. The log will record the following information:

- Sample number and depth
- Standard penetration test blow counts per six inch advance
- Recovery
- Unified Soil Classification, color, consistency or density, and moisture content
- Depth of boring
- Boring refusal
- Water table depth
- Water losses, if applicable

- Method of advancing boring
- Depth, thickness, identification and description of stratum changes
- Depth interval sampled
- Depth at which hole diameter (bit size) changes
- Depth and location of loss of circulation
- Location of fractures, joints, faults, cavities or weathered zones.
- Water-bearing strata
- Static water level initially and after development
- Elevations will be shown on final logs

Figure 5-1 shows the soil test boring field report that will be used at DDMT. Once the boring is completed, a well will be installed as soon as practical, but no later than within 24 hours. Measures will be taken to protect the integrity of the well during any interim periods. In the event that a boring should prove to be unusable for any reason, it will be grouted from the base to the land surface.

SOIL TEST BORING RECORD 09 83

LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION
KENNESAW, GEORGIA

JOB NO. ____________
JOB NAME ____________
DATE: ____________
WEATHER ____________
DRILLER ____________
HOURS DRILLING ____________

BORING NO. ____________
GROUND SURFACE ELEV. ____________
HOURS MOVING ____________
PAGE ____ OF ____

DEPTH (FEET)	STRATA DESCRIPTION	#	"N" 1	2	3	4	N	PID	REC	SOIL CLASSIFICATON AND REMARKS	DEPTH (FEET)

BORING TERMINATED: ____________
BORING REFUSAL: ____________
WATER TOB DEPTH ____________
WATER 24 HR.: DEPTH ____________
WATER LOSSES ____________
CASING: SIZE ____________ LENGTH ____________

METHOD OF ADVANCING BORING	DEPTH
POWER AUGER	TO
HAND CHOP: W/MUD: W/WATER	TO
ROTARY DRILL: W/MUD: W/WATER	TO
DIAMOND CORE	TO

QA / QC INSTALLED BY: ________ CHECKED BY: ________ DISCREPANCIES: ____________

6.0 DECONTAMINATION PROCEDURES

All drilling and sampling will be performed in a manner to minimize the unnecessary contact of contaminated soil with field personnel and equipment. Decontamination at DDMT has two primary goals: to prevent the spread of contamination to non-contaminated areas; and to prevent the cross contamination of samples used for chemical analysis. The decontamination of field personnel is discussed in Section 6.0 of the Safety Plan (DDMT Work Plan - Volume IV).

6.1 DRILLING EQUIPMENT DECONTAMINATION

The drill head assembly, table, and tools will be steam cleaned between each sampling location. Gross contamination adhering to the augers, drill head, or rig will be manually removed with a shovel or trowel. High-pressure steam will then be used to wash the drilling equipment. Wash/Rinse water will be allowed to infiltrate into the soil.

6.2 SAMPLER DECONTAMINATION

A split spoon or a continuous CME sampler will be used to collect soil samples for chemical analysis. The split spoon will be decontaminated prior to collecting soil samples. The continuous sampler will be decontaminated between each boring. Decontamination will consist of a high-pressure steam wash or decontamination with alconox, nitric acid, methanol and deionized water as described in the Sampling/Analysis Plans (Work Plan - Volume III). Sampling utensils, such as mixing bowls, spatulas, and spoons will be similarly cleaned. Decontamination fluids will be allowed to infiltrate into the soil.

7.0 WELL DESIGN AND INSTALLATION

7.1 MONITORING WELL DESIGN

Type II and Type III water quality monitoring wells are shown in Figures 4-1 and 4-2, respectively. The Type II diagram will be completed for each shallow monitoring well and the Type III diagram will be completed for each deep monitoring well. Each well diagram will provide the following data:

- total well depth
- depth of well screen
- depth to top of sand pack
- depth of surface casing (Type III well only)
- thickness of bentonite seal
- depth to base of grout seal
- water table elevation
- well stick-up
- screen length, location, diameter, slot sizes
- date installed
- quantity and type of materials installed
- manufacturer of materials installed
- professional in charge of well installation
- any sealing-off of a water-bearing stata

7.2 MONITORING WELL INSTALLATION

Installation of the well casing and screen can differ slightly depending upon the drilling technique utilized in advancing the boring. The following sections discuss well installation using either a Hollow Stem Auger (HSA) technique or Mud Rotary (MR) techniques.

7.2.1 Hollow Stem Auger Technique

When a boring is advanced using Hollow Stem Augers, the following protocol will be followed to install the well casing and screen in the shallow wells.

- install the 2-inch PVC screen, riser and 2 foot sump through the hollow stem augers with enough riser pipe to extend the well casing about 2 feet above the ground surface.

- install artificial sand pack through the annular opening. Water in small amounts may be used to prevent bridging of the sand in the annulus.

- remove hollow stem augers incrementally as the annulus space fills with sand.

- continue installing sand pack until at least 2 feet above the top of the well screen.

- install a minimum 2-foot bentonite seal (allowing 30 minutes swell time).

- remove hollow stem augers from boring.

- grout boring annulus to land surface with grout/bentonite mixture. Install steel security cap, concrete pad and posts. The grout will be allowed to set a minimum of 48 hours before developing the well.

7.2.2 Mud Rotary Technique

When a boring is advanced using Mud Rotary Technique, the following protocol will be followed to install the well casing and screen in the shallow wells.

- after termination of boring, all drilling rods will be removed.

- install the 2-inch PVC screen, riser and 2 foot sump with enough riser pipe to extend about 2 feet above the ground surface. Centralizers may be necessary to center the pipe in the borehole.

- remove the mud cake from the boring wall by pumping potable water through the well casing and screen.

- install the sand pack with a tremie pipe from the bottom of the boring until at least 2 feet above the top of the well screen.

- install minimum 2-foot bentonite seal.

- grout boring annulus to ground surface with grout/bentonite mixture. Install steel security cap, concrete pad and posts. The grout shall be allowed to set a minimum of 48 hours before developing the well.

8.0 MONITORING WELL DEVELOPMENT

The development of the wells will be performed as soon as practical after well installation, but no sooner than 48 hours after placement of the internal grout collar. Development protocol will be as follows:

a. measure static water level in well

b. measure total well depth

c. record start time of development

d. remove formation water using compressed air technique, by pumping and/or surging, without the use of acids, dispersing agents, or explosives

e. collect water sample initially, as necessary during development and at the end of development, and perform field measurement of specific conductance, pH and temperature

f. development will continue for 4 hours or until specific conductance, pH and turbidity are constant and the water produced is relatively free of turbidity

g. denote physical characteristics of water throughout well development (color, odor, turbidity, etc.)

h. record completion time of development

i. record the total quantity of water removed

j. record any problems or unusual occurrences

k. measure static water level

l. measure total well depth.

Well development will continue for 4 hours and until the following conditions are met: well water is reasonably clear; sediment thickness remaining in the well is less than 5 percent of the saturated screen length; and, at least 5 well volumes (including saturated annulus sand pack, 30% porosity) have been removed. After final development of the well a one liter sample of water from the well will be collected in a clear glass jar and labeled. The sample will be photographed with a 35 mm color slide and submitted as part of the well log. Well development data will be recorded on a form similar to Figure 8-1.

FIGURE 8-1

WELL DEVELOPMENT DATA

RI/FS AT DEFENSE DEPOT MEMPHIS, TN

LAW ENVIRONMENTAL, INC. JOB NAME ________ JOB NO. ________

BY ________ DATE ________ ________ ________ SHEET ____ OF ____

WELL DEVELOPMENT DATA

1. Well No. ________
2. Date of Installation: ________
3. Date of Development: ________
4. Static Water Level: Before Dev. ________ ft.; 24 Hours After ________ ft.
5. Quantity of Water Loss During Drilling, If Used ________ Gal.
6. Quantity of Standing Water in Well and Annulus Before Dev ________ Gal.

	Start	During		End
7. Specific Conductance (umbos/cm)				
Temperature (c°)				
PH (s.u.)				

8. Depth From Top of Well Casing to Bottom of Well ________ ft.
9. Screen Length ________ ft.
10. Depth to Top of Sediment: Before Dev. ________ ft.; After Dev. ________ ft.
11. Physical Character of Water: ________
12. Type and Size of Well Development Equipment: ________
13. Description of Surge Technique, If Used: ________
14. Height of Well Casing Above Ground Surface: ________ ft.
15. Quantity of Water Removed: ________ Gal.

    Time for Removal: ________ Hr./Min.
16. 1-Pint Water Sample Collected: ________ (Time)

*Development Conditions:
1) Well Water if Reasonably Clear
2) Sediment Thickness <5% of Screen Length
3) Removal of 5 Well Volumes, Including Saturated Filter Annulus
4) Stabilization of Specific Conductance and Water Temperature

9.0 IN-SITU HYDRAULIC CONDUCTIVITY

A hydraulic conductivity test will be performed on each well after well development. The in-situ hydraulic conductivity tests which will be performed at this site are known as the "slug in" and "slug out" tests. The "slug in" test involves inserting a slug (solid PVC rod) into the water column in the well to raise the water level. The recovery back down to static water level is recorded over time. The slug is removed for the "slug out" test and the recovery back up to static water level is recorded over time. Test results will be measured using an electronic hydrologic monitoring device.

The data are then plotted on semi-logarithmic paper. The following formula is utilized to calculate hydraulic conductivity (K):

$$K = \frac{\frac{r_2}{r_c} \ln(R_e/r_w)}{2L_e} \qquad \frac{1}{t} \qquad \frac{\ln Y_O}{Y_t}$$

Where r_c - well radius

R_e - effective radial distance over which the head difference is dissipated

r_w - radial distance between well center and undisturbed aquifer

L_e - height of saturated screen

y_o - water level y at time zero

y_t - water level y at time t

t - time since y_o

This formula is taken from Bower, H. and R.C. Rice, A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, Vol. 12, No. 3, June 1976, and is essentially the same as the formula referenced in Section 10.3 of the SOW.

The test conditions and measurements will be recorded on a form similar to Figure 9-1. The raw test data of time and well recovery will be field plotted to identify anomalous readings. The formation permeability will be computed using appropriate predictive equations.

FIGURE 9-1

IN-SITU

HYDRAULIC CONDUCTIVITY TEST

1. Well Number: ______

2. Type of Test: Slug In ___ Slug Out ___

3. Well Constants:

Boring Diameter (r_w)	______
Casing Diameter (r_c)	______
Well Depth (feet)	______
Static Water Level (feet)	______
Saturated Screen Length (feet)	______

4. Test Data

Point No.	Time (t)	Hydraulic Head (h)
1	______	______
2	______	______
3	______	______
4	______	______
5	______	______
6	______	______
7	______	______
8	______	______
9	______	______
10	______	______
11	______	______
12	______	______
13	______	______
14	______	______
15	______	______

REMARKS:

10.0 PROJECT ASSIGNMENTS AND RESPONSIBILITY

A geologist or engineer, shall be present at each operating drill rig and be responsible for the logging of samples, monitoring of drilling operations, recording of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of each rig. Each geologist, or engineer, will have on-site QA/QC and safety responsibility and will have a copy of the Safety Program Plan and Soil Boring and Well Installation Plan. The geologist/engineer will report directly to the Site Manager.

The Site Manager for DDMT will be Mr. Robert Manson. He is a professionally registered geologist with over 10 years experience. Mr. Manson will report directly to the Project Manager regarding field work and safety at DDMT.

DDMT WORK PLAN - VOLUME III

FINAL SAMPLING AND ANALYSIS PLAN

For

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)

At

DEFENSE DEPOT MEMPHIS, TENNESSEE (DDMT)
CONTRACT NO. DACA87-88-C-0092

Prepared for:

U.S. Army Corps of Engineers
Huntsville Division
P. O. Box 1600
Huntsville, Alabama 35807

Prepared by:

Law Environmental, Incorporated
Government Services Division
112 TownPark Drive
Kennesaw, Georgia 30144-5599

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1.0 INTRODUCTION

The purpose of this project is to perform a CERCLA Remedial Investigation/Feasibility Study (RI/FS) at Defense Depot Memphis, Tennessee (DDMT). It has been shown or is strongly suspected that contaminants of concern have been released to the environment at this site. The objectives of this RI/FS are: (1) to determine the presence or absence of environmental contamination at DDMT; (2) to determine the extent and potential for migration of those contaminants detected; (3) to identify public health and environmental concerns; and (4) to recommend appropriate remedial actions. The RI serves as the data collection mechanism for site and waste characterization, and for conducting treatability testing as necessary to evaluate the performance and cost of the treatment technologies and support the design of selected remedies. The FS provides for the screening, development and detailed evaluation of potential remedial alternatives.

This project will be performed in accordance with the US Army Corps of Engineer (USACE) Scope of Work dated June 28, 1988, and the U. S. Environmental Protection Agency's (USEPA's) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Law Environmental, Inc., Government Services Division (LEGS) will perform the data collection and analyses in order to evaluate the extent of constituent release at each of the sites based on the directed sampling program, and will compile, evaluate and report the results of the evaluation to the USACE in accordance with the guidance provided in the above mentioned documents.

1.1 SITE TOXIC AND HAZARDOUS SUBSTANCES

Based on prior investigations, the chemicals which have been detected in samples from the study sites at DDMT include the following groups and specific chemicals:

VOLATILE ORGANICS: 1,1-Dichloroethylene
Trichloroethylene
Trans-1,2-Dichloroethylene
Tetrachloroethylene
Chloroform
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
Methylbromide

METALS: Manganese

HERBICIDES

PESTICIDES/POLYCHLORINATED BIPHENYLS

PENTACHLOROPHENOL (with DIOXIN and FURAN)

MUSTARD GAS (THIODIGLYCOL)

LEWISITE (CHLOROVINYLARSINE DICHLORIDE)

OIL, GREASE & PAINT THINNER

METHYLENE CHLORIDE

This Sampling/Analysis and QA/QC Plan has been designed to monitor site media for these constituents. The purpose of this Plan is to provide protocols for all Sampling/Analysis and QA/QC regarding the DDMT RI/FS. The Plan covers project organization and responsibility, sampling, and analysis. It is Volume III of the DDMT Work Plan.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

2.1 PROJECT ORGANIZATION

The work activities for this project will be organized into four primary work areas: drilling and sampling, surveying, chemical analysis, and site assessment (Figure 2-1). LEGS will perform the drilling and sampling, and site assessment activities. LEGS has subcontracted with International Technology Corporation to perform the chemical analysis of the soil and water samples. A local surveying firm will be selected to survey the monitoring well and soil boring locations and prepare a site map. The Remedial Investigation Report (RI) and a Feasibility Study Report (FS) will be prepared by LEGS.

2.1.1 Law Environmental, Inc.

LEGS will provide the project management, engineering and analysis, and drilling and sampling through its in-house resources. Law Engineering, our parent company, was founded in 1946 as an Atlanta chemical testing laboratory, which then evolved into geotechnical and construction materials testing. Law has an excellent reputation in these basic engineering and testing areas. Law Engineering added environmental testing and analysis to its expertise in 1976. Law Environmental, Inc. became a wholly owned subsidiary of Law Engineering on January 1, 1987. LEGS will manage all of the field, laboratory, and office work related to the DDMT RI/FS.

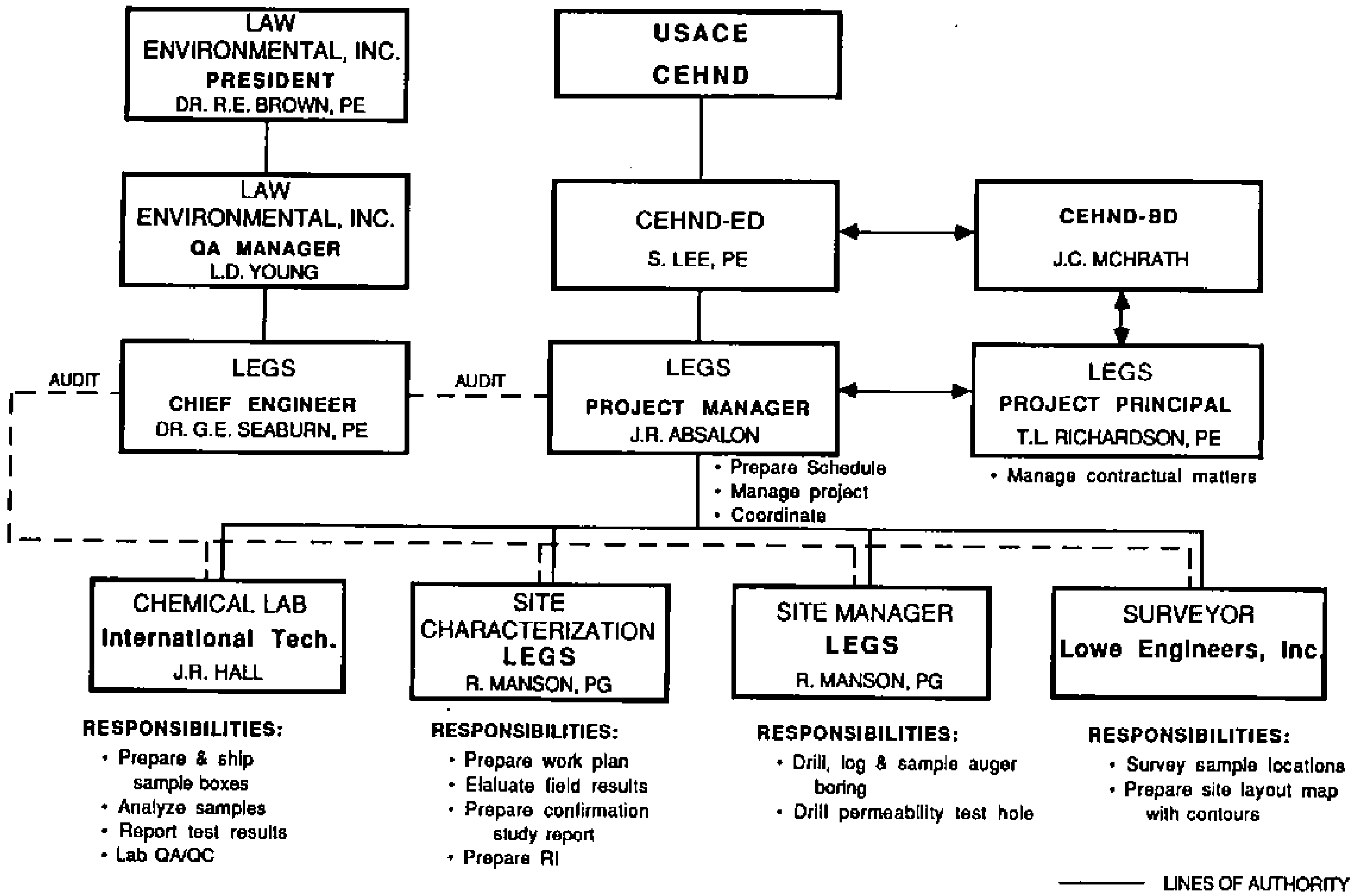
2.1.2 International Technology Corporation

International Technology (IT) is a full service laboratory plus a high hazard limited access facility located in Knoxville, Tennessee. The high hazard facility is operated for the analysis of extremely hazardous components such as dioxins and dibenzofurans. Specialties include: EPA Contract Laboratory Program (CLP) projects, analyses for dioxin/dibenzofurans and

FIGURE 2-1

PROJECT ORGANIZATION AND RESPONSIBILITIES

RI/FS AT DEFENSE DEPOT MEMPHIS, TN



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PCBs, metals, and hazardous waste incineration by products and mixed waste analyses. A list of ITs certifications can be found in Table 2-1. International Technology will be responsible for providing sample shipping containers, chain of custody documents, chemical analysis, report generation and laboratory quality assurance/quality control (QA/QC). IT will report directly to the Project Manager during all phases of the project.

All laboratory work is performed in accordance with approved USEPA, American Society for Testing and Materials and/or US Army protocols. In addition, QA/QC programs are maintained for both instruments and analytical procedures.

2.2 KEY INDIVIDUALS

Key project participants for the site investigation include the project manager, project principal, site manager, project chemist, health and safety officer, laboratory manager, and the field work parties. Described in the following paragraphs are the proposed project assignments and responsibilities, a list of individuals expected to serve in each capacity, and a brief synopsis of the participants related experience. Detailed resumes of the key individuals are presented in Appendix A.

- PROJECT MANAGER - Is responsible for overall management of the DDMT investigation. Coordinates between office and field personnel, manages administrative requirements, schedules, technical approach, implementation, and report preparation. Mr. John R. Absalon will serve as the Project Manager. He is a registered Professional Geologist in nine states, including Tennessee, with approximately 16 years experience in project management and hazardous waste site investigations. With LEGS, Mr. Absalon is a Senior Geologist.

TABLE 2-1

CERTIFICATIONS
ITAS - KNOXVILLE

National Approvals/Accreditations

American Industrial Hygiene Association
American Association for Laboratory Accreditation

State Certifications

California Department of Health Services
Florida Department of Health and Rehabilitative Services
South Carolina Department of Health and Environmental Control
New York State Department of Health
North Carolina Department of Public Health
Tennessee Department of Public Health
Utah Department of Health

Qualified by/Suitability Status by

New Jersey Superfund Program
New York State Superfund Program
U.S. Environmental Protection Agency Contract Lab Program (Organics, Inorganics, Dioxins)
Minnesota Superfund Program
Virginia Superfund Program
Tennessee Superfund Program
National Bureau of Standards
U.S. Army Corps of Engineers, Waterways Experiment Station
U.S. Army Corps of Engineers, Huntsville, Alabama
Tennessee Valley Authority

Memberships

American Council of Independent Laboratories
American Society for Testing and Materials

- PROJECT PRINCIPAL - Provides technical quality control, oversight and direction for all aspects of the site investigation and data evaluation. He serves as the senior reviewer of the engineering reports on the DDMT investigation. Mr. Thomas L. Richardson will serve in this capacity. He is a registered Professional Engineer in Tennessee with 15 years experience in geotechnical engineering and hazardous waste investigation. Mr. Richardson reports to the Chief Engineer of Law Environmental's Government Services Division, Dr. Gerald E. Seaburn.

- SITE MANAGER - Is responsible for implementation of Safety Program Plan, Soil Boring and Monitoring Well Installation Plan, and this Sampling and Analysis Plan during the field investigation phase. He reports directly to the Project Manager. Mr. Robert Manson will serve as the Site Manager for the investigation. Mr. Manson is a Professional Geologist with eleven years of experience as a Professional Geologist and three years of experience as a hydrogeologist.

- PROJECT CHEMIST - Is responsible for preparing and implementing the field sampling, preservation, chain-of-custody, and shipping activities. Mr. Vincent Tersegno is a chemist with five years experience in hazardous materials handling programs with LEGS. He has experience on RCRA and Superfund sites throughout the country. Specific experience includes preparation of sampling plans and coordination of sampling activities for several USACE site assessments.

- HEALTH AND SAFETY OFFICER - Oversees the Safety Program Plan for DDMT. He conducts personnel training, administers company hazard assessment and surveillance medical program, and coordinates with Site Manager for site safety. He is available for consultation during the actual investigation. Dr. Jack Peng is the Law Environmental Safety Officer. He is a registered Professional Engineer and a certified

Industrial Hygienist. Dr. Peng has approximately 13 years experience in hazardous waste investigations.

- LABORATORY PROJECT MANAGER - Is responsible for handling and analysis of water and soil samples received by the laboratory. This person also oversees sample travel through the lab, analytical procedures, quality control, reporting and sample disposal. Ms. Robyn M. Wagner is the Project Manager for this project. She is a biologist with over 9 years of technical and laboratory experience.

- WORK PARTY - Performs on-site tasks contained in this plan, including the soil borings, surveying and monitoring well installation under the direction of the Field Manager. The work parties include drilling crews and the surveying team.

2.3 PROJECT QA RESPONSIBILITIES

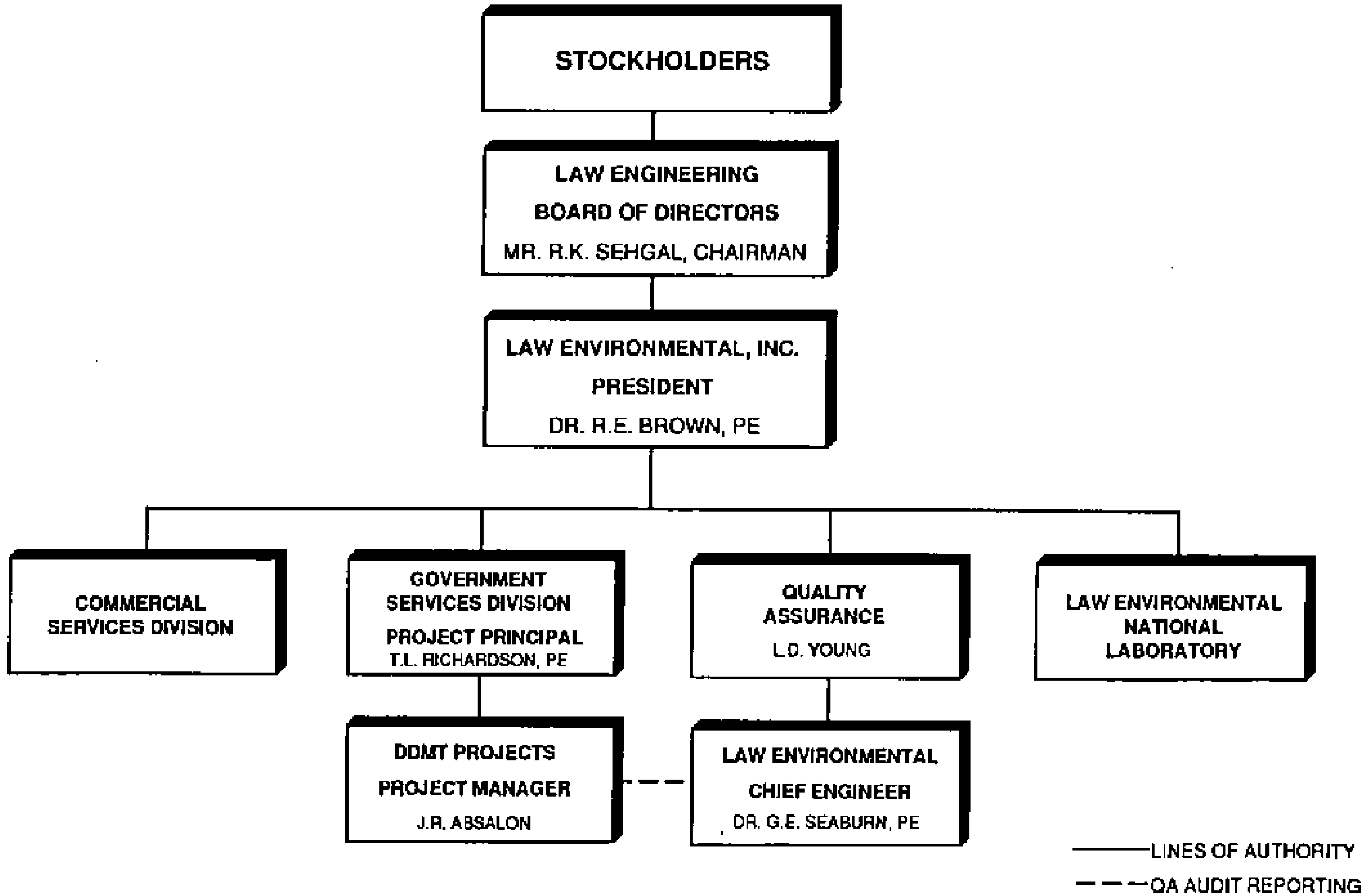
Law Environmental, Inc. has established a strong internal QA program with an associated QA manual, engineering procedures manual, equipment calibration procedures manual, and specialty manuals for hazardous waste site investigations and software documentation. Law Environmental employees use these manuals as the basis for conducting all company work within the QA program.

Dr. R.E. Brown is the President of Law Environmental, Inc. Dr. Brown is ultimately responsible for Corporate QA. The Corporate QA Office is managed by Mr. Larry Young, who is responsible for daily management and auditing Law Environmental's QA Program (Figure 2-2). Each Law Environmental branch office and subsidiary has a Chief Engineer and/or Scientist, who is the primary QA officer of that group. Dr. Gerald Seaburn is the Chief Engineer for this project. Thus the Law Environmental lines of QA responsibility and audit flow from Corporate QA (Dr. Brown and Mr. Young) through Dr. Gerald Seaburn to the Division level (Mr. Richardson) where project level audits occur. This line of QA is outside of the operational lines of authority.

FIGURE 2-2

PROJECT RELATIONSHIP OF CORPORATE ORGANIZATION AND QA RESPONSIBILITIES

RI/FS AT DEFENSE DEPOT MEMPHIS, TN



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2.4 ANALYTICAL LABORATORY QUALIFICATIONS

IT was selected by LEGS to perform the chemical analysis on the field samples. The IT laboratory in Knoxville was founded in 1962 to provide high quality, fully documented analytical data for industry. Quality assurance and quality control were built into the design of the laboratory and its operations. IT's comprehensive technical reports, with their fully integrated QA data, demonstrate the laboratory's commitment to provide credible and defensible data.

2.4.1 Laboratory Organization and Personnel

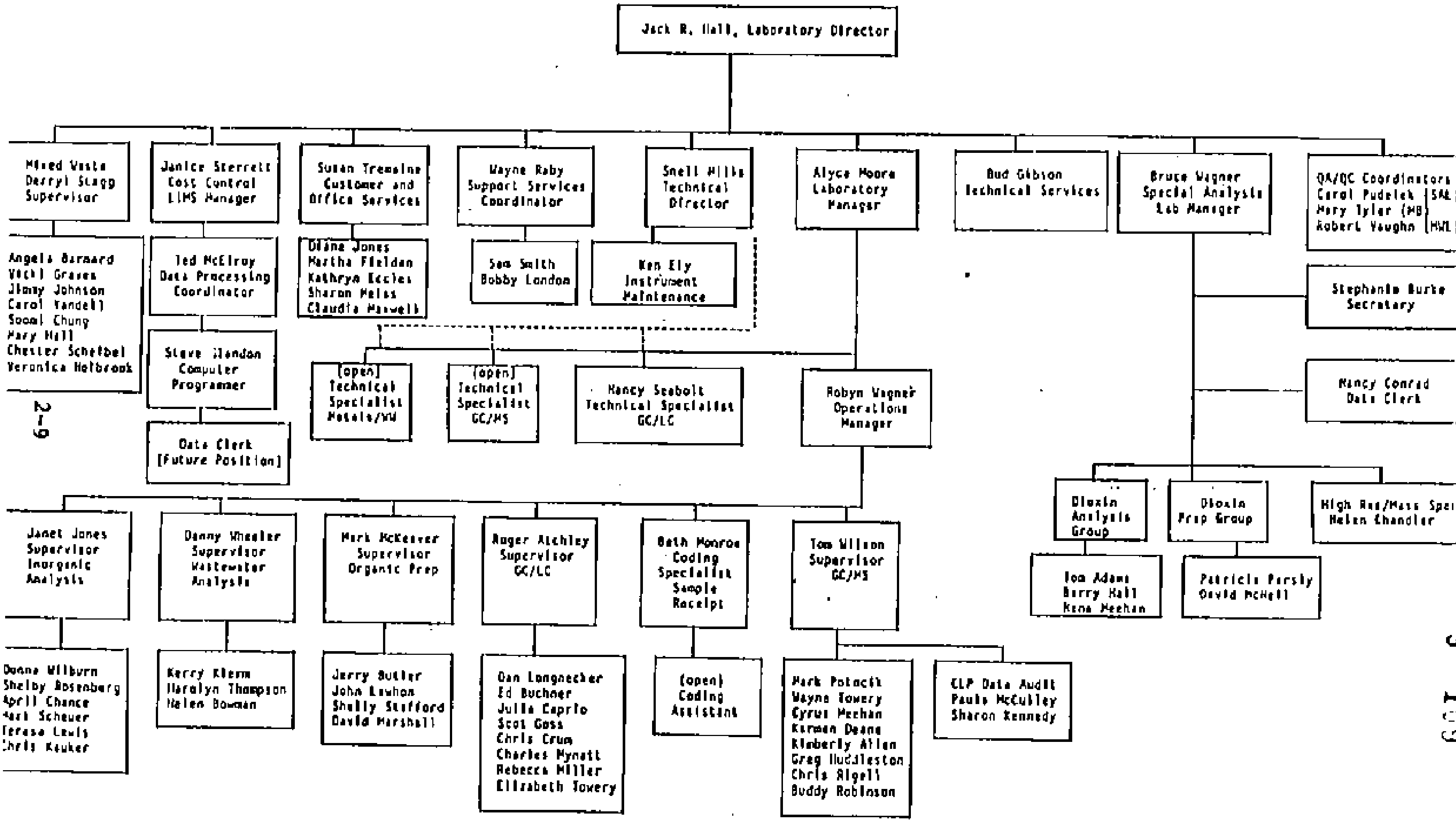
The overall organization of IT is shown in Figure 2-3. Specific personnel have been identified who are responsible for implementing the QA aspects of this project. IT designed this management organization and its management systems based on the many years of experience of the principals in the commercial laboratory business and believes it is the best system for efficiently managing the analysis of large volumes of samples while, at the same time, maintaining high quality and responsiveness to the specialized needs of individual clients. The elements of the overall IT management structure are presented in Appendix A.

2.4.2 Facilities and Equipment

IT Analytical Services (ITAS) consists of ten laboratories with a total area of over 130,000 square feet, including more than 90,000 feet of multi-functional, diversified laboratory work space. These laboratories employ the latest state-of-the-art designs in independent controls and operational isolation. They are zoned to provide safeguards against cross-contamination and arranged by work function to increase the efficiency of analytical operations. Since work functions or projects may vary, the laboratory areas are designed for flexibility. Several aspects of the laboratories worth noting are:

FIGURE 2-3

ORGANIZATIONAL CHART
IT Analytical Services - Knoxville



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- Large sample storage areas with isolation, refrigeration, and storage

- Isolated chemical and standard storage areas

- Large dedicated sample preparation areas

- Separate instrumentation areas

- Diversity of available hood systems to meet a variety of project needs

A key portion of the IT Special Analysis Laboratory is a limited access laboratory located in Knoxville, Tennessee, designed and equipped to provide total containment and isolation of hazardous materials to protect the laboratory

ITAS laboratories are fully equipped with manual and automated state-of-the-art instrumentation. The addition of autosamplers and data integrators to the majority of our instrumentation has enhanced our laboratory capacity while maintaining cost controls.

Instrumentation includes gas chromatograph/mass spectrometers and gas chromatographs with a wide range of detectors for the determination of trace organics, graphite furnace and hydride generator atomic absorption spectrophotometers and inductively coupled argon plasma spectrometers for the analysis of trace metals and additional instrumentation for wet chemical applications.

Instruments are calibrated prior to the analysis of each set of samples. In addition, routine maintenance is scheduled and performed by on-site instrument repair specialists. The ITAS program for calibration and maintenance is designed and implemented to ensure compliance with applicable EPA, NRC, and NQ-1 guidelines.

The total number of key instruments currently at the IT Knoxville laboratory is shown in the instrument summary presented as Table 2-2.

New instrumentation and equipment are regularly reviewed for consideration to achieve new analytical capabilities, improve precision and accuracy of current techniques, and reduce analytical costs while maintaining or improving quality.

Each IT laboratory utilizes state-of-the-art information management systems and analytical instrumentation for sample tracking, scheduling and reporting. These systems utilize both commercially available and customized software. They are used to track the course of a sample through the laboratory, from sample receipt to analysis to final report to archiving. The information systems in the individual IT laboratories are electronically linked to each other, to field stations and to central management.

In addition to laboratory reports consisting of Certificates of Analysis and/or EPA CLP data packages, IT Analytical Services has the capability of producing custom report summaries in client-specified formats. These reports can be delivered hard-copied and bound or in computer formats such as ASCII text, Dbase, or Lotus 123 files on floppy diskettes.

Analytical test results from GC, HPLC, GC/MS, AA, ICAP, IC, or Wet Chemistry are produced using a variety of instrumentation. Data from these analyses can be combined with the project/sample information in a relational database to provide sample/analysis data in a highly flexible format. ITAS can couple the database containing field and lab data with an assortment of proprietary and off-the-shelf software to perform statistical and trend analyses, to generate detailed graphical presentations of the data, and for sophisticated modeling and predictive analyses.

TABLE 2-2

LABORATORY EQUIPMENT
ITAS - KNOXVILLE
(MIDDLEBROOK PIKE LAB)

INSTRUMENT/EQUIPMENT	MANUFACTURER/MODEL
A. Metals	
2 AA/Emission Spectrophotometers	Instrumentation Labs/Model 151
AA/Emission Spectrophotometer	Instrumentation Labs/Model 951
AA/Emission Spectrophotometer	Thermal Jarrell Ash/Video 12E
Atomic Vapor Accessory	Instrumentation Labs/Model 440
Autosampler (for AA)	Instrumentation Labs/Plasma 254
Graphite Furnace Atomizer	Instrumentation Labs/Model 655
Graphite Furnace Atomizer	Thermal Jarrell Ash/188
ICAP Emission Spectrometer	Thermal Jarrell Ash/1100
B. Inorganics and Wet Chemistry	
Total Organic Carbon Analyzer	OI/Model 7000
TOC Autosampler	OI/Model 168-402
Ultraviolet Visible Spectrometer	Perkin-Elmer/Model 552
2 Sonicators	Tekmar/Model 500
C. Chromatography	
Gas Chromatograph	Perkin-Elmer/Sigma 2B
Gas Chromatograph	Varian/Model 3740 Dual EC
Gas Chromatograph	VG/Model Trio-2
Gas Chromatograph	Perkin-Elmer/Sigma 3
2 Gas Chromatographs	Tracor/Model 222
2 Gas Chromatographs	Tracor/Model T-560
2 Gas Chromatographs	Tracor/Model T-565
2 Gas Chromatographs	Varian/Model 3700
2 Gas Chromatograph Data Stations	Perkin-Elmer/Sigma 15
Autosampler (GC)	Perkin-Elmer/Model AS100B
2 Autosamplers (GC)	Tracor/Model 770
6 Autosamplers (GC)	Varian/Autosampler Aerographs 8000
2 Intergrators (GC)	Perkin-Elmer/LCI-100
3 Purge & Traps	Tekmar/LSC-2
High Performance Liquid Chromatograph	Perkin-Elmer/Series 4-10
High Performance Liquid Chromatograph	Perkin-Elmer/Series 3-B
Ion Chromatograph	Dionex/Model 2000i
Integrator (IC)	Dionex/Model 4270

TABLE 2-2

LABORATORY EQUIPMENT
ITAS - KNOXVILLE
(MIDDLEBROOK PIKE LAB)

(Continued)

INSTRUMENT/EQUIPMENT	MANUFACTURER/MODEL
D. Mass Spectrometry	
2 Gas Chromatograph-Mass Spectrometers/ DS	Finnigan/4000
Gas Chromatograph-Mass Spectrometer/ DS	Finnigan/4500
3 Gas Chromatograph-Mass Spectrometers/ DS	Finnigan/OWA 20/30
3 Autosamplers (VOA)	Tekmar/ALS
Dynamic Headspace Analyzer, Concentrator	Tekmar/4000, 4100
E. Computer Equipment	
Laboratory Computer	Perkin-Elmer/7500 Professional Computer
Laboratory Computer	Perkin-Elmer/Model 3600
Laboratory Computer	Perkin-Elmer/3230
22 CRTs	Perkin-Elmer
4 Personal Computer	IBM/AT
Color Graphic Terminal	Perkin-Elmer
7 Dot-Matrix Printers	Perkin-Elmer
2 Letter-Quality Printers	Perkin-Elmer
Color Plotter	Perkin-Elmer

The ITAS laboratory data management systems assure confidentiality of the client and all data collected and allows rapid access to sample status at client or management request. These systems provide more efficient sample tracking while minimizing sample turnaround and assuring data integrity.

3.0 SAMPLING

The objective of the DDMT field investigation is to determine the nature and extent of soil and groundwater contamination resulting from past operations at the facility. LEGS will then determine the potential risks to public health and the environment due to any constituent release and recommend appropriate remedial actions. To accomplish these objectives LEGS will collect representative samples of the site media for analysis.

3.1 SELECTION OF SAMPLING LOCATIONS

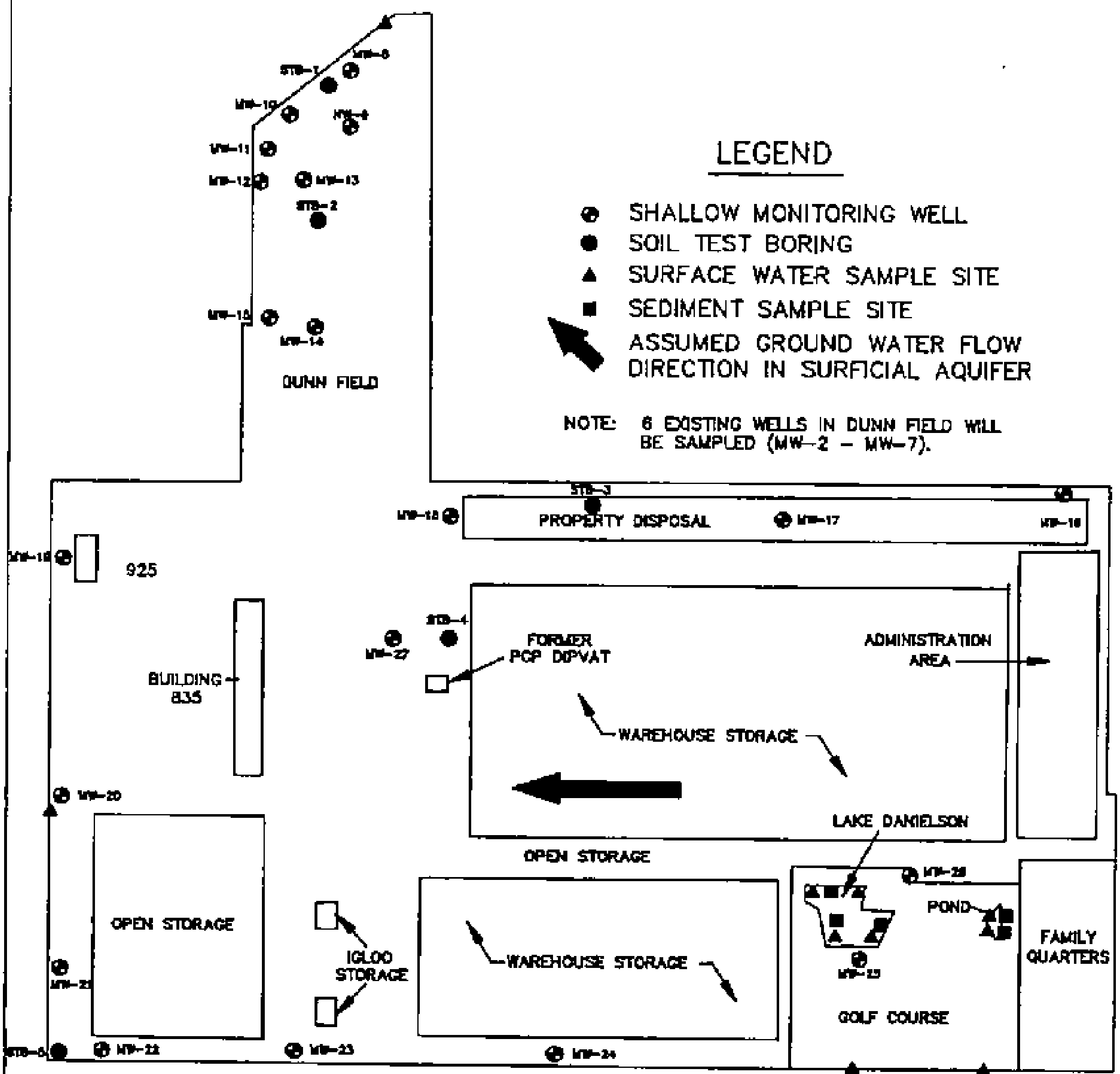
3.1.1 Introduction

Samples for chemical analysis at DDMT will include ground water, surface water, sediments, surface soils, and soils at depth. To accomplish the goals of the field investigation, extensive research on the part of the project team has gone into the selection of the sampling locations. The following sections discuss the rationale for the selection of specific sampling locations as well as figures depicting the proposed sampling locations. Additional discussion on this subject can be found in the Soil Boring and Monitoring Well Installation Plan Vol. II.

3.1.2 Soil Test Boring Locations

The purpose of the soil test borings will be to characterize the subsurface geology and to collect soil samples for chemical analysis. The soil test borings have been located to optimize both objectives. Figure 3-1 shows the proposed sampling locations for the main installation and Dunn Field. As shown on the figure the five borings form a north-south transect of the entire site. Two borings will be on the main part of the installation and three will be in Dunn Field. These locations will provide chemical samples and geologic data for the installation.

FIGURE 3-1
SAMPLING LOCATIONS
DEFENSE DEPOT MEMPHIS, TENNESSEE



SOURCE: GEOHYDROLOGIC STUDY NO. 38-26-0195-83, DDM, MEMPHIS, TN, 21 JUNE – 2 JULY, 1982

SCALE: 1"~1000'

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3.1.3 Monitoring Well Locations

A total of six ground water monitoring wells currently exist in the Dunn Field Area. These wells will be utilized in the LEGS sampling effort. As specified in the Scope of Work an additional 20 wells will be drilled. Twelve wells are proposed for the main installation and eight wells at Dunn Field. The proposed locations are shown in Figure 3-1. These locations have been selected based upon reviews of background data regarding geology, geohydrology, and past waste management practices at DDMT. Each location is near a potential waste source or is downgradient of waste sources.

3.1.4 Surface Soil Sample Locations

A total of 40 shallow (less than 18 inches in depth) surface soil samples will be collected by the LEGS staff. Past waste management practices and hazardous materials handling locations will be the guiding factors in choosing locations for the samples (Figure 3-1). The following table lists areas where samples will be obtained.

- Dunn Field Area
- Property Disposal Area
- PCP Dipvat Area
- Open Storage Area
- Lake Danielson/Pond Area
- Format Recoupment Area
- Paint Shop/Sand Blast Area

The exact locations of the sample points will be determined in the field by the Field Manager based upon visual inspection of the area and using best engineering judgment.

3.1.5 Surface Water Sample Locations

A total of ten surface water samples will be collected during this investigation. In an investigation such as this, surface water sample sites are influenced strongly by the relatively small amount of surface water present. Surface water is sampled where it is found (Figure 3-1). Lake Danielson which has experienced two documented fish kills possibly due to pesticide use, will be looked at closely. The following lists the samples by area and number:

- Lake Danielson	4 samples
- Golf course pond	2 samples
- South perimeter	2 samples
- West perimeter	1 sample
- North perimeter	1 sample

3.1.6 Sediment Sample Locations

A total of ten sediment samples will be collected from five locations at DDMT. Sediment samples will be concentrated in the golf course area because of past pesticide use practices (Figure 3-1). Each location will generate two samples; one from the sediment surface and a second from the nine inch depth. Three separate locations will be from Lake Danielson and two separate locations will be from the adjacent small pond.

3.2 SAMPLES TO BE COLLECTED

LEGS intends to collect twenty-six groundwater samples, ten surface water samples, ten sediment samples and fifty-five soil samples at the DDMT. In addition field control samples (i.e., duplicate samples, split samples, trip blanks and equipment blanks) will be collected. The breakdown of samples by sample type, sample location and analyte to be analyzed for is discussed in the following sections.

3.2.1 Soil/Sediment Samples

A total of 55 soil samples will be obtained from DDMT consisting of 15 soil samples collected from the five stratigraphic test borings and 40 shallow soil samples collected from various locations around the installation (Figure 3-1). No shallow soil sample shall exceed 18 inches in depth.

There will be a total of 10 sediment samples collected from five locations. Each location will generate two samples; one from the sediment surface and a second from the nine inch depth. Three separate locations will be from Lake Danielson and two separate locations will be from the adjacent small pond.

The QA/QC requirements for soil and sediment sampling will be met by collecting 13 QC samples. These will consist of 1 travel blank (water), 1 equipment blank (water), 5 field duplicates, 3 samples for matrix spikes (MS) and 3 samples for matrix spike duplicate (MSD). The QA/QC breakdown is shown in Table 3-1.

3.2.2 Ground-Water Samples

There will be a total of 34 samples collected for ground-water analysis. This includes 26 samples from shallow ground-water monitoring wells and 8 QC samples consisting of 1 travel blank, 1 equipment blank, 2 field duplicates and a total of 4 MS/MSD samples. Refer to Table 3-1 for the QA/QC breakdown.

3.2.3 Surface Water Samples

There will be a total of 15 samples collected for surface water analysis. This includes 10 surface water samples and 5 QC samples which include 1 travel blank, 1 equipment blank, 1 field duplicate and a total of 2 MS/MSD samples. Refer to Table 3-1 for the QA/QC breakdown.

TABLE 3-1

REQUIRED QUALITY CONTROL/QUALITY ASSURANCE SAMPLES

Task	Matrix Type	Number of Samples	Travel Blanks	Equipment Blanks	Field Duplicate	Total MS/MSD	Total QC
7	Ground Water	26	1	1	2	2/2	8
8	Surface Water	10	1	1	1	1/1	5
9	Sediment	10	-	-	1	1/1	3
	Shallow Soil	40	1	1	2	2/2	8
	Strati-graphic Soil	15	-	-	2	-	2

3.2.4 QC Samples

The distribution of QA/QC samples have been outlined in the above section on a per matrix basis. Field controls for soil, sediment and groundwater samples shall consist of at least one duplicate, one travel blank and one equipment blank for every twenty samples collected. Field controls for surface water will be collected at a one in ten frequency. Table 3-1 contains the complete QA/QC sample breakdown.

3.3 SAMPLE COLLECTION METHODS

Different sample types (i.e., grab vs composite, soil vs. ground water) require specific sampling procedures, as described herein. Care has been taken to determine the best practical sampling procedure that will result in obtaining representative samples. The samples must maintain the integrity of the original medium through collection, transportation and delivery to the analyst. The site samples will be collected and containerized (if necessary) as described in the following paragraphs.

3.3.1 Ground Water Samples

The subsurface is a unique heterogeneous environment. Gas exchange, biological and other chemical reactions and conditions are different from the surface environment. Ground water is somewhat insulated from surface temperature and pressure variations. Rapid and significant changes can occur in ground water samples upon exposure to the surface (i.e., sunlight, temperature and pressure). Therefore, ground water sampling is conducted in a manner to minimize interaction of the sample and the surface environment. The equipment and protocol for collecting ground water samples at DDMT is discussed in the following paragraphs.

3.3.1.1 Sampling Equipment

Many variations of ground water sampling equipment are available depending upon the objective of the sampling program. The DDMT ground water samples will be obtained with pre-cleaned PVC bailers. Pre-cleaning will be performed in the laboratory and in the field in accordance with recommended EPA procedures. Pre-cleaning shall consist of the following steps: (1) remove gross contamination using scrapers, (2) wash with a brush in a bucket filled with an Alconox soap solution, (3) rinse in a second bucket containing tap water and a brush, (4) spray with a 10% nitric acid rinse, (5) repeat Step 3, (6) spray with methanol, (7) rinse with deionized water, and (8) air dry.

3.3.1.2 Sampling Protocol

The sampling protocol at the DDMT will be as follows:

a. Measure Water Level - Using clean, non-contaminating equipment (i.e., an electronic level indicator or a fiberglass tape) determine the water level in the well and calculate fluid volume in the casing and screen.

b. Purge Well - Remove at least five well volumes with a PVC bailer or by pumping. If the well does not recharge fast enough to allow five well volumes to be removed, the well will be pumped or bailed dry and sampled as soon as sufficient recharge has occurred to allow collection of a sample.

c. Collect Sample - Lower the PVC bailer slowly until it contacts the water surface and allow the bailer to sink to the desired depth and fill with a minimum of surface disturbance. Care will be taken so that the sample is collected from the screened portion of the well and not from the overlying riser section or the underlying sand-sump section of the well. Slowly withdraw the bailer, being careful to prevent contact of the bailer line with the ground. Tip the bailer and slowly discharge the contents into the appropriate container. The process will be repeated as necessary to fill each container to the required volume. Samples to be analyzed for volatile organics will be collected first to minimize the effects of disturbance of the water surface in the well on the volatiles analysis. Sample containers will be filled completely leaving no air space above the liquid portion to minimize volatilization. Ground-water samples to be analyzed for dissolved metals will be filtered in the field through a filter membrane with 0.45 micron pore size. Sample containers and sample preservation are discussed in Sections 3.4 and 3.5, respectively.

d. <u>Label Sample</u> - Once the sample is collected, label each container providing the following data: sample identification number, project number, date, time, person sampling, intended chemical analysis, and preservative(s) added. Record the information in the bound field notebook and complete all chain-of-custody and request for analysis documents as discussed in Sections 3.6 and 3.7. The bound field notebook will have prenumbered pages and entries will be made in indelible ink. Data from the sampling episode will also be recorded on the Law Field Sampling Report form shown in Figure 3-2.

e. <u>Custody, Handling and Shipping</u> - Place the properly labeled sample bottle in the appropriate carrying container and maintain the sample at 4° C throughout the sampling and transportation periods. The shipping container will be an IT "Sample Shuttle" cooler. The lid of the cooler will be taped shut with the custody seals provided with each Sample Shuttle. Samples are shipped on the day collected from the site directly to the laboratory by overnight courier. Chain-of-custody and request for analysis documents are shipped in air-tight plastic bags in each container (taped

FIGURE 3-2

LAW FIELD SAMPLING FORM

RI/FS AT DEFENSE DEPOT MEMPHIS, TN

FIELD SAMPLING REPORT

LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION
KENNESAW, GEORGIA

JOB NO. ____
JOB NAME ____
DATE ____ TIME ____
SAMPLING POINT (LOCATION) ____
DEPTH ____

SAMPLE INFORMATION

SAMPLE I.D. NO.: ____

MATERIAL: ____ WATER ____ SOIL ____ SLUDGE ____ OTHER (LIST) ____

TYPE: ____ GRAB ____ COMPOSITE ____ OTHER (LIST) ____

HAZARDOUS?: ____ YES ____ NO ____ UNKNOWN

CONTAINER		NUMBER	PRESERVATIVE/ PREPARATION	COMMENTS
TYPE	VOLUME			

COMMENTS: (WELL PURGING VOLUME: SAMPLE APPEARANCE; ODOR; COLOR, ETC.)

____

____

FIELD MEASUREMENTS

PARAMETER	EQUIPMENT I.D.	RESULTS (UNITS)	COMMENTS

COMMENTS: (CALIBRATIONS, FIELD MODIFICATIONS, INSTRUMENT PROBLEMS)

____

____

GENERAL INFORMATION

WEATHER ____ AIR TEMPERATURE ____

SAMPLES SHIPPED TO: ____

SPECIAL HANDLING: ____

MODE OF SHIPMENT: ____ CAR/TRUCK ____ BUS ____ PLANE ____ COMMERCIAL VEHICLE

QA/QC

SAMPLE COLLECTED BY: ____ SAMPLING OBSERVED BY: ____

DISCREPENCIES: ____

to the inside of the lid) with applicable samples. The laboratory is notified by phone of the sample shipment. This process is discussed in detail in Sections 3.6 and 3.7.

3.3.2 Soil Samples

Split-spoon sampling, continuous sampling, and hand auger sampling techniques will be used to collect grab samples at 40 different shallow soil sampling locations around the site and at five soil test boring locations as described in Section 3.1. The depth of each sample from the soil test borings will based on photoionization detector (PID) readings during drilling. If there are no significant PID readings the samples will be obtained at depths judged by the Field Manager to represent the greatest potential for contamination (i.e., low permeability layers in the unsaturated zone, at the water table, etc.). The following sections present a discussion of equipment, procedures, and protocol for soil sampling at the site.

Grab samples for chemical analysis will be collected from soil sampling locations in borings drilled with a hollow stem auger. The Soil Borings and Monitoring Well Installation Plan discusses the soil sampling protocols that will be followed. Each piece of sampling equipment will be steam-cleaned before use to minimize potential cross-contamination.

Split Spoon or Continuous Sampling Protocol - The procedures for collecting soil samples with the hollow-stem auger and split-spoon sampler or continuous sampler will be as follows:

a. Collect Sample - Hollow-stem auger from the ground surface to the specified sampling depth. Obtain soil samples from the boring using a split-spoon sampler or continuous CME sampler at the specified depth intervals (see Section 3.2.1). The split spoons will be decontaminated between each sample for chemical analysis using the procedures described in Section 3.3.1.1. Transfer the sample into an appropriate sample container. After the boring is completed, steam-clean all of the sampling equipment to prevent cross-contamination. Samples to be analyzed for volatile organic compounds will be removed from the sampler first. The sample will be disturbed as little as possible to minimize volatilization of organic compounds in the sample. The remainder of the sample will be placed in a stainless steel mixing bowl. It will be mixed thoroughly before containerizing other samples (i.e., metals, duplicate/split samples, etc.).

b. Label Sample - Once the sample is collected, label the sample bottle with the appropriate sample tag providing the following data: sample identification number, project number, data, time, person sampling, analysis requested and preservative(s) added. Seal the sample containers with custody tape (for volatiles vials, tape the custody seal to the bottle cap). Complete all chain-of-custody documents and record the sampling event in the bound field notebook in indelible ink.

c. Custody, Handling and Shipping - Place the properly labeled and sealed containers in a plastic "ziplock" type bag and seal it. Place about three inches of inert cushioning and absorbing material (i.e., vermiculite) in the bottom of the cooler and arrange the sample bags in the cooler so that they do not touch. Pack the samples in ice (also in bags) and styrofoam packing beads or bubble wrap. Samples will be packed so as to maintain a temperature of 4° C. Seal chain-of-custody and request for analysis documents in air-tight plastic bags and tape them to the inside of the cooler lid. Tape the lid of the cooler shut with the provided custody seals. Samples will be shipped to the laboratory via overnight courier on the day they are collected. The laboratory will be notified by phone of the sample shipment.

3.3.3 Sediment Samples

A Wildco stainless steel Hand Corer will be used to collect the sediment samples from Lake Danielson and the adjacent pond.

a. Collect Sample - Stabilize the boat or work platform to assure as nearly as possible a vertical drop and recovery of the core sampler. Position the core sampler over the drop point and steady momentarily. With the line arranged to run freely, release the sampler. When the corer has stopped, take up the slack in the line and begin to retrieve. Lift the corer above the water surface and, keeping it as vertical as possible, bring it aboard the work station. Cap the end of the cellulose butyl acetate (CBA) core liner tube, (label bottom) release the valve, free the core liner, slide it from the core tube and cap the other end (label top). There will be one sediment sample collected from the sediment surface and one sediment sample collected at the 9 inch depth from each sediment core. Uncap both ends of the CBA core liner containing the sediment sample. Insert a stainless steel or teflon plunger into the CBA core liner end marked "bottom". Push the plunger gently so that the "top" sediment is being deposited into a stainless steel mixing bowl, cut the first six inches of this sediment thoroughly before containerizing the sample. Each sample will require two VOA vials and one 250 ml. glass wide mouth container. This sediment portion will be labeled surface. Following this procedure cut the next six inch sediment portion. (6 inch - 12 inch section) for the nine inch sample.

b. Label Samples - Same as previous protocol.

c. Custody, Handling, and Shipping - Same as previous protocol.

3.4 SAMPLE CONTAINERS

Samples for chemical analysis will be collected and placed in IT provided containers. Appropriate containers for the media and constituents under investigation at the site are identified in Table 3-2. All container caps will have Teflon liners. Vials for VOA samples will have Teflon-lined septa. Each container will be labeled giving the sample identification number, date, time, analysis requested, name of sampler, project number and preservative(s) added.

Prior to use at DDMT the sample containers and caps will be cleaned by the following procedures: hand-wash in Alconox or equivalent detergent solution at 150^{o}, rinse in hot tap water, rinse with cold tap water, rinse with distilled water. In addition, containers used for collection of samples to be analyzed for EPA organic priority pollutants will be cleaned in a manner appropriate to the test procedure. All sample containers and caps will either be purchased pre-cleaned by IT or will be cleaned at the IT laboratory and shipped to the site in a ready-to-use condition.

3.5 SAMPLE PRESERVATION METHODS

All of the samples will be stored and shipped on ice to maintain the temperature at approximately 4^{o} C. Additional sample preservation methods required by specific analyses are identified in Table 3-2. Water samples to be analyzed for metals will be checked to ensure that a $pH<2$ is attained.

3.6 SAMPLE IDENTIFICATION

Field sampling personnel must properly identify all samples taken in the field by using the sample tag attached to or affixed around the sample container (the samples will also have labels as specified in Sections 3.3.1 and 3.3.2). The sample tag must contain the site name; sample identification number; project

TABLE 3-2
SAMPLE CONTAINERS, PRESERVATIVES AND HOLDING TIMES

Parameter	Container[a]	Preservation	Holding Time
	SOIL SAMPLES		
Volatile Organics	40 ml glass VOA vials; teflon-lined septum, no head space	Cool, 4°C	14 days
Pesticides & PCBs	250 ml wide-mouth amber glass; at least 3/4 full	Cool, 4°C	7 days for extraction; 40 days for analysis
Extractable Organics	250 ml wide-mouth amber glass; at least 3/4 full	Cool, 4°C	7 days for extraction; 40 days for analysis
Metals	250 ml wide-mouth amber glass; at least 3/4 full	Cool, 4°C	6 months; (mercury - 28 days)
EP-Toxicity	250 ml wide-mouth amber glass; at least 3/4 full	Cool, 4°C	7 days for extraction; 40 anlayze within 28 days for Hg and 40 days for other metals.
	WATER SAMPLES		
Volatile Organics	40 ml glass vials; teflon-lined septum, no head space	Cool, 4°C store inverted	14 days
Pesticides & PCBs	1 liter glass bottle	Cool, 4°C	7 days for extraction; 40 days for analysis
Extractable Organics	1 liter amber glass bottle	Cool, 4°C	7 days for extraction; 40 days for analysis
Metals, Total	1 liter polyethylene bottle	HNO^3 to pH<2; Cool, 4°C	6 months (Mercury-28 days)

a All containers have teflon-lined lids

number; the date, time, and location of sample collection; designation of the sample as either grab or composite; notation of the type of sample (e.g., ground water, soil, surface water); identification of any preservative(s) added; and signature of the sampler. The sample tags are to be placed on the bottles so as not to obscure any QA/QC data on the bottles; sample identification information must be printed in a legible manner using indelible ink. Field identification information must be sufficient to enable cross-reference with the field notebook.

3.7 TRANSPORTATION AND CHAIN-OF-CUSTODY

Chain-of-custody procedures are intended to document sample possession from the time of collection to disposal in accordance with state and federal guidelines. For the purpose of these procedures, a sample is considered in custody of it is:

- In one's actual possession;
- In view, after being in physical possession;
- Locked so that no one can tamper with it;
- In a secured area, restricted to authorized personnel.

3.7.1 Chain-of-Custody Records

IT will provide coolers to transport the samples from the site to their laboratory in Knoxville, TN. These coolers will be metal and in good condition. IT will provide properly cleaned sample containers in each cooler. The type of container will vary depending on the analysis required. Coolers will be shipped from the site to the laboratory via overnight courier on the day of sampling whenever possible.

Chain-of-custody records are provided in each sample cooler. The custody record will be fully completed in duplicate, using black carbon paper where possible, by the field technician who has been designated by the Project Manager as being responsible for sample shipment to the laboratory for analysis. The information specified on the chain-of-custody records will contain the same level of detail found in the site logbook, with the exception that the on-site measurement data need not be recorded. The custody record will include, at a minimum, the following information:

- name of person collecting samples
- date and time samples were collected
- type of sampling conducted (composite/grab)
- location of sampling station

- number and type of containers used
- signature of LEGS field technician relinquishing samples to non-LEGS person such as Federal Express agent
- date and time of custody transfer to overnight courier

In addition, if samples are known to require rapid turnaround in the laboratory because of project time constraints or analytical concerns (e.g., extraction time or sample retention period limitations, etc.) the person completing the chain-of-custody record will note these constraints in the remarks section of the custody record.

If it is not practicable to seal all containers at a Federal Express office, they should be sealed beforehand. The duplicate custody record will therefore have the signature of the relinquishing field technician and a statement of intent such as "To Federal Express (Memphis Office), p.m. 01/31/89". The duplicate custody record is placed in a plastic bag, taped to the underside of the box lid, and the box closed. The container is then tightly bound with filament tape and, if required, may be padlocked at the discretion of the Project Manager. Finally, at least two custody seals are to be signed by the individual relinquishing custody and affixed in such a way so that the box cannot be opened without breaking them.

At the shipping agent's office, the relinquishing individual will put all the specific shipping data (airway bill number, office, time, date) on the original custody record which is to be transmitted to the laboratory. It is the Project Manager's responsibility to ensure that all are consistent and they are made part of the permanent job file maintained at IT.

At the laboratory, the sample custodian (hereinafter referred to as "custodian") will open the package, retrieve the duplicate record, and complete the "Received by Laboratory by" box by affixing his signature. The custodian will also fill in the "Method of Shipment:" box with the shipper's name (e.g., Federal Express) and airway bill number.

3.7.2 Custody Seals

Custody seals are preprinted adhesive-backed seals with security slots designed to break if they are disturbed. With the exception of VOA vials, individual sample bottles are sealed over the cap by the sampling technician. Sample shipping containers are sealed in as many places as necessary to ensure security. Seals are signed and dated before use. On receipt at the laboratory, the custodian will check (and certify by completing logbook entries) that seals on boxes and bottles are intact.

3.7.3 Laboratory Custody

Laboratory chain-of-custody procedures are intended to document sample possession from the time of sample receipt to disposal in accordance with state and federal guidelines.

All samples received at IT have chain-of-custody initiated at the time of receipt. All samples are logged into the master sample log and assigned an internal sample number. All pertinent sample information is recorded in the master sample log. Once samples have been logged in and the chain-of-custody is complete, copies of the chain-of-custody are distributed to all individuals that will be handling the samples as well as to the project and operations management personnel.

Details regarding IT standard chain-of-custody operating procedures are provided in the IT Standard Operating Procedures (SOP) for DDMT which have been provided, in their entirety, to the USACE Project Manager and Contracting officer at USACE's Huntsville Division (CEHND).

4.0 ANALYSES

4.1 PARAMETERS

Tables 4-1 and 4-2 illustrate the water and soil/sediment samples to be collected and the analyses to be performed respectively. The required analyses are all EPA approved methods.

4.2 ANALYTICAL METHODS

All chemical analyses will be performed by the LEGS subcontractor, IT. IT will perform all analyses using established EPA and/or USATHAMA methods. The analytical methods that will be used for this investigation are listed in Table 4-3. The complete text of the appropriate analytical methodologies are provided in the IT SOP and are available upon request from CEHND. The anticipated analytical method detection limits are provided in Appendix B.

4.3 LABORATORY QC/QA

Environmental measurements have inherent limitations arising from equipment problems, procedural deviations, and changes in ambient conditions. Most of these measurements are analyses made for extremely low concentrations of constituents and are subject to chemical interferences, instrument limitations and uncertainties that affect the accuracy of the determination. It is essential to minimize these factors so that the measurements accurately reflect the character of the sample collected.

All data gathered by LEGS during the course of this investigation or processed by the laboratory will meet objectives of accuracy, precision, sensitivity, completeness, representativeness, and comparability. These characteristics are defined in the following paragraphs.

TABLE 4-1

GROUND WATER AND SURFACE WATER SAMPLES
BASIC CONTRACT
REQUIRED ANALYSES AND APPROVED EPA METHODS

PARAMETERS	EPA METHOD	TASK 7 Ground Water Analysis FIELD	TASK 7 Ground Water Analysis QA/QC	TASK 8 Surface Water Analysis FIELD	TASK 8 Surface Water Analysis QA/QC
GC/MS for Volatile Organics	EPA 8240	28**	8	10	5
GC/MS for Semi-Volatile Organics	EPA 8250	26	8	10	5
PCBs/Pesticides	EPA 8080	26	8	10	5
Metals*	EPA 6010	26	8	10	5
Mercury (Hg)	EPA 7470	26	8	10	5
pH, temp, and conductance	Determined in field	Field	NA	FIELD	NA

* Metals by Method 6010 shall include: Antimony, Arsenic, Barium, Cadium, Chromium, Copper, Lead, Silver, Selenium, Nickel, and Zinc.

** Number of volatile organic analyses for Task 7 includes travel and equipment blanks from Task 9.

TABLE 4-2

SOIL AND SEDIMENT SAMPLES
BASIC CONTRACT
REQUIRED ANALYSES AND APPROVED EPA METHODS

PARAMETERS	EPA METHOD	Shallow Soil	Total QC	Sediment	Total QC	Stratigraphic Soils	Total QC
GC/MS for Volatile Organics	EPA 8240	40	8	10	3	15	2
GC/MS for Semi-Volatile Organics	EPA 8250	40	8	10	3	15	2
PCBs/Pesticides	EPA 8080	40	8	10	3	15	2
Metals*	EPA 3050+ 6010	40	8	10	3		2
Mercury (Hg)	EPA 7471	40	8	10	3	15	2
EP Toxicity	EPA 1310					15	2
pH, temp, and conductance	Determined in field	NA	--	NA	--	NA	--

* Metals by Method 6010 shall include: Antimony, Arsenic, Barium, Cadium, Chromium, Copper, Lead, Silver, Selenium, Nickel, and Zinc.

TABLE 4-3

APPROVED ANALYTICAL METHODS

Analysis	Analytical Methods
Water Samples:	
Volatile Halocarbons	EPA 8240
Volatile Aromatics	EPA 8240
Pesticides & PCBs	EPA 8080
Semi-Volatile Organics	EPA 8250
Metals:	
Antimony	EPA 6010
Arsenic	EPA 6010
Barium	EPA 6010
Cadmium	EPA 6010
Chromium	EPA 6010
Copper	EPA 6010
Lead	EPA 6010
Nickel	EPA 6010
Silver	EPA 6010
Selenium	EPA 6010
Zinc	EPA 6010
Mercury	EPA 7470
Soil Samples:	
Volatile Halocarbons	EPA 8240
Volatile Aromatics	EPA 8240
Pesticides & PCBs	EPA 8080
Semi Volatile Organics	EPA 850
Metals:	
Antimony	EPA 3050 + 6010
Arsenic	EPA 3050 + 6010
Barium	EPA 3050 + 6010
Cadmium	EPA 3050 + 6010
Chromium	EPA 3050 + 6010
Copper	EPA 3050 + 6010
Lead	EPA 3050 + 6010
Nickel	EPA 3050 + 6010
Silver	EPA 3050 + 6010
Selenium	EPA 3050 + 6010
Zinc	EPA 3050 + 6010
Mercury	EPA 7471
EP- Toxicity	EPA 1310

<u>Accuracy</u> - Accuracy is a measure of the bias in a system. Accuracy is defined as the degree of agreement of a measurement with an accepted reference or true value. To determine the accuracy of an analytical method, a sample spiking program will be conducted. The results of sample spiking will be used to calculate the quality control parameter for accuracy evaluation, the Percent Recovery (%R). The Percent Recovery is defined as 100 times the observed concentration, minus the sample concentration, divided by the true concentration of the spike.

$$\%R = \frac{X - T}{K} \times 100$$

where: X = Analytical result from the spiked sample
T = Analytical result from the unspiked aliquot
K = Known value of the spike
%R = Percent Recovery

<u>Precision</u> - Precision is the measure of the mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of standard deviation or Relative Percent Difference (RPD). Precision is inferred through the use of duplicate samples. RPD for each component is calculated using the following equation:

$$RPD = \frac{A - B}{(A + B)/2} \times 100$$

where: A = Replicate Value 1
B = Replicate Value 2
RPD = Relative Percent Difference

The calculated Percent Recovery and RPD will be summarized. The RPD data will be used to evaluate the long term precision of the analytical method.

Completeness - Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct or normal conditions. Over 90 percent of all data obtained on this project should be valid based upon evaluation of the quality control data.

Representativeness - Representativeness is the degree to which data accurately and precisely represent a characteristic population, a process control, or an environmental condition. Appropriate sampling procedures will be implemented so that the samples are representative of the environmental matrices from which they were obtained.

Comparability - Comparability refers to the degree to which one data set can be compared to another. Appropriate sampling, analytical and reporting processes will be standardized so that the samples of similar matrices may be compared. Data reporting procedures and standardized analytical methods are discussed in another section of this plan.

Sensitivity - The anticipated detection limits for each of the methods to be employed on this program are summarized in Appendix B. Actual method detection limits for each analysis will be calculated and reported in accordance with the procedures outlined in the IT SOP. All of the anticipated method detection limits meet the sensitivity requirements for the end use of the data.

QC Check and Corrective Action Procedures - The types and number of QC checks that will be inserted into the sample sets are summarized in the method-specific SOPs which are available upon request. These IT methods are consistent with the USEPA methods provided in SW-846. Corrective action procedures to be employed when results fall outside control limits are detailed in the IT laboratory QC procedures provided in the IT SOP. In general, the analytical QC procedures (e.g., numbers and types of QC samples, QC charts, etc.) are consistent with those described in the appropriate EPA methods in SW-846.

5.0 DATA ANALYSIS AND REPORTING

The procedures employed by IT to assure the validity and accuracy of data analysis and reporting are discussed in detail in the IT-SOP. The topics covered are described briefly below with reference to the appropriate sections of the IT-SOP:

Data Analysis Scheme - Procedure required to evaluate analytical results for individual analytes including units and equations required to calculate concentrations are discussed in the method specific SOPs.

Limits of Data Acceptability - Feedback systems used to identify potential problems and corrective actions measures taken when the limits of acceptability are exceeded, personnel responsible for initiating and carrying out corrective actions, and the demonstration of the re-establishment of control (Section 6.0 of the IT-SOP).

Data Management Systems - Procedures for the collection of raw data, data storage, data QA documentation and data security (Section 12.0 of the IT-SOP).

Responsible Individuals - Individuals involved in the reporting sequence are identified in Section 16.0 of the IT-SOP.

Data Reporting Formats - Data reporting procedures are described in Section 11.0 of the IT-SOP. IT will report all analytical results (including non-quantified concentrations) to LEGS. In the RI and the FS Engineering Reports, LEGS will only report the quantified concentrations.

Data Review Procedures - The standard data review procedures utilized by IT to insure the precision, accuracy and completeness of the analytical data are summarized in Section 10.0 of the IT-SOP.

6.0 PROGRAM CONTROLS

The following sections briefly describe the internal program controls that are incorporated into IT's SOP and will be followed in their entirety during this program.

6.1 CALIBRATION PROCEDURES AND FREQUENCY

Table 2-1 provided a complete listing of the appropriate laboratory instrumentation. IT's program for instrument calibration and maintenance is described in detail in the SOP-DDMT.

6.2 INTERNAL QC CHECKS

As discussed in section 5.0, IT's SOPs for internal QC checks are provided in their SOP.

6.3 PREVENTATIVE MAINTENANCE

Preventative maintenance is discussed in the IT SOP.

6.4 EXTERNAL CERTIFICATION

IT is currently certified by the State of Tennessee, Department of Public Health for the analysis of drinking water and wastewater, and the analysis of hazardous wastes associated with state-sponsored Superfund sites. It has numerous other certifications and qualifications listed in Table 2-1. The State Certifications are issued as a result of successful analysis of proficiency samples (including trace metals and organics) followed by an inspection of the IT laboratory to assess custody and documentation procedures.

IT is a qualified U.S. Environmental Protection Agency Contract Lab (CLP) in organics, inorganics and dioxins.

APPENDIX A

RESUMES

7. **Brief resume of Key Persons, Specialists and Individual Consultants anticipated for this project.**

a. **Name & Title:** Gerald E. Seaburn, Ph.D., PE.
Corporate Consultant/Vice President
Principal Hydrologist

b. **Project Assignment:** Principal-In-Charge

c. **Name of Firm with which associated:**
Law Environmental, Inc.

d. **Years experience: With This Firm** 12 **With other Firms** 10

e. **Education: Degree(s)/Year/Specialization**
PHD/1976/Water Resources Planning & Management
MSCE/1965/Hydraulic Engineering
BSCE/1964/Civil Engineering
BS/1962/Engineering

f. **Active Registration: Year First Registered/Discipline**
1968/Civil Engineering/FL/NY

g. **Other Experience and Qualifications relevant to the proposed project:**
Dr. Seaburn has 15 years of wide ranging experience with projects involving groundwater/surface water interaction throughout the State of Florida. Dr. Seaburn is an expert in computer modeling of flow and contaminant movement. Many of his projects have considered potential or actual groundwater contamination form municipal waste sites and industrial facilities. Dr. Seaburn has managed numerous hazardous waste assessments throughout Florida, including preparations of remediation plans and clean-up designs. Others have dealt with storm-water and other surface water control facilities. He has been active in both design and permitting phases of projects and has extensive experience in dealing with regulatory agencies.

7. **Brief resume of Key Persons, Specialists and Individual Consultants anticipated for this project.**

a. **Name & Title:** Jack Peng, Ph.D., CIH

b. **Project Assignment:**
Health and Safety Officer

c. **Name of Firm with which associated:**
Law Environmental, Inc. Atlanta, Georgia

d. **Years experience: With This Firm** 1 **With other Firms** 14

e. **Education: Degree(s)/Year/Specialization**
Ph.D/Environmental Health Science/Industrial Hygiene
MS/Environmental Health Science
BS/Forestry

f. **Active Registration: Year First Registered/Discipline**

1979/Certified Occupational Hearing Conservationist
1983/Certified Industrial Hygienist

g. **Other Experience and Qualifications relevant to the proposed project:**

Dr. Peng is the Director of Occupational Health and Industrial Hygiene. In this capacity he is responsible for all matters concerning Health and Safety for Law Environmental Inc. Dr. Peng and his staff provide training in accordance with EPA and OSHA for all personnel involved in the investigation of hazardous waste sites. In addition, training is provided to both our industrial and government clients. Prior to coming with Law Environmental, Dr. Peng was Industrial Hygiene Manager for the International Paper Company. He was responsible for all aspects of Industrial hygiene for the corporation and provided technical direction and supervision to the staff of Industrial Hygienists. Dr. Peng and his staff were responsible for all 110 facilities in the United States. Prior to his IP experience, he taught graduate and undergraduate courses in Environmental Sciences and Environmental Law and Policy.

Dr. Peng and his staff at Law Environmental develops 40-hr Health and Safety training course for hazardous waste operation to comply with OSHA 29CIR1910-120 which is part of Superfund Amendment Reauthorization Act of 1986. This course is being taught at ten cities nationwide.

7. Brief resume of Key Persons, Specialists and Individual Consultants anticipated for this project.

a. Name & Title: Thomas L. Richardson

b. Project Assignment:
Principal Engineer

c. Name of Firm with which associated:
Law Engineering

d. Years experience: With This Firm 12 With other Firms 3

e. Education: Degree(s)/Year/Specialization
MSCE/GEORGIA Institute of Technology
BSCE/DUKE University

f. Active Registration: Year First Registered/Discipline
1980/Civil Engineering

g. Other Experience and Qualifications relevant to the proposed project:

Mr. Richardson has directed a variety of confirmation and remedial investigations on RCRA, CERCLA, and DERA hazardous waste sites. He has a wide variety of experience within the hazardous waste field. He has provided direct project coordination for well installation, soil and water sampling, and laboratory testing. He has also been involved in evaluation of existing waste isolation facilities. He has managed the field work, sampling and analysis at an oil recycling facility, and he has directed confirmation studies adjacent to an existing chemical plant in Georgia. He was the principal investigator of the integrity of existing slurry walls surrounding a landfill. He also participated in the design of a new landfill facility. Mr. Richardson routinely prepares plans and conducts senior-level reviews for studies at DOD sites on active and abandoned facilities. He has directed the evaluation of groundwater impact on design and construction, including recommendations for groundwater control methods such as drains, dewatering systems, recharge systems, and waterproofing. He has also been involved in a wide range of geotechnical activities, including assessment for siting and preliminary design, investigations for final design, design consultation, and construction related activities. He has a wide range of geotechnical investigation experience including in-situ evaluation of modulus, strength, and premeability characteristics. His geotechnical construction experience includes inspection, quality control, and instrumentation.

7. Brief resume of Key Persons, Specialists and Individual Consultants anticipated for this project.

a. Name & Title: John R. Absalon

b. Project Assignment: Project Manager

c. Name of Firm with which associated:
Law Environmental, Inc. Atlanta, Georgia

d. Years experience: With This Firm 4 With other Firms 12

e. Education: Degree(s)/Year/Specialization
BS/1973/Geology

f. Active Registration: Year First Registered/Discipline
1980/Professional Geologist

g. Other Experience and Qualifications relevant to the proposed project:

Mr. Absalon has sixteen years of waste management, environmental geology, hydrogeology and geotechnical engineering experience. He has obtained significant regulatory compliance experience with USEPA, USACE, DOE, regional, state and local environmental water resource agencies. Mr. Absalon has managed Installation Restoration Program (IRP) projects for over seven years at a wide variety of DOD installations. He has performed 40 IRP studies at USAF AND DOD facilities located at installations in 30 states and one territory. He has proposed, planned, conducted, and reported the complete range of USAF IRP projects including PA/SI, Confirmation, Pre-RI, Remedial Investigations and Feasibility Studies (RI/FS), Remedial Action Plan (RAP), Closure and Post-Closure studies. He has experience in leading assessments (PA/SI), RI/FS, RAPs, and Environmental Impact Studies (EIS). Mr. Absalon has had direct "hands on" experience on the USAF IRP, USACE Defense Environmental Restoration Program (DERP), and such USEPA programs as CERCLA, SARA, RCRA, FIFRA, TSCA, and CWA. To date, he has completed seven RI/FS projects under CERCLA. Army Corps of Engineers Defense Environmental Restoration Program (DERP) and such USEPA programs as CERCLA, SARA, RCRA, FIFRA, TSCA and CWA. To date, he has completed seven RI/FS projects under CERCLA. He has personally managed and conducted IRP studies at experimental herbicide test grids, aerial weapon impact sites, nuclear accident sites, a reactor inactivation, low level radiation waste sites, experimental chemical laboratory waste sites (two AFLCs), POL depots, FPTAs, solvent spills, fuel spills, UST, sludge drying beds, lagoons, landfills, PCB spills, and EOD zones. He also performed ground-water quality studies at US Army chemical warfare sites, US Army and US Navy munitions loading facilities, and an ordnance manufacturing plant.

7. Brief resume of Key Persons, Specialists and Individual Consultants anticipated for this project.

a. Name & Title: Robert D. Manson, PG
Project Geologist

. Project Assignment:
Site Manager

c. Name of Firm with which associated:
Law Environmental, Inc. Atlanta, Georgia

d. Years experience: With This Firm 1 **With other Firms** 12

e. Education: Degree(s)/Year/Specialization
BS/1976/Geology

f. Active Registration: Year First Registered/Discipline
1988/Professional Geologist

g. Other Experience and Qualifications relevant to the proposed project:

Mr. Manson has 12 years experience as a professional geologist/hydrogeologist. He has supervised numerous geoologic projects and prepared written reports and support materials, such as geologic maps, cross-sections, tabular geologic analysis and geophysical exhibits. He has been responsible for site evaluation, selection, inspection, permitting, and compliance with regulations of E.P.A., U.S. Fish and Wildlife, National Park Service, and numerous state regulatory agencies. Mr. Manson has been responsible for all geologic aspects of drilling operations including logging, sampling, coring, sample description, fresh water aquifer protection and site safety. Mr. Manson has hydrogeologic experience in six states: Texas, Arkansas, Florida, Georgia, Kentucky and Tennessee. He has had experience on USEPA programs such as CERCLA, SARA, RCRA, FIFRA, TSCA, and CWA. Before coming to Law Environmental, Mr. Manson was in charge of all environmental compliance sampling and monitoring for the Kennedy Space Center, Florida.

7. **Brief resume of Key Persons, Specialists and Individual Consultants anticipated for this project.**

a. **Name & Title:** Frank W. Thomas

b. **Project Assignment:**
Site Geologist

c. **Name of Firm with which associated:**
Law Environmental, Inc. Atlanta, Georgia

d. **Years experience: With This Firm** _0_ **With other Firms** _4_

e. **Education: Degree(s)/Year/Specialization**
MS/1989/Geophysics
BS equiv/1986/Geology
BA/1978/Biology

f. **Active Registration: Year First Registered/Discipline**

g. **Other Experience and Qualifications relevant to the proposed project:**

Mr. Thomas has 4 years of geophysical and geological field experience. He has been a consultant on numerous projects where he was responsible for geophysical/geological data acquisition, analysis, and interpretion. This included written and oral reports, surface and subsuface mapping, preparation of cross sections, and stratigraphic interpretations. Mr. Thomas also has 2 years experience involving inverse and forward modeling techniques.

Professional Qualifications

Mr. Hall is a professional chemist with 23 years of experience in the collection and chemical analysis of environmental samples. His experience ranges from analysis of air, water, and milk for radiological constituents to analysis of a wide variety of chemical wastes, including experience in coordinating the analytical analyses and monitoring needs for the startup of coal liquification and chemical pilot plants. Currently, he has responsibility for the four IT analytical laboratories in the South. Mr. Hall has worked in a personnel supervisory and project management capacity for more than 16 years. The current projects and laboratories he is actively involved with are: method development for organic pollutants; compliance testing for specific CLP organics; testing of vents for treatment equipment design; analysis of hazardous pollutants in waste materials and environmental media for EPA and several industrial clients; testing of specific emissions from test burns for a variety of wastes; and Resource Conservation and Recovery Act analysis. Mr. Hall has been involved in the design of IT's Special Analysis, Mixed Waste, and Austin Environmental laboratories and is currently locating and designing a laboratory in Florida.

Education

B.S., Chemistry, Pennsylvania State University, University Park, Pennsylvania; 1962

Experience and Background

1984 - Present — Director, Southern Analytical Operations, IT Corporation, Knoxville Tennessee. Responsible for four analytical services laboratories that:

- Provide consulting and analytical services to industrial and governmental clients.
- Have full-service capabilities for analyzing environmental media and hazardous materials for inorganic and organic constituents at the parts-per-trillion through percent levels.
- Responsible for negotiating and managing large analytical services contracts, introduction of new technologies into the laboratories, budgeting, and quality assurance of the laboratories.

1982 - 1984 — Manager, Proposal Administration, IT Corporation, Knoxville, Tennessee. Was responsible for the evaluation of requests for proposals and managing the preparation of proposals for analytical, engineering, and technical services. Managed special analytical chemistry projects (EPA Interlaboratory Study for Priority Pollutants).

1980 - 1982 Vice-President and Manager of Analytical and Technical Services, IT Enviroscience, Division of IT Corporation, Knoxville, Tennessee. Managed the IT Enviroscience analytical laboratory and oversaw conceptual design through construction of a state-of-the art, limited-access analytical laboratory for analyzing extremely hazardous materials as an addition to the Knoxville laboratory and a 40-foot mobile laboratory with similar capabilities.

1975 - 1980 Manager, Analytical Services Department, Hydroscience, Inc., Knoxville, Tennessee. Was responsible for maintaining the analytical technology of Hydroscience at a high level of the state of the art. Utilizing extensive experience in chromatograpy, managed the Knoxville Laboratory Analytical Services Group, which specializes in the analysis of trace organic compounds in environmental matrices.

1968 - 1975 Senior Analytical Chemist, Michigan Division Analytical Laboratories, Dow Chemical Company, Midland, Michigan. Was responsible for the analysis of environmental samples in the Michigan Division Analytical Laboratory. Functions included development of procedures for in-plant monitoring of all discharges. Plants thoroughly studied included chlorinated benzene, 2-4 dichlorophenoxy acetic acid, 0,0 dimethyl-o(3.5.6-trichloro-2-pridyl phosphate), salicylic acid, glycol ethers, and polyethylene glycols.

Senior Analytical Chemist, Analytical Laboratories. Was responsible for research and method development for specific compound analysis of environmental samples (air, water, and solid wastes). Coordinated air- and water-sampling programs in production processes of phenol, alkyl phenols, chlorinated phenolics, chlorinated benzenes, and herbicides.

Analytical Chemist, Waste Control Department. Was responsible for analysis of samples from waste control research projects and waste water treatment plants. Involved in implementation of new analytical instrumentation in laboratory and on-stream at WWTP.

1964- 1968 Supervisor, Radiological Health Analytical Section, Pennsylvania Department of Health, Harrisburg, Pennsylvania. Primary function of group was the analysis of air, water, and milk for radiological constituents.

Supervisor, Public Waters Analysis Section, Division of Sanitary Engineering. Section was responsible for sampling and analysis of all public and drinking waters of Pennsylvania for compliance with federal and state regulations.

Chemist, Division of Sanitary Engineering, Industrial Wastewater Section. Was responsible for sampling and analysis of industrial wastewaters of Pennsylvania for compliance with state and federal discharge permits. Worked with other regulatory agencies on analytical method development and training programs. Experience included reviewing process chemistry of chemical, pharmaceutical, and formulating plants and requesting discharge permits. Evaluated potential of air and water discharges.

Publications

Hall, J. R., D. Stagg, and S. Clark, 1987, "Guidelines and Precautions in Collecting and Analyzing for Mixed Wastes," presented at the 1987 Winter Meeting of the American Nuclear Society.

Hall, J. R., 1983, "Quality Assurance in Environmental Trace Analysis," Liquid Chromatography in Environmental Analysis, edited by James F. Lawrence, Humana Press.

Hall, J. R., J. R. Florance, and D. L. Strother, 1981a, EPA Method Study, Method 604-Phenols, Contract No. 68-03-2625, submitted to Quality Assurance Branch, EMSL, EPA - Cincinnati, Ohio, for publication.

Hall, J. R., J. R. Florance, and D. L. Strother, 1981b, EPA Method Study 22, Method 612-Chlorinated Hydrocarbons, Contract No. 68-03-2625, submitted to Quality Assurance Branch, EMSL, EPA - Cincinnati, Ohio, for publication.

Hall, J. R., J. R. Florance, 1980, "Implementation of a Quality Assurance Program for the Determination of Trace Organics in Environmental Samples," presented at the 1980 Pittsburgh Conference.

Hall, J. R., C. W. Stuewe, R. C. Wilmolth, and J. L. Kennedy, 1979, Removal of Trace Elements from Acid Mine Drainage, EPA-600/7-79-101.

Hall, J. R., M. N. Wass, and R. A. Solomon, 1978, "Problems Encountered with the EPA Protocol Procedures for Screening of Industrial Waste Effluents for Priority Pollutants," presented at the 176th National Meeting, ACS.

Hall, J. R., 1977a, "Effect of New Effluent Guidelines on the Industrial Waste Treatment Laboratory," presented at Mid-Atlantic Industrial Waste Conference.

Hall, J. R., 1977b, "The Effect of Recent Legislation on the Industrial Wastewater Laboratory", presented at the New York Water Pollution Control Federation Meeting.

Hall, J. R., J. R. Florance, and R. D. Fox, 1976, "Role of New Techniques in Wastewater Analysis," presented at the 31st Purdue Industrial Waste Conference.

Hall, J. R., 1970, "Determination of Select Phthalates in Wastewater," presented at the 166th National Meeting ACS.

Hall, J. R., R. T. Richards, and D. T. Donovan, 1967, "A Preliminary Report on the Use of Silver Metal Membrane Filters in Sampling for Coal Tar Pitch Volatiles," Amer. Ind. Hyg. Assoc. J..

Professional Qualifications

Ms. Jones is a chemist experienced in the collection and analysis of environmental samples. Her recent experience includes management of a laboratory in Florida with responsibilities ranging from sales and marketing through sample collection, analysis, report and invoice preparation. Instrumental experience includes atomic absorption spectrophotometry (flame and flameless techniques), inductively coupled argon plasma, gas chromatography and total organic carbon analysis. She has experience with wet chemical techniques and environmental microbiology. As Sales and Customer Services Representative, she acted as liaison between customers and laboratory personnel, as well as promoting new business through telephone inquiries from potential customers. She is experienced in laboratory Quality Assurance/Quality Control (QA/QC) procedures and data review. Her writing experience includes data reports, Standard Operating Procedures, proposals, and QA project plans.

Education

B.A. (with honors), Chemistry, University of Tennessee, Knoxville, Tennessee; 1980
Flameless Atomic Absorption Analysis, Instrumentation Laboratories, Atlanta, Georgia; 1981
1982 Winter Conference on Plasma Spectrochemistry, Orlando, Florida; January 1982
American Management Association course, "The Basics of Telephone Selling Techniques"; April 1986

Experience and Background

1987 - Present <u>Inorganic Analyses Coordinator, IT Corporation, Knoxville, Tennessee.</u> Responsible for the following:

- Supervising the AA/ICP laboratory.
- Providing technical support to the Water/Wastewater laboratory.
- Supervising and/or performing sample preparation, analysis, data reporting, and departmental QC review for the metals laboratory.
- Analysis techniques include atomic absorption, atomic emission, graphite furnace AA, cold vapor AA for mercury, and inductively coupled plasma.

1986 - 1987 <u>QA/QC Coordinator, IT Corporation, Knoxville, Tennessee.</u> Responsible for all quality assurance functions pertaining to laboratory operations. Specific job duties include: initiating and supervising on-going QA programs; entering intralaboratory and external QC samples into the sample stream; determining and maintaining accuracy and precision data; writing and reviewing QA/QC programs, project plans, proposals, reports and Standard Operating Procedures; initiating, establishing, and maintaining preventive maintenance programs, corrective actions, method R&D, new employee QC training programs, and sample receipt and preservation protocols; handling matters pertaining to ITAS accreditations, certifications, and outside QA audits and inspections; and supervising inventory and quality control of reagents, calibration standards, and Standard Reference Materials.

1984 - 1986 Sales and Customer Services Representative, IT Corporation, Knoxville, Tennessee. Responsible for normal telephone inquiries from potential clients, including intercompany requests, quoting prices and answering client requests on sample status. Works with sales and marketing on proposals.

1983 - 1984 Laboratory Manager, Envirolab, Briley, Wild & Associates, Ormond Beach, Florida. Responsible for marketing and client relations, sample collection, sample analysis, report and invoice preparation. Analytical departments included atomic absorption, gas chromatography, total organic carbon, wet chemistry, and microbiology.

1980 - 1983 Group Leader, Atomic Absorption, IT Corporation, Knoxville, Tennessee. Responsible for scheduling technicians, sample preparation and all analyses by atomic absorption (flame and flameless) and inductively coupled argon plasma.

1979- 1980 Accounting Clerk, Plasma Alliance, Production Statistics, Knoxville, Tennessee. Responsible for plasma inventory control. Also prepared expense reports and cash reports.

1977 - 1979 Office Assistant, University of Tennessee, Knoxville, Tennessee. Responsible for general office duties including typing, filing and reception for two U.T. departments - math and athletics.

1976 - 1977 Assistant Bookkeeper, Frank Wylie Realty, Knoxville, Tennessee. Responsible for maintaining and balancing the books for all departments including rental properties. Also worked as backup receptionist.

Professional Affiliations

American Chemical Society
Florida Society for Environmental Analysts

Professional Qualifications

Mr. Klemm's education includes organic chemistry, inorganic chemistry, environmental chemistry, as well as zoology, microbiology, botany, anatomy and physiology, and genetics. He has taught science courses at the high school level.

Education

B.S., Biology, Environmental Studies, and Secondary Education, Manchester College, North Manchester, Indiana; 1981

Experience and Background

1985 - Present — Lab Technician, IT Corporation, Knoxville, Tennessee. Responsible for the following:

- Measuring the quantity of the following parameters in water and soil samples: cyanides, pH, phenols, orthophosphates, total phosphorus, biochemical oxygen demand (BOD), chemical oxygen demand (COD), chloride, carbon tetrachloride, oil and grease, fluoride, sulfate, nitrate, nitrite, total dissolved solids, total suspended solids, total settleable solids, ammonia, total kjeldahl nitrogen, surfactants, hexavalent chromium.
- Assisted with setup of wet chemistry department for mixed waste radiological lab.

1984 - 1985 — Salesman/Manager Trainee, Color Tile Incorporated, Knoxville, Tennessee. Assisted manager in the daily operations of a retail store. Responsible for pricing merchandise, unloading warehouse trucks, stocking merchandise, taking physical inventories, and selling merchandise to customers.

1982 - 1984 — Dorm-Master/Teacher/Coach, The Harvey School, Katonah, New York. Responsible for teaching seventh grade life science, eighth grade physical science, ninth grade earth science, and tenth grade biology. Dormitory duties included supervising ten to thirteen seventh, eighth, and ninth grade boys. Coached seventh grade soccer, seventh and eighth grade ice hockey, and high school tennis.

1982 — Substitute Biology Teacher, Lake Ridge Academy, North Ridgeville, Ohio. (Replaced full-time teacher who was on maternity leave). Taught seventh grade general science, ninth grade biology, and tenth grade ecology.

1981 - 1982 — Chain O'Lakes State Park, Albion, Indiana. Responsible for the state parks interpretive activities, such as nature hikes, animal displays and talks. Also designed and built display cases for nature center.

Professional Qualifications

Ms. Moore has fourteen years of experience in analytical operations, supervision and management, and extensive experience in all aspects of sample preparation and analysis of environmental samples for metals, anions, classical parameters and organic analysis, as well as experience in microbiology, biological and aquatic samples and EP Toxicity extraction techniques for waste disposal. She has extensive experience in laboratory scheduling, writing and evaluating reports. In addition, she possesses background in screening applicants and handling personnel problems.

Education

- Gas Chromatography Course, Southern Analytical, Knoxville, Tennessee; January 1978
- Perkin-Elmer One Day Seminar, Infrared, Knoxville, Tennessee; April 1976
- "Instrumentation and Application of Liquid and Gas Chromatography", Perkin-Elmer Seminar, Knoxville, Tennessee; 1975
- "Atomic Absorption Seminar", Varian Instrument Division, Knoxville, Tennessee; 1973
- "Techniques of Solid Waste Management", Knoxville, Tennessee; January 1972
- "Microbiological Analysis of Water and Wastewater", Millipore Workshop, Chattanooga, Tennessee; September 1972
- "Society for Applied Spectroscopy", Eleventh National Meeting, Dallas, Texas; September 1972

Experience and Background

1971 - Present — Laboratory Manager, IT Corporation, Knoxville, Tennessee. Former Lab Manager at Stewart Laboratories, Inc., which was acquired by IT Corporation in July 1981. Responsible for supervision of all analytical groups, covering a two-shift operation and involving:

- Scheduling projects, shifting laboratory personnel to meet changes in work loads, evaluating data and writing reports, expansion and changes in laboratory facilities, instructing new employees and coordinating all day-to-day operations.
- Handles client calls dealing with technical questions and sales and customer service.
- Works closely with quality control coordinator to assure continued excellent quality of laboratory operations.
- Assists IT Field operations where possible and as needed.

- Provides support to field operations, evaluates data and compiles reports.
- Assists analytical groups by actual "hands on" analytical testing. Trains new personnel and assists in interviewing and hiring of personnel.
- Schedules and coordinates large government projects.

1961 - 1968 <u>Assistant Manager and Bookkeeper, Cashier, Robert Hall Clothes, Knoxville, Tennessee.</u> Handled all bookkeeping duties and managed store operations in manager's absence.

Professional Qualifications

Mr. Mills is an experienced analytical chemist in gas chromatography (GC) and gas chromatography/mass spectrometry (GC/MS) methods and equipment. He has performed analyses of waste materials and environmental samples in laboratory and field laboratory operations. Mr. Mills also has experience in computer services and maintenance, including programming and development of several custom programs and specialized libraries for the quantitative analysis of priority pollutants by GC/MS/DS.

Education

B.A., Chemistry, Maryville College, Maryville, Tennessee; 1979

Experience and Background

1986 - Present   Technical Director, IT Corporation, Knoxville, Tennessee. Responsible for current laboratory technology growth and the introduction of new techniques for analysis of complex environmental matrices. Responsibilities include:

- Technical review of operations.
- Project management - large multimatrix and multiparameter projects.
- Review and recommend capital expenditures.
- Methodology and Standard Operating Procedure approval.
- Troubleshooting in technical areas requiring assistance with project unique analytical chemistry problems.

1979 - 1986   Group Leader, IT Corporation, Knoxville, Tennessee. Responsible for all GC/MS analytical services at IT Analytical Services. Schedules work load, supervises analytical chemists and instrument maintenance of the GC/MS/DS systems. Responsible for:

- Ambient air analysis on EPA contracts and for coordination and preparation of all sampling container kits sent out to clients.
- Involved extensively in confirmation of polychlorinated biphenyls (PCBs) by GC/MS involving transformer oil; environmentally degraded PCBs in biological tissues, soil, sediment, and sludge; PCBs and products of incomplete combustion from incinerator test burns; and has developed a number of custom GC/MS methods for this purpose.
- Project Manager for Environmental Protection Agency-Contract Laboratory Program (EPA-CLP) for government contracts.

Professional Qualifications

Nancy Seabolt has over ten years' experience in sample preparation and chemical analysis of environmental samples, including analysis of air, soil, water, biological tissues and miscellaneous types of waste samples for pesticides, polychlorinated biphenyls (PCB's) and trace organic compounds. She also has experience with gas chromatography using various detectors, high performance liquid chromatography, total organic halogen and other organic analysis techniques, as well as some experience with Atomic Absorption (AA) and gas chromatography/mass spectrometry (GC/MS).

Education

M.S., Chemistry, University of Georgia, Athens, Georgia; 1977
B.S., Chemistry, North Georgia College, Dahlonega, Georgia; 1973

Experience and Background

1986 - Present — Technical Specialist for Gas and Liquid Chromatography, IT Corporation, Knoxville, Tennessee. Responsible for:

- Method development for GC and HPLC, as well as troubleshooting instrument and project problems.
- Evaluating new instruments and techniques in addition to reviewing and updating current methodology.
- Bringing new instruments on-line and training technicians in their use.
- Assisting in technical proposals and project design.

1985 - 1986 — Technical Manager for Gas and Liquid Chromatography, IT Corporation, Knoxville, Tennessee. Responsibilities included scheduling of analyses and supervision of both chemists and technicians; method development for GC and HPLC, as well as, troubleshooting instrument and project problems; evaluating new instruments and techniques in addition to reviewing and updating current methodology; bringing new instruments on-line and training technicians in their use; and assisting in technical proposals and project design.

1978 - 1985 — Analysis Coordinator, Chromatography and Absorption, IT Corporation, Knoxville, Tennessee. Direct supervision of all organic analyses at ITAS with the exception of GC/MS. Areas of responsibility included organic sample preparation, GC, HPLC, Total Organic Carbon (TOC), Total Organic Halogens (TOX), Ultraviolet (UV)-visible, infrared, and special applications. Intermittant experience with GC/MS, both running samples and interpreting data. In addition, conducted method development in organic analysis. Supervised three chemists and two technicians.

1976 - 1978 <u>Pesticide Residue Analyst, University of Georgia Cooperative Extension, Athens, Georgia</u>. Conducted pesticide residue and trace metal analysis in feed ingredients, biological tissues, and soil and water samples. Techniques included gas chromatography, HPLC, and flame and flameless atomic absorption. Developed method for analysis of arsenic in chicken parts.

1973 - 1975 <u>Graduate Research Assistant in Organic Photochemistry, University of Georgia</u>. Involved in organic photochemistry. Participated in study of photodegradation products of 2,4-D.

Publications

Seabolt, N. D., P. B. Bush., R. S. Halbrooks, and J. H. Jenkins, 1980, "Mercury Accumulation in Georgia Otters", presented at the River Otter Research Workshop, Florida State Museum, March 27-29, 1980, Gainesville, Florida.

Seabolt, N. D., 1977, "An Investigation of the Segmental Mobility of 8-Ketohexadecyltrimethylammonium Bromide," Master's Thesis, University of Georgia, Athens, Georgia.

MARY E. TYLER

Professional Qualifications

Mary Tyler is experienced in collecting chemical and biological samples for analyses of water and wastewater, and has done extensive work and study involved in anaerobic waste treatment systems and the gas chromatographic analyses of such systems - influents, effluents and by-products. She has been responsible for coordinating the commercial GC analyses in her group. She also did calculations and QC review of data. Currently, she is Quality Control Coordinator.

Education

M.S., Environmental Engineering, University of Notre Dame, Notre Dame, Indiana; 1984
B.A., Biology, Indiana University, Bloomington, Indiana; 1980

Experience and Background

1987 - Present — QA/QC Coordinator, IT Corporation, Knoxville, Tennessee. Responsible for all quality assurance functions pertaining to laboratory operations. Specific job duties include:

- Initiating and supervising on-going QA programs.
- Entering intralaboratory and external QC samples into the sample stream.
- Determining and maintaining accuracy and precision data.
- Initiating, establishing, and maintaining preventive maintenance programs, corrective actions, method R & D, new employee training programs, and sample receipt and preservation protocols.
- Handling matters pertaining to ITAS accreditations, certifications, and outside QA audits and inspections.
- Supervising inventory and quality control of reagents, calibration standards, and Standard Reference Materials.

1984 - 1987 — Chemist, IT Corporation, Knoxville, Tennessee. Experienced in analyzing extracts for PCBs, priority pollutant pesticides, city water pesticides and herbicides. Experienced also in total organic halide and total organic carbon, gasoline and diesel fuel analysis. Responsible for the commercial gas chromatography analysis and calculations and miscellaneous organics sections of the GC Department.

1982 - 1984 — Engineering Assistant, Elkhart Wastewater Treatment Plant, Elkhart, Indiana. Conducted solids balance and routine calculations of daily operating data, supervised and managed pilot tests for plant expansion, assisted in operator and laboratory technician training programs and prepared monthly operating reports.

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1980 - 1982 Engineering Assistant and Laboratory Technician, TenEch Environmental Enginners, Inc., South Bend, Indiana. Conducted chemical and microbiological analyses of water and wastewater, trained laboratory technicians, managed and operated an anaerobic wastewater treatment project, participated in aerobic treatability study, prepared equipment and trained personnel for field sampling projects, performed engineering support activities such as data calculating, report preparation and drafting.

1979 - 1980 Laboratory Technician, Indiana University, Bloomington, Indiana. Worked part-time in the microbiology laboratory of the Environmental Health and Safety Department. Collected and analyzed campus milk, drinking water and stream water. Prepared weekly laboratory reports and maintained lab.

ROBYN M. WAGNER

Professional Qualifications

Robyn Wagner has eight years of experience in laboratory operations management, analytical laboratory supervision, project design, project management, analytical chemistry, and biology/chemistry research. She is experienced in the supervision of analytical, mobile, and biological/toxicological laboratories and competent in the use of gas chromatography, high performance liquid chromatography, DC argon plasma emission spectroscopy, infrared spectroscopy, classical wet methods, and programming in BASIC.

Education

B.S., Biology, Rutgers University, New Brunswick, New Jersey; 1981

ACS Short Courses:
Capillary Gas Chromatography: Techniques and Problem Solving; 1983
Effective Management Techniques; 1984
Effective Management Techniques for Chemical Analysis Laboratories; 1985

Experience and Background

1986 - Present: Operations Manager, IT Corporation, Knoxville, Tennessee. Responsible for management of daily laboratory operations; review all analytical data and report to Laboratory Manager for approval; handle client calls dealing with technical questions, sales, and customer service; supervise quality control activities performed as part of routine analytical operations; schedule projects and set priorities; responsible for supervision of group supervisors.

1985 - 1986: (On special assignment), IT Corporation, Knoxville, Tennessee. Assigned to the Knoxville analytical laboratories to expand technical expertise and develop working knowledge of all laboratory areas including laboratory information and data management, water and wastewater analyses, metals analyses, organic preparation, GC/LC, GC/MS and dioxin/furan analyses.

1981 - 1985: Laboratory Supervisor, IT Corporation, Edison, New Jersey. Supervised a group of seven chemists and two technicians to provide analytical support to the USEPA under EERU Contract No. 68-03-3069. Established work plans, budgets and manpower forecasts for both R+D and emergency response activities, and was responsible for sampling and analytical expenditures of $1,000,000. covering more than 100 different EERU projects. Directed research projects to evaluate equipment and develop rapid methodology for use onboard EPA's mobile laboratory. Supervised and performed analysis of hazardous materials in complex environmental

Professional Qualifications

Thomas Wilson has been a gas chromatography/mass spectrometry (GC/MS) chemist since 1978. He worked in GC/MS pollutant analysis for nine years, and has recently served as Group Leader for major effluent guidelines isotope dilution contract, and now is the GC/MS Group Supervisor. Chemistry, electronics, and computer programming background qualify him for problem solving associated with interpretation and evaluation of raw analytical data and development of programs specifically designed to perform those functions. He has extensive experience in electronics and computer programming, having programmed in machine, assembly, and higher languages for several minicomputers, such as TI 980, PNP, and NOVA series. He was listed in Journal of Analytical Chemistry at the University of Tennessee in 1972 as its outstanding undergraduate analytical chemistry student.

Education

A.B.D., Chemistry, University of Tennessee, Knoxville, Tennessee; 1976
B.A., Biology, Vanderbilt University, Nashville, Tennessee; 1968

Experience and Background

1986 - Present — GC/MS Group Supervisor, IT Corporation, Knoxville, Tennessee. Responsible for:

- Coordinating and prioritizing projects.
- Reviewing and overseeing QC on all analyses.
- Training personnel.
- Purchasing for GC/MS needs.
- Expediting and improving procedures in GC/MS group as a whole.
- Commercial and CLP analyses, including special projects, to cover all phases of GC/MS work.

1978 - 1986 — Group Leader for Special EPA Projects, IT Corporation, Knoxville, Tennessee. Responsible for effluent guidelines work, and for GC/MS extractables analyses for hazardous waste contracts and all phases of GC/MS priority pollutant analysis, including development and optimization of procedures. Also responsible for Finnigan 4000 operation; GC/MS analysis including priority pollutant VOA's, base neutrals, and acid extractables, as assigned; application of GC/MS and GC techniques to wastewater analysis.

1972 - 1976 — Department of Chemistry, University of Tennessee, Knoxville, Tennessee. Conducted recitation classes and laboratories for various freshman courses, administered and proctored tests and exams, graded tests and laboratory papers.

matrices using standard, as well as, non-standard methodology, and a variety of analytical techniques (GC/MS, GC, HPLC, IR, TOC, DCP emission spectroscopy). Designed and directed extent of contamination studies. Responsible for the development and implementation of internal quality control procedures to ensure reliable and statistically sound data generation. Designed and managed an external quality assurance program to assure the validity of environmental measurements made during the testing of EPA prototypical hardware, including the mobile incinerator and the carbon regenerator. Responsible for the daily operation of EPA's central and mobile laboratories.

1980 - 1981 Laboratory Technician, USEPA-OHMSB, Edison, New Jersey. Performed methods development research and environmental sample analyses. Preparation of rapid analytical methods for publication. Performed sample analyses onboard mobile laboratories during emergency response activations. Experience in repair and maintenance of analytical instruments.

1979 - 1980 Laboratory Technician, USEPA-Region II, Edison, New Jersey. Performed acute and chronic aquatic toxicology tests in support of the National Pollution Discharge Elimination Program. Assisted in the design of a flow-through aquatic bioassay system for the Surveillance and Analysis Division, Biology/Toxicology Laboratory. Maintained and cultured bioassay test organisms. Responsible for the daily operation of the laboratory. Conducted independent research of the life cycle of *Daphnia magna*.

1979 US Forest Service, Camptonville, California. Participated in the biology intern program.

Professional Affiliations

Member of the American Chemical Society
Member of the ACS Environmental Chemistry Division
Member of the American Institute of Chemists

Publications

Wagner, R., et. al., March 1984, "A Comprehensive Strategy for On-Site Analysis of Hazardous Waste," presented at the 1984 Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Atlantic City, New Jersey.

Wagner, R., D. Remeta, and M. Gruenfeld, March 1985, "Rapid On-Site Methods of Chemical Analysis," CONTAMINATED LAND: Reclamation and Treatment, R. E. Montgomery ed., Plenum Publishing Corp., New York, pp. 257-310.

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1972 - 1976	Research Worker, University of Tennessee, Department of Chemistry, Knoxville, Tennessee. Conducted research under Dr. W. A. Van Hook. Involved osmotic pressure-free energy relationships between heavy and "natural" waters. Also did work for Dr. J. W. Larsen on research and development analysis of protein in hamburger meat.

APPENDIX B

ANTICIPATED METHOD

DETECTION LIMITS

ANTICIPATED METHOD DETECTION LIMITS

METHOD/ANALYTE	Water Detection Limit (ug/l)	Soil Detection Limit (ug/kg)
EPA 6010:		
Antimony	32	32
Arsenic	53	53
Barium	2	2
Cadmium	4	4
Chromium	7	7
Copper	6	6
Lead	42	42
Nickel	15	15
Selenium	75	75
Silver	7	7
Zinc	2	2
EPA 7470/7471:		
Mercury	0.2	0.2
EPA 8240:		
Acetone	100	100
Benzene	5	5
Bromodichloromethane	5	5
Bromoform	5	5
Bromomethane	10	10
2-Butanone	100	100
Carbon Disulfide	5	5
Carbon Tetrachloride	5	5
Chlorobenzene	5	5
Chloroethane	10	10
2-Chloroethyl Vinyl Ether	10	10
Chloroform	5	5
Chloromethane	10	10
Dibromochloromethane	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethane	5	5
1,1-Dichloroethylene	5	5
t-1,2-Dichloroethylene	5	5
1,2-Dichloropropane	5	5
c-1,3-Dichloropropene	5	5
t-1,3-Dichloropropene	5	5
Ethylbenzene	5	5
2-Hexanone	50	50
4-Methyl-2-pentanone	50	50
Methylene Chloride	5	5

Styrene	5	5
Tetrachloroethylene	5	5
1,1,2,2-Tetrachloroethane	5	5
Toluene	5	5
1,1,1-Trichloroethane	5	5
1,1,2-Trichloroethane	5	5
Trichloroethylene	5	5
Vinyl Acetate	50	50
Vinyl Chloride	10	10
Total Xylenes	5	5
EPA METHOD 8080:		
Aldrin	0.04	2.68
a-BHC	0.03	2.01
b-BHC	0.06	4.02
d-BHC	0.09	6.03
g-BHC (Lindane)	0.04	2.68
Chlordane	0.04	2.68
4,4'-DDD	0.11	7.37
4,4'-DDE	0.12	8.04
4,4'-DDT	0.12	8.04
Dieldrin	0.02	1.34
Endosulfan I	0.14	9.38
Endosulfan II	0.04	2.68
Endosulfan Sulfate	0.66	44.2
Endrin	0.06	4.02
Endrin aldehyde	0.23	15.4
Heptachlor	0.03	2.01
Heptachlor epoxide	0.83	55.6
Methoxychlor	1.76	118
Toxaphene	2.4	161
PCB-1016	--	--
PCB-1221	--	--
PCB-1232	--	--
PCB-1242	0.65	43.6
PCB-1248	--	--
PCB-1254	--	--
PCB-1260	--	--
EPA METHOD 8250:		
Acenapthene	19	1,273
Acenapthylene	35	2,345
Acetophenone	--	--
Alddrin	19	1,273
Aniline	--	--
Anthracene	19	1,273
4-Aminobiphenyl	--	--
Aroclor-1016	--	--
Aroclor-1221	300	20,100
Aroclor-1232	--	--

Aroclor-1242	--	--
Aroclor-1248	--	--
Aroclor-1254	360	24,120
Aroclor-1260	--	--
Benzidine	440	29,480
Benzoic acid	--	--
Benzo(a)anthracene	78	5,226
Benzo(b)fluoranthene	48	3,216
Benzo(k)fluoranthene	25	1,675
Benzo(g,h,i)perylene	41	2,747
Benzo(a)pyrene	25	1,675
Benzyl alcohol	--	--
a-BHC	--	--
b-BHC	42	2,814
d-BHC	31	2,077
g-BHC	--	--
Bis(2-chloroethoxy)methane	53	3,551
Bis(2-chloroethyl)ether	57	3,819
Bis (2-chloroisopropyl)ether	57	3,819
Bis(2-ethylhexyl)phthalate	25	1,675
4-Bromophenyl phenyl ether	19	1,273
Butyl benzyl phthalate	25	1,675
Chlordane	--	--
4-Chloroaniline	--	--
1-Chloronapthalene	--	--
2-Chloronapthalene	19	1,273
4-Chlorophenyl phenyl ether	42	2,814
Chrysene	25	1,675
4,4'-DDD	28	1,876
4,4'-DDE	56	3,752
4,4'-DDT	47	3,149
Dibenzo(a,j)acridine	--	--
Dibenzo(a,h)anthracene	25	1,675
Dibenzofuran	--	--
Di-n-butylphthalate	25	1,675
1,3-Dichlorobenzene	19	1,273
1,4-Dichlorobenzene	44	2,948
1,2-Dichlorobenzene	19	1,273
3,3'-Dichlorobenzidine	165	11,055
2,4-Dichlorophenol	27	1,809
2,6-Dichlorophenol	--	--
Dieldrin	25	1,675
Diethylphthalate	19	1,273
p-Dimethylaminobenzene	--	--
7,12-Dimethylbenzo(a)anthracene	--	--
a,a-Dimethylphenylamine	--	--
2,4-Dimethylphenol	27	1,809
Dimethylphthalate	16	1,072
4,6-Dinitro-2-methylphenol	240	16,080
2,4-Dinitrophenol	420	28,140

2,4-Dinitrotoluene	57	3,819
2,6-Dinitroltoluene	19	1,273
Diphenylamine	--	--
1,2-Diphenylhydrazine	--	--
Di-n-octylphthalate	25	1,675
Endosulfan I	--	--
Endosulfan II	--	--
Endosulfan sulfate	56	3,752
Endrin	--	--
Endrin aldehyde	--	--
Endrin ketone	--	--
Ethyl methanesulfonate	--	--
Fluoranthene	22	1,474
Fluorene	19	1,273
2-Fluorobiphenyl	--	--
2-Fluorophenol	--	--
Heptachlor	19	1,273
Heptachlor epoxide	22	1,474
Hexachlorobenzene	19	1,273
Hexachlorobutadiene	9	603
Hexachlorocyclopentadiene	--	--
Hexachloroethane	16	1,072
Indeno(1,2,3-cd)pyrene	37	2,479
Isophorone	22	1,474
Methoxychlor	--	--
3-Methoxychloranthene	--	--
Methyl methansulfonate	--	--
2-Methylnapthalene	--	--
2-Methylphenol	--	--
4-Methylphenol	--	--
Napthalene	16	1,072
1-Napthylamine	--	--
2-Napthylamine	--	--
2-Nitroaniline	--	--
3-Nitroaniline	--	--
4-Nitroaniline	--	--
Nitrobenzene	19	1,273
2-Nitrophenol	36	2,412
4-Nitrophenol	24	1,608
N-Nitroso-di-n-butylamine	--	--
N-Nitrosodimethylamine	--	--
N-Nitrosodiphenylamine	19	1,273
N-Nitroso-di-n-propylamine	--	--
N-Nitrosopiperidine	--	--
Pentachlorobenzene	--	--
Pentachloronitrobenzene	--	--
Pentachlorophenol	36	2,412
Perylene	--	--
Phenacetin	--	--
Phenanthrene	54	3,618

Phenol	15	1,005
2-Picoline	--	--
Pronamide	--	--
Pyrene	19	1,273
Terphenyl	--	--
1,2,4,5-Tetrachlorobenzene	--	--
2,3,4,6-Tetrachlorophenol	--	--
2,4,6-Tribromophenol	--	--
1,2,4-Trichlorobenzene	19	1,273
2,4,5-Trichlorophenol	--	--
2,4,6-Trichlorophenol	27	1,809
Toxaphene	--	--

SOURCE: USEPA. 1986. Test Methods for Evaluating Solid Waste. SW-846, Third Edition. Washington, DC: US Environmental Protection Agency.

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DDMT WORK PLAN - VOLUME IV

FINAL SAFETY HEALTH AND EMERGENCY RESPONSE PLAN (SHERP)

For

REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)

At

DEFENSE DEPOT MEMPHIS, TENNESSEE (DDMT)
CONTRACT NO. DACA87-88-C-0092

Prepared for:

U.S. Army Corps of Engineers
Huntsville Division
P. O. Box 1600
Huntsville, Alabama 35807

Prepared by:

Law Environmental, Incorporated
Government Services Division
112 TownPark Drive
Kennesaw, Georgia 30144-5599

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1.0 INTRODUCTION

1.1 PLAN OBJECTIVE

The health and safety of site workers and the public is a primary concern and goal during hazardous materials investigations. Thus, a comprehensive, carefully managed, and thoroughly documented Safety, Health and Emergency Response Plan (SHERP) is crucial for successful project completion.

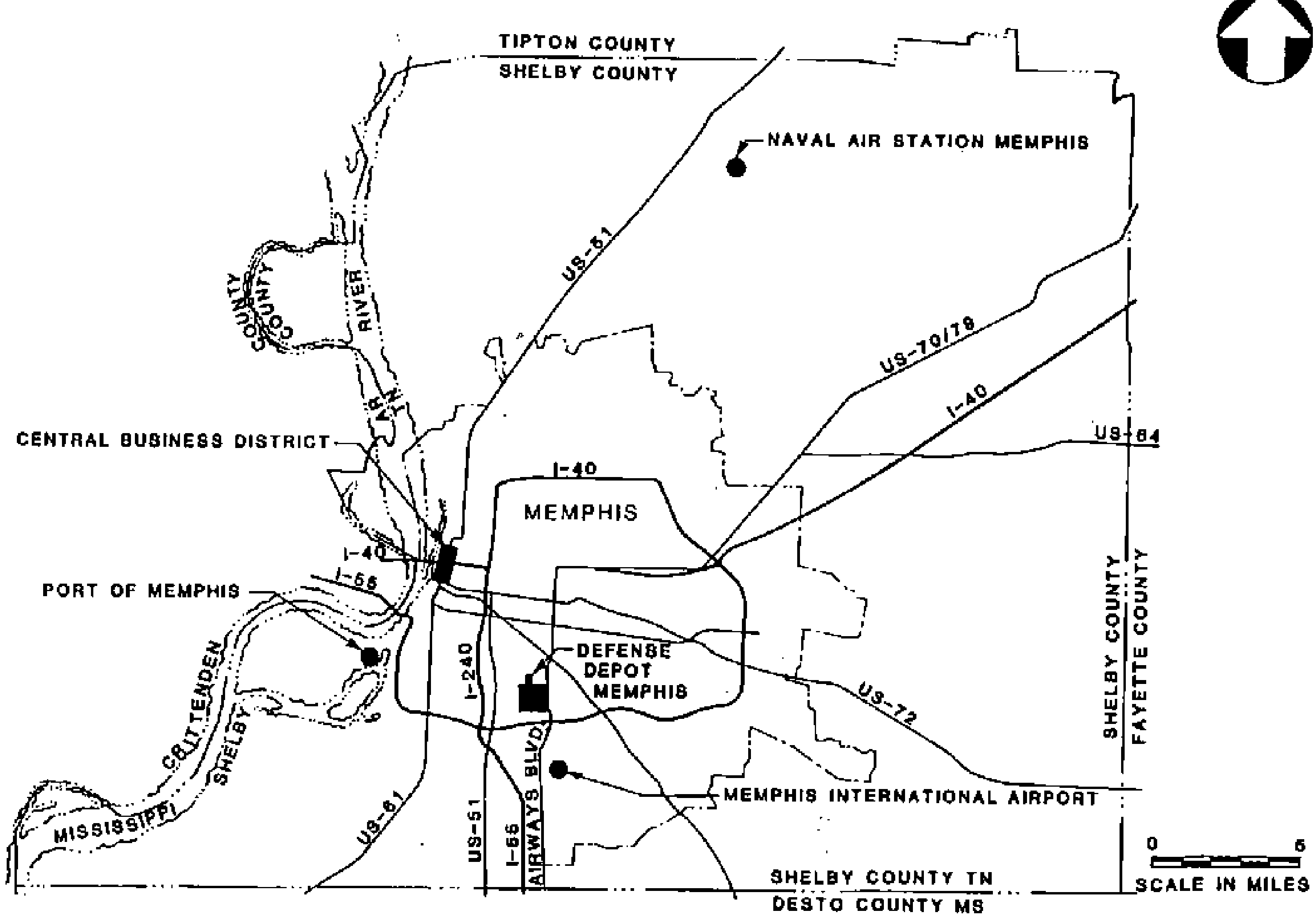
The plan describes field implementation of the SHERP, specific responsibilities, training requirements, protective equipment, and operating procedures that have been adapted to meet site-specific requirements, emergency procedures and medical monitoring. Its flexibility allows unanticipated site-specific problems to be addressed while assuring adequate and suitable worker protection. This site specific plan is based on actual site inspections. The SHERP will be bound with other pertinent information, and given to the Site Manager as a field reference manual for safety, health and emergency responses. The complete SHERP will be discussed with all site personnel and will be made available for review through the Site Manager to ensure sufficient awareness of potential hazardous conditions and safety procedures on the site.

Appendix A presents additional field work requirements by the Technical Escort Unit for subsurface investigations at suspected chemical burial sites at Dunn Field.

1.2 SITE DESCRIPTION

The Defense Depot at Memphis, Tennessee (DDMT) is located in Memphis, Shelby County, Tennessee (see Figure 1-1). DDMT is currently managed by the Defense Logistic Agency (DLA). DDMT consists of 642 acres and has been in operation since 1942. The Depot stockpiles and distributes material goods for the

FIGURE 1-1
DDMT LOCATION MAP



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Department of Defense throughout the south-central United States. Some of these materials included hazardous materials such as pesticides, cleaning solvents, and petroleum products. A more detailed description for DDMT is presented in Volume I of the Work Plan.

1.3 HAZARD ASSESSMENT

A site inspection visit to DDMT, was performed by Law Environmental personnel, prior to the preparation of this SHERP. The purpose of the visit was to evaluate potentially hazardous conditions that might be encountered during the field investigation. The following hazard assessment data have been developed for potential hazardous substances that may be present at the site. The hazardous constituent list is based upon background information provided by the U.S. Army Corps of Engineers (USACE), and data gathered during the initial site inspection.

1.3.1 Suspected Constituents

According to documents provided by the USACE, operations at DDMT disposed of wastes consisting of the following compounds:

Potential Source	Contaminants of Concern
o Mustard/Lewisite	o Thiodiglycol
o Solvents	o Acetone n-Butyl Acetate Carbon Tetrachloride Chloroform 1,1-Dichloroethane 1,2-Dichloroethylene 1,1-Dichloroethylene Isooctanol Methyl ethyl ketone (MEK) Morpholine

1,1,2,2-Tetrachloroethane
Tetrachloroethylene
1,1,1-Trichloroethane
1,1,2-trichloroethane
Trichloroethylene
Toluene

o Pesticides/Herbicides	o DDD, DDT, DDE, Chlordane, Aldrin, Malathion, 2,4-D, Zinc Chromate, Dieldrin
o PCP Dip Tank	o Pentachlorophenol (PCP) Dioxin/Furan
o Transformers	o PCB
o Spills	o Hydrofluoric Acid, Naptha,
o Paints	o Cadmium, Chromium, Lead
o Burials at Dunn Field	o Trichloroacetic Acid ortho-Tolidine dihydrochloride

1.3.2 Characteristics of Suspected Constituents

Table 1-1 contains a list of the chemical contaminants of concern which are suspected to be present at DDMT. The table also lists the physical characteristics, odor threshold, regulatory exposure limits, respirator breakthrough times, and resistant material. The following is a brief discussion of each constituent. The complete Chemical Hazard Response Information System (CHRIS) files for all constituents except mustard gas are presented in Appendix A in the form of Chapter 2, Agent Information from Safety Regulations for chemical agents H, HD, and HT (DARCOM-R 385-31).

TABLE 1-1

CHARACTERISTICS OF SUSPECTED CONTAMINANTS

DEFENSE DEPOT - MEMPHIS, TENNESSEE

INDICATOR CHEMICAL	SPECIFIC GRAVITY	REID VAPOR PRESSURE (psia)	WATER(1) SOLUBILITY (lbs/lbs H_2O)	LEL/UEL(2) (%)	EXPOSURE LIMITS TLV(3) ACGIH (ppm)	EXPOSURE LIMITS IDLH(4) (ppm)	ODOR THRESHOLD (ppm)	RESPIRATOR (5) CARTRIDGE BREAKTHROUGH Time (minutes)	CHEMICAL RESISTANT MATERIAL
SOLVENTS:									
Acetone	.791	7.3	miscible	2.6/12.8	750	20,000	100	37	Nylon, rubber
n-Butyl Acetate	0.86	0.5	1.0	1.7/7.6	150	10,000	10	77	Nylon; Delrin
Carbon Tetrachloride	1.59	3.8	.08	Not flammable	5, skin	300	>10	77	Viton
Chloroform	1.49	6.4	.80	Not flammable	10	1000	205-307	33	Viton
1,1-Dichloroethane	1.17	17.4	.50	5.6/11.4	200	4000	NA	23	Viton
1,1-Dichloroethylene	1.21	18.3	.50	7.3/16	5	20	NA	-	-
1,2-Dichloroethylene	1.27	NA	.63	9.7/12.8	200	4000	NA	30	Viton
Isooctanol (6)	.829	NA	.60	NA	NA	NA	<1	-	-
Methyl ethyl Ketone	.806	3.5	27	1.8/11.5	200	NA	10	82	Polypropylene nylon
Morpholine	1.0	0.5	miscible	1.8/10.8	20,skin	NA	<1	-	Rubber
1,1,2,2 Tetra-chloroethane	1.60	0.5	.25	Not flammable	1, skin	150	0.5	104	Viton
Tetrachloroethylene (perchloroethane)	1.63	NA	.02	Not flammable	50	500	5	107	Viton
1,1,1-Trichloroethane	1.31	4.0	.07	7/16	350	450	100	-	Viton
1,1,2 Trichloroethane	1.31	NA	NA	7/16	10, skin	1000	100	72	Viton
Trichloroethylene	1.46	2.5	.11	8/10.5	50	1000	50	55	Viton
Toluene	.867	1.1	.05	1.3/7	100	2,000	<1	94	Nylon, Viton

TABLE 1-1 (CONTINUED)

CHARACTERISTICS OF SUSPECTED CONTAMINANTS

DEFENSE DEPOT - MEMPHIS, TENNESSEE

INDICATOR CHEMICAL	SPECIFIC GRAVITY	REID VAPOR PRESSURE (psia)	WATER(1) SOLUBILITY (lbs/lbs H_2O)	LEL/UEL(2) (%)	EXPOSURE LIMITS TLV(3) ACGIH (ppm)	EXPOSURE LIMITS IDLH(4) (ppm)	ODOR THRESHOLD (ppm)	RESPIRATOR(5) CARTRIDGE BREAKTHROUGH Time (minutes)	CHEMICAL RESISTANT MATERIAL
PESTICIDES/HERBICIDES:									
Aldrin	1.6	NA	0	-	.25 mg/m^3, skin	100 mg/m^3	NA	-	-
Chlordane	1.60	NA	insoluble	0.7/5	0.5 mg/m3, skin	500 mg/m^3	NA	NA	NA
2,4 D	1.563	NA	NA	NA	10 mg/m^3	500mg/m^3	3.13mg/m^3	-	-
DDD	NA	NA	NA	NA	-	-	-	-	
DDE	-	NA	NA	NA	-		-	-	-
DOT	1.56	NA	insoluble	Not flammable	1 mg/m^3	NA	NA	NA	NA
Dieldrin	.791	7.25	insoluble	NA	0.25 mg/m^3	450 mg/m^3	<1	-	-
Malathion	1.23	NA	.014	NA	10 mg/m^3, skin	5000 mg/m^3	-	-	-
Methyl Bromide	1.68	45	.090	10/15	5,skin	2,000	Odorless		Kynar/Viton
Zinc Chromate	3.43	NA	.100	NA	.01 mg/m^3	500 mg/m^3	Odorless	-	-
MISCELLANEOUS									
PCP (Pentachlorophenol)	1.98	NA	.100	Not flammable	0.5 mg/m^3, skin	150 mg/m^3	NA	NA	.
Dioxin	NA	<1	<1	2/22	100	NA	NA	NA	NA
Furan	0.94	<1	NA	2.3/14.3	10	NA	NA	NA	NA
PCB	1.3 - 1.8	NA	insoluble	Not flammable	0.5 -1.0 mg/m^3	5-10 mg/m^3	NA	NA	NA

TABLE 1-1 (CONTINUED)

CHARACTERISTICS OF SUSPECTED CONTAMINANTS

DEFENSE DEPOT - MEMPHIS, TENNESSEE

INDICATOR CHEMICAL	SPECIFIC GRAVITY	REID VAPOR PRESSURE (psia)	WATER(1) SOLUBILITY (lbs/lbs H_2O)	LEL/UEL(2) (%)	EXPOSURE LIMITS TLV(3) ACGIH (ppm)	IDLH(4) (ppm)	ODOR THRESHOLD (ppm)	RESPIRATOR (5) CARTRIDGE BREAKTHROUGH Time (minutes)	CHEMICAL RESISTANT MATERIAL
Naptha (7)	.86 - .88	0.13	insoluble	NA	100	10,000	4.7	-	Kynar; Viton
Hydrofluoric Acid	1.26	Varies	miscible	NA	3	20	NA	-	Neoprene nitrile NBR
Trichloroacetic Acid	1.6	Imm. at 51oC	.13	NA	1	NA	1.6-2.5 mg/m^3	-	
o-Tolidine (Dihydrochloride)	1.0	0.1 mm at 20°C	miscible	NA	A2 skin	NA	NA	NA1	
Thiodiglycol	1.19	NA	Misc in water	NA	NA	NA	NA	NA	(Thiodiethylenel) glyco

(1) Pounds/Pounds of Water
(2) Lower Explosive Limit (LEL)/Upper Explosive Limit (UEL)
(3) Threshold Limit Value (TLV) established by American Conference of Governmental Industrial Hygienist (ACGIH)
(4) Immediately Dangerous to Life or Health (IDLH)
(5) Time to reach one percent breakthrough at concentration of 1000 ppm.
(6) Data for this compound is for Octanol
(7) Coal Tar
NA = Not Available

1.3.2.1 Chlorinated Hydrocarbons

Specific chlorinated hydrocarbons that may potentially be present at the site include: Carbon Tetrachloride, Chloroform, 1,1-Dichloroethane, 1,2-Dichloroethane, 1,2-Dichloroethylene, 1,1,2,2-Tetrachloroethane, Tetrachloroethylene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, and Trichloroethylene. These compounds are characteristically colorless, volatile, highly flammable liquids with a chloroform-like odor. The chlorinated hydrocarbons have high vapor pressure and higher specific gravities than water. Exposure may occur by inhalation of vapors, supplemented by skin adsorption. Exposure to the liquid and vapor may produce irritation to eyes, skin, and upper respiratory tract. Liquid aspirated into the lungs can cause serious pulmonary damage. Acute exposure results in central nervous system depression, headache, dizziness, nausea, and deterioration of the liver and kidneys. The threshold limit values for the chlorinated hydrocarbons listed range from 1 ppm (1,1,2,2-Tetrachloroethane) to 350 ppm (1,1,1-Trichloroethane).

1.3.2.2 Other Solvents

Other solvents which may be potentially on the site are acetone, n-butyl acetate, isooctanol, MEK and toluene. As a class, these solvents are colorless, volatile and flammable with characteristic odors. Their vapors irritate the eyes and upper respiratory tract. Acute exposures cause dizziness, headache, anesthesia and respiratory arrest. Contact with liquid solvent irritates the eyes and dries the skin. Aspiration into the lungs causes gagging and pulmonary edema, while ingestion causes vomiting, diarrhea and depressed respiration. Liver and kidney damage can follow ingestion. The threshold limit values for these solvents range from 100 ppm (toluene) to 750 ppm (acetone).

1.3.2.3 Pentachlorophenol (PCP)

PCP has been used as a wood-preservative, herbicide, defoliant, and antimicrobial agent. Exposure may occur through inhalation of contaminated soils and skin adsorption. Exposure may cause local irritation and systemic effects- characterized by profuse sweating, fever, and gastrointestinal pains- eventually effecting the liver and kidneys. There is some evidence that PCPs are carcinogenic in laboratory animals.

1.3.2.4 Metal Contaminants

Metals that might potentially be present on the site include chromium, cadmium, and lead. Chromium compounds may act as allergens in some workers, causing dermatitis to exposed skin. Acute exposure, which is unlikely at the site, may cause coughing, wheezing, and headaches. Hexavalent chromium is a known carcinogenic substance with a TLV of 0.05 mg/m3. The early effects of lead poisoning are non-specific. Later symptoms (usually reversible) include fatique, headaches, aching bones, and decreased appetite. Cadmium, although potentially toxic, should not present exposure problems with the precautions being taken to reduce exposure to other materials present. The TLV's for lead and cadmium are 0.15 mg/m3 and 0.05 mg/m3 respectively.

1.3.2.5 Pesticides

A wide variety of pesticides has been used at DDMT. Pesticides, in general, are not readily volatized into air. Investigative activities such as drilling and sampling do not generate significant amounts of dust. Therefore, workers should not experience potentially hazardous exposure to pesticides via inhalation. Proper skin protection will be provided with the use of Tyvek coveralls, gloves, boots, and goggles. Commonly used pesticides include:

Dioxin (TCDD) / Furan

Dioxin is a colorless, needlelike crystal that has been used as a herbicide. It is carcinogenic. Exposure may occur via oral or dermal contact. It is a mild irritant to eyes. Exposure may cause severe problems to the liver, and chloracne.

Furan is a clear-white liquid. Exposure may occur via inhalation or dermal contact. Exposure may produce a narcotic effect in affected humans.

Chlordane

Chlordane is a amber liquid with a chlorine-like odor that has been used as an insecticide. It is a suspected human carcinogen. Exposure may occur through inhalation or skin adsorption. Exposure may cause hyperexcitability and convulsions. Chronic exposure can cause liver damage.

DDT

DDT is a colorless-white crystal with a slight aromatic odor. It is a common air contaminant and exposure via inhalation, oral or dermal contact. Acute exposure causes tremors in the head/neck muscles, mild convulsions, cardiac/respiratory failure, and death. Chronic exposure causes dermatitis, convulsions, central nervous system degeneration, coma, and death.

Aldrin

Aldrin is a light to dark brown solid or solution used as an insecticide or fumigant. Ingestion, inhalation or dermal absorption of an acutely toxic dose will cause nausea, vomiting, hyperexcitability, tremors, convulsions and ventricular fibrillation. Kidney and liver damage is reversible to an extent. Ingestion of 25 gr. has caused death in children. The threshold limit value is 0.25 mg/m^3 for aldrin.

2,4-D

2,4-Dichlorophenoxyacetic acid is a systemic herbicide which is an odorless, white or solid. Exposure to 2,4-D dust may irritate the eyes. Ingestion produces gastroenteric distress, diarrhea, mild CNS depression, difficulty in swallowing and transient liver and kidney injury. The threshold limit value is 10 mg/m^3.

Malathion

Malathion (Cythion) is a liquid insecticide with a strong "skunk-like" odor. Exposure to malathion fumes causes headache, blurred vision, constriction of the pupils, weakness, nausea, cramps, diarrhea and chest tightness. Muscle twitching and convulsions may follow. These symptoms develop over a period of eight hours. The threshold limit value is 10 mg/m^3 with 5000 mg/m^3 being immediately dangerous to life and health.

Zinc Chromate

Zinc chromate is a yellow, odorless solid used as a fungicide. Inhalation of the dust causes irritation of the nose and throat. Ingestion of zinc chromate can cause irritation or corrosion of the alimentary tract, circulatory collapse, and toxic nephritis. Skin or eye contact causes irritation. Chronic inhalation exposure to zinc chromate is associated with lung cancer. The threshold limit value is 0.05 mg/m^3.

Methyl Bromide

Methyl bromide is a colorless liquefied gas with a weak, chloroform-like odor. Methyl bromide is used as a fumigant. Inhalation of vapors produces lung congestion and pulmonary edema. Higher concentrations cause rapid narcosis and death. Methyl bromide liquid irritates the eyes and skin on contact. Methyl bromide has a threshold limit value of 5 ppm and is easily absorbed via the skin.

Dieldrin

Dieldrin is a light brown solid insecticide with a mild chemical odor. Inhalation, ingestion or dermal contact causes irritability, nauseas, vomiting, fainting, convulsions and coma. The threshold limit value is 0.25 mg/m^3 and is absorbed via the skin. The NIOSH time-weighted average PEL is 0.15 mg/m^3.

1.3.2.6 Miscellaneous Constituents

Miscellaneous constituents include:

Morpholine

Morpholine is a colorless, oily liquid solvent with a fishy, ammonia odor which is used as a rubber accelerator, and as an ingredient in boiler water, waxes, polishes, detergents and as a corrosion inhibitor. Contact with liquid morpholine causes skin and eye burns. Inhalation or dermal absorption may produce nausea and headache. The threshold limit value is 20 ppm with a short-term inhalation limit of 20 ppm for 15 minutes. The odor threshold is 0.01 ppm.

Hydrofluoric Acid

Hydrofluoric acid is a watery liquid with an irritating odor. It is a non-oxidizing mineral acid which causes serious and painful burns of the eyes and skin. The threshold limit value is 3 ppm. Although hydrofluoric acid was previously spilled on the DDMT site, no remnants of the spills are expected to remain to the present time as hydrofluoric acid is quickly degraded in the environment.

Naphtha

Naphtha (Coal Tar) is a mixture of benzene, toluene and xylenes which is the active ingredient in moth balls. Naphtha is primarily a narcotic and causes unconsciousness with high concentration inhalation exposures. Chronic exposure are associated with leukemia.

Trichloroacetic Acid

Trichloroacetic acid is a colorless, crystalline solid with a sharp, pungent odor. It is used in organic synthesis, medicine, pharmacy and in herbicides. The TLV is 1 ppm. Small bottles of trichloroacetic acid were buried at Dunn Field in 1965. In aqueous conditions, trichloroacetic acid decomposes at room temperature to chloroform and carbon dioxide (Kearney, 1975). The persistence of trichloroacetic acid in soil varies from 14 to 90 days and is dependent on soil type, moisture, and temperature (Worthing, 1979).

O-Tolidine (dihydrochloride)

O-Tolidine is absorbed through the skin and is an assumed human carcinogen. No specific threshold limit value is given by ACGIH. This material was buried at Dunn Field in 1955. O-Tolidine has a high melting point and is not volatile. Also, this constituent is only slightly soluble in water. The potential hazard to field workers from inhalation or skin exposures is low (HSDB, 1988).

1.3.3 Hazard Assessment Summary

Based on the initial site inspection, the potential for health-threatening contamination exists and warrants increased personal protection for the Field Work Team. Intrusive activities, such as soil boring, monitoring well installation, and sampling increase the potential for exposure to hazardous substances.

Requirements for personal protective equipment and safety protocol will be discussed in Section 4.0.

*****

2.0 RESPONSIBILITIES

The Project Manager, Site Manager, and Health and Safety Officer are responsible for formulating and enforcing health and safety requirements. These responsibilities include:

- Assuring that all site team members have received the required 40-hour health, safety and emergency response training;
- Assuring that all team members have completed the required medical examination and have met the qualification criteria for site work;
- Assuring that all equipment used on site is suitable and adequate;
- Assuring that site standard operating procedures are followed at all times; and
- Addressing any unusual problems or conditions that may be encountered.

The Site Manager, Mr. Robert Manson, will also serve as the Field Safety Coordinator. He will have direct responsibility for administering the SHERP relative to all site activities, and will be in the field full-time while site activities are in progress. His primary operational responsibilities will be environmental monitoring, including air and soil monitoring. Mr. Manson has completed his 40-hour course titled "Health and Safety for Hazardous Waste Operations" as required by OSHA (29 CFR 1910.120), Red Cross first aid and CPR training. In addition, Mr. Manson has received the required eight hours of training for on-site management and supervisor personnel in accordance with OSHA [29 CFR 1910.120(e)(3)]. This training and his experience on other hazardous waste sites qualify him as the Field Safety

Coordinator. Mr. Greg Myers will serve as the Alternate Field Safety Coordinator. Mr. Myers has successfully completed the same training programs as Mr. Manson.

The Project Manager, Mr. Steven Shugart, has overall responsibility for the the project and will visit the site during field operations. He will direct the Site Manager and will confirm that the SHERP is properly implemented. The Project Manager reports to the Principal Engineer, Mr. Thomas L. Richardson, who has ultimate responsibility for the project.

The Health and Safety Officer, Dr. Jack Peng, has responsibility for reviewing and approving the SHERP and responding to any non-routine matters that relate to health, safety, and emergency response during the project life. The Health and Safety Officer provides an independent check on the implementation of the SHERP at the site. The Health and Safety officer may visit the site at any time to monitor compliance with the provisions of the SHERP. Field Personnel will report directly to the Site Manager. Subcontract Personnel will also report directly to the Site Manager. A brief description of each individual's experience and capabilities is presented in Section 2.2 of the DDMT Work Plan.

3.0 PERSONNEL HAZARD TRAINING

3.1 COMPREHENSIVE TRAINING

A thorough understanding of the types of hazards most likely to be encountered at hazardous waste sites and personal protection measures needed to protect on-site personnel are the first requirements of a complete SHERP. As a result, Law Environmental requires that each project team member participate at a minimum in a 40-hour comprehensive training course which complies with OSHA 29 CFR 1910.120. Annual refresher training is also an integral part of overall hazardous waste awareness.

Table 3-1 provides an outline of Law Environmental, Inc.'s comprehensive training course. The training courses are conducted by the company Health and Safety Officer, and representatives from outside companies who manufacture and distribute safety equipment. The course includes a hands-on training session to familiarize the participants with safety equipment and field situations.

Subcontractors and visitors entering designated work areas will be subject to all applicable health and safety requirements during field operations at the site. The Site Manager is responsible for briefing the subcontractor's personnel on potential contamination that may be encountered on the site, site safety, and the emergency response plan. Potential subcontractors that may work on the project include the drilling crew and the survey crew. Each of the subcontractors and visitors will be under the direct supervision of the Site Manager or his representative.

Table 3-1

LAW ENVIRONMENTAL TRAINING COURSE
HEALTH AND SAFETY PROCEDURES
AT
HAZARDOUS WASTE SITES

I. HEALTH AND SAFETY

   A. Introduction/Background
   B. Attitude and Behavior
   C. General Safety Practices

      1. Overview of personnel protection equipment
      2. EPA levels of protection
      3. Procedures for site investigation

         a. Planning before departure
         b. At the site
         c. Decontamination and site exit

      4. Environmental monitoring equipment

         a. Detector tubes (Draeger)
         b. Organic vapor analyzers (OVA)
         c. Photoionization Detectors (Photovac TIP, HNU)

   D. General Occupational Health

      1. Common classes of chemicals
      2. Exposure routes
      3. Physical, chemical properties, toxicity
      4. Medical monitoring
      5. Pulmonary function tests

   E. DOT Labeling Regulations
   F. Safety Regulations

II. PERSONAL PROTECTION

A. EPA Levels of Protection

1. Selection criteria
2. Equipment

B. Respiratory Protection

1. Types of respirators
2. Fit testing
3. Cartridge selection
4. Cleaning, maintenance, storage

C. Protective Clothing

1. Types, materials
2. Selection
3. Protection from various chemicals

D. Self-contained Breathing Apparatus

III. RESPIRATOR FIT TESTING

A. Qualitative Fit Testing of Employees

1. Personal safety data sheets
2. Cleaning, repairing, maintenance

IV. EQUIPMENT DEMONSTRATION AND PRACTICE SESSIONS

A. Draeger Detector Tube Sampling
B. Organic Vapor Analyzers
C. SCBAs
D. Protective Clothing

V. HAZARDOUS WASTE FUNDAMENTALS

A. Determination of a Hazardous Waste
B. Labeling, Manifests, Placarding
C. Proper Shipping Names, Transportation
D. Material Safety Data Sheets

VI. QA/QC CONSIDERATIONS

A. Requirements
B. Standard Forms
C. Chain of Custody

VII. SITE OPERATIONS

A. Work Zones
B. Sampling Techniques
C. Equipment Decontamination
D. Sample Handling

VIII. REVIEW OF SITE-SPECIFIC STANDARD OPERATION PROCEDURES

A. SHERP for the Site
B. QC Plan for the Site

3.2 PRE-INVESTIGATIVE HEALTH AND SAFETY BRIEFING

Prior to the start of any field activity the Site Manager and Project Manager will meet with all workers and subcontractors. These meetings will discuss in detail the hazards specific to the site and will specify the proper work uniform for each work area. As part of this meeting the Standard Operating Procedures (SOPs) will be outlined. It is the responsibility of the Site Manager to ensure that all workers are thoroughly familiar with each specific SOP and the overall chain of command at the site.

3.3 MORNING SAFETY MEETINGS

Morning safety meetings help in the safe execution of the field work. These meetings are the responsibility of the Site Manager. The Site Manager will inform field personnel of any changes from the previous day activities. Responsible individuals will be identified and routes for emergency corrective actions will be shown.

3.4 POST-INVESTIGATION SAFETY MEETING

Immediately following completion of field work, a meeting will be held to review the implementation of the SHERP. The objective of this meeting is to provide a basis for future SHERP's.

4.0 FIELD IMPLEMENTATION

The SHERP addresses all phases of field operations at the site, including:

- Names of key personnel responsible for site safety and health
- Work practices
- Hazard identification and assessment
- Established work zones
- Level of personal protective equipment required in each zone
- Sampling procedures
- Entry and exit routes
- Decontamination procedures
- Accident/emergency response
- Medical surveillance
- Training
- Record keeping

A review of the history and conditions of the study area indicated the extent and nature of the hazardous conditions. Based on the information obtained, the primary exposure to workers by hazardous constituents will be through contact with contaminated soil or water. The inhalation of vapors during intrusive activities also appears to be an important source of contact. As a result, the site investigation will be performed primarily under Level D personnel protection with the additional requirement for nitrile gloves and Tyvek coveralls (levels of protection A through D are described in Appendix A). Provisions are made to further upgrade levels of protection if necessary. Level C protective equipment will be available on-site.

4.1 PERSONAL PROTECTIVE EQUIPMENT

It is well established that worker efficiency decreases in direct proportion to the amount of protective gear required. Thus, it is desirable to use as little equipment as possible while providing adequate protection. Anything less than maximum protection (Levels A or B) cannot be specified without (1) carefully defining site conditions, (2) allowing extra safety margins, (3) having higher level equipment readily available, and (4) anticipating worst-case conditions. In the event of conflicting requirements, the most protective level shall apply. It cannot be emphasized too strongly, that these requirements are subject to change at any time by the Health and Safety Officer or the Site Manager based on contaminant monitoring, visual observations, or changes in work or site conditions.

This SHERP recognizes four levels of personal protection (levels A, B, C, and D). Personal protective equipment selection is based on three separate criteria: EPA Levels of Protection as defined in Standard Operating Safety Guides; Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, provisions of OSHA 29 CFR 1910 and 1926; and, the U.S. Army Corps of Engineers Safety and Health Requirements Manual EM 385-1-1. The required protective equipment and selection criteria for all levels of protection are summarized in Appendix A. Based on these criteria, and the results of our site inspection, we have chosen to initially use a modified Level D protection (described in Appendix A) for various site activities. The following levels of protection are those that may be utilized at the site for the proposed field investigations. Section 4.6 presents additional safety equipment required for field work.

LEVEL D

Level D is defined as the basic work uniform. Based on the initial site reconnaissance, the field investigations at DDMT will be conducted in the modified Level D work uniform with the additional requirement of nitrile gloves and coated Tyvek coveralls. However, safety equipment will be available on-site to upgrade protection to Level C if necessary. The Level D safety equipment includes:

- Distinct field work clothes
- Coated tyvek or disposable chemical resistant coveralls
- Viton or nitrile rubber boots, with steel toe and shank
- Disposable outer boots (optional)
- Hard-hats
- Face shield (optional)
- Viton gloves with optional cotton liners . Gloves are required when any contact with soil or water on-site is necessary.

LEVEL C

Level C (as defined in Appendix A) equipment includes the following:

- Half-face, air-purifying respirator, with cartridges for organic vapors, dusts and mists.
- Tyvek coveralls or disposable chemical-resistant coveralls
- Viton gloves, with optional cotton liners
- Cotton gloves as liners if needed
- Neoprene or nitrile rubber boots, with steel toe and shank
- Disposable outer boots (optional)
- Hard-hats
- Safety glasses or goggles

LEVEL B

If Level B conditions are encountered, site work will be terminated, the USACE will be notified, and the contract will be modified to allow upgrades necessary to operate at this level. Level B (as defined in Appendix A) equipment includes the following:

- Pressure-demand (Positive Pressure) SCBA, NIOSH/MSHA approved
- Polylaminated chemical-resistant coveralls

- Inner chemically resistant gloves (Viton)
- Outer chemically resistant gloves (Viton)
- Hard hat
- Inner boots with steel toe and shank
- Disposable outer boots (optional), taped to cuff
- Two-way radio communication

4.2 MONITORING

4.2.1 Environmental Monitoring

The primary health and safety concerns during field activities are physical contact with contaminated soil and the inhalation of vapors. Frequent photoionization detector (PID) measurements will be conducted with a Photovac TIP or HNU PID during all drilling and sampling activities. During drilling, a measurement will be obtained each time the drill stem is removed from the auger flights to take a soil sample. During well development and all sampling activities, a PID measurement will be taken each time a sample is taken, and not less than each half-hour. The photoionization detectors will be calibrated each day using the appropriate calibration gas.

In addition, certain constituents have action levels near the reasonable detection limits of the PID units (approximately 1 ppm). For this reason, a flame-ionization detector (FID) with gas chromatagraph (GC) attachment, or other method of determining specific organic constituents, will be used to supplement the PID readings. The FID-GC unit will be used to identify if constituents with low action levels are present (specifically 1,1,2,2-Tetrachloroethane). An FID-GC reading will be made each time the PID instrument indicates even low levels of constituents. FID-GC readings will be made a minimum of every two hours during drilling, well installation, and sampling activities. The FID-GC unit will be regularly calibrated according to the manufacturers recommendations.

An explosimeter (MSA Model 2A) will be used to check for explosive atmospheres in the boreholes at the same intervals as the PID. The explosimeter measures from 0 to 100 percent of the Lower Explosive Limit (LEL). The LEL is the minimum concentration of vapors in the air forming a mixture elevated enough to burn or explode, given a source of ignition. If the explosimeter reading is greater than 20 percent of the LEL, then work will be stopped and the situation evaluated. Section 4.5 provides a discussion of the specific gear required for each specific work task and the action levels for each task.

Environmental monitoring will be performed frequently during drilling and sampling. Each time the auger is advanced five feet during drilling, the borehole headspace will be monitored using the PID and explosimeter. The soil contained in each sampler removed from the boring will be monitored with the PID and the reading will be recorded in the lithologic log. During sampling, well headspace measurements will be taken with the PID when the well is initially opened and during sample collection.

4.2.2 Personnel Monitoring

Cold weather is expected during the field investigation. To minimize health problems when the outside temperature is below freezing, at least one 15 - minute break will be allowed every two hours for workers to warm up. If work continues into the summer months, heat stress may become a health related problem especially when wearing protective equipment. During warm weather, workers will be continually observed (through the buddy system and by on-site managers) for signs of heat stress, elevated body temperature, and other adverse health effects. Monitoring of personnel wearing impervious clothing will commence when the ambient temperature is 72.5°F or above. Monitoring frequency will increase as the ambient temperature increases or as slow recovery rates are observed. When temperatures exceed 72.5°F, workers will be monitored for heat stress at the intervals described in Table 4-1. Monitoring will be performed by the Site Manager.

The following techniques will be used to monitor the body's recuperative abilities. Heart rate (HR) will be measured by the pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats per minute. If the HR is higher, the next work period will be shortened by 10 percent while the length of the rest period remains the same. If the pulse rate is 100 beats per minute at the beginning of the next rest period, the following work cycle will be shortened by 33 percent.

4.3 ACTION LEVELS OF PERSONAL PROTECTION

When predetermined constituent levels are indicated by field instrumentation, action is dictated to preclude exposing personnel to hazardous conditions. The action may be either engineering controls to reduce constituent levels, or personal protection.

Airborne contamination with both PID and FID units will be monitored as described previously. A review of Table 1-1 indicates that the threshold limit values (TLV's) for volatile compounds range as low as 1 ppm (1,1,2,2 Tetrachloroethane) and 5 ppm (Carbon tetrachloride, 1,1,1-Dichloroethylene, and Methyl Bromide). The remaining compounds have TLV values of 10 ppm or higher. Based on this, an action level of 5 ppm is applicable for all compounds except the two discussed above. The FID-GC unit will be used to determine if those specific constituents are present, and in what concentration. If they are present, the action limit will be one-half the TLV for each constituent. If not present, the general action level will apply.

If action levels are exceeded, four options can be exercised to reduce worker exposure. High volume fans may be employed to vent volatile constituents away from the work area. The fans will be

TABLE 4-1
Heat/Rest Table

Adjusted* Temperature(°F)	Normal Work Conditions (min)	Tyvek Suit Work Conditions (min)
90.0 +	45	15
87.5 +	60	30
82.5 +	90	60
77.5 +	120	90
72.5 +	150	120

* Adjusted Temperature = Air Temperature (°F) + [13 x % Sunshine]

placed away from work area to minimize any electrical hazard. The efficiency of this method will be monitored by frequent PID measurements. If the fan is not employed, or is not effective in reducing breathing-zone PID measurements below the action level, Level C personal protection will be instituted. Upgrading to Level C requires the addition of a half-faced respirator with a cartridge for organic vapors, dusts, and mists, to the modified Level D protection initially used at the site. PID measurements will continue after addition of respirators to the work uniforms. The concentration of breathed air will then be calculated using the following relationship.

$$\text{Breathed Air} = \frac{\text{Ambient Air}}{\text{Respirator Protection Factor}}$$

where:

1) Ambient air - measured by PID

2) Respirator Protection Factor is 10 for half-face respirators and 50 for full face respirators.

If the calculated breathed air is not below the stated action levels, either a different respirator will be used or the work site will be evacuated. The work site will be evacuated immediately if PID measurements in the breathing zone is greater than 250 ppm, in general, or less for specific constituents as shown in Table 4-2.

If respirators are required, cartridges will be replaced at one-half the calculated respirator break through time. The calculated respirator break through time shall be based on the values presented in Table 1-1, adjusted for the ratio of actual airborne concentrations to the 1000 ppm stated. The FID-GC will be used to identify the air-borne constituents present, and the lowest respirator break through time will be used in the calculation.

TABLE 4-2
Action Levels for Personnel Protection

AIRBORNE VOLATILE CONSTITUENTS

PID/FID READINGS IN THE BREATHING ZONE	ACTION
0-5 ppm above background	Level D
5-250 ppm above background	Level C
>250 ppm above background	Evacuate the site immediately

If Carbon Tetrachloride, 1,1,1-Dichloroethylene, or Methyl Bromide is present

FID-GC READING	ACTION
< 2.5 PPM	Level D
2.5 - 30 ppm	Level C
> 30 ppm	Evacuate site

If 1,1,2,2-Tetrachloroethane is present

FID-GC READING	ACTION
< 0.5 ppm	Level D
0.5 - 15 ppm	Engineering techniques or Level C
> 15 ppm	Evacuate site

EXPLOSIMETER READINGS	ACTION (1)
< 10% LEL (2)	Continue work, monitor every 5 minutes
10-20% LEL	Stop work and evaluate the situation; continue monitoring every five minutes.
> 20% LEL	Evacuate the site immediately.

(1) Modified from standard operating Safety Guides, USEPA, November, 1984. Listed levels are more stringent than EPA guidelines.

(2) LEL - Lower Explosive Limit

Explosimeter readings will be taken at frequent intervals. All work will stop and the work area will be evacuated if the explosimeter readings indicate flammable vapor concentrations greater than 20% of the Lower Explosive Limit (LEL).

The explosimeter action levels were modified from Standard Operating Safety Guides, USEPA, November, 1984. Listed levels are more stringent than EPA guidelines. Task specific action levels (i.e., site surveying, soil boring, and soil sampling) are discussed in Section 4.5.

4.4 WORK ZONES

For Safety purposes, a hazardous waste site is generally divided into three specific zones on the basis of contamination potential: Zone 1 - Exclusion Zone; Zone 2 - Contamination Reduction Zone; and Zone 3 - Support Zone.

The Exclusion Zone is the suspected area of greatest environmental contamination and presents the greatest potential for worker exposure. Personnel entering the area must wear the mandated level of protection. In certain instances, different levels of protection will be required depending on the tasks to be performed within that zone. The Support Zone serves as a clean, control area. The Contamination Reduction Zone serves as a transition area between the Exclusion Zone and the Support Zone. Decontamination facilities are located in the Contamination Reduction Zone. All areas will be defined and marked as appropriate.

At the DDMT site, the establishment of these three specific zones will be based on the location of intrusive activities. If hazardous conditions develop during site operations, work will be stopped and the three zones and any necessary additional zones will be developed. The Exclusion Zone will be designated as an area within a 15 foot radius of the boring. The Site Manager may extend this zone based on prevailing wind direction and ambient concentrations encountered. The Support Zone will be considered any area outside the Exclusion Zone. The Contamination Reduction Zone will be established when appropriate. The zones will be marked by appropriate flags and stakes, and personnel will be briefed about activities and protective equipment for each zone.

4.5 TASK SPECIFIC LEVELS OF PROTECTION/WORK ZONES

Based on experience at similar sites, it appears that the primary exposure to contaminants may occur through physical contact or through inhalation while handling potentially contaminated samples. It seems appropriate, therefore, to specify protective measures based on the work activity, rather than requiring a site-wide level of protection. All work zones located in Dunn Field will be approved by the US Army Technical Escort Unit prior to investigating suspected chemical burial sites.

4.5.1 Topographic Survey

All site surveying will be conducted after soil boring and sampling have been accomplished. The site will be in its original configuration and no specific Exclusion Zone is required. The surveying work will be non-intrusive and therefore the survey crew will be allowed to perform the site survey in a basic work uniform (Level D) unless significant contamination is discovered during the field investigations at the site. In the case where high levels were observed with the PID in the breathing zone, around the site, the survey crew would be required to perform its work with the appropriate up-graded protection which would include appropriate respirators equipped with suitable cartridges for organic vapors, dusts, and mists.

4.5.2 Soil Boring and Well Installation

For soil boring and well installation, including soil sampling, personal levels of protection will initially be the modified

Level D as designated previously. However, if contamination above action levels is encountered during the soil boring and sampling, the previously specified work zones will be established.

4.5.3 Well Development and Water Sampling

The modified Level D designated previously, will be used during well development and both ground water and surface water sampling. In addition, due to the increased potential for splashed water, face shields and taping of gloves and boots will be required. However, if contamination above action levels is encountered the previously described work zones will be established.

4.5.4 Sediment Sampling

Sediment samples will be obtained from Lake Danielson. The sampling will be done from a small row boat available at the site. Strict boating rules will be enforced to minimize the potential for capsizing. The personal protection level for this sampling will be the modified level D previously described, with the addition of lifejackets, face shields, and taping of gloves and boots. In the event of capsize, the samplers will proceed as fast as possible to emergency shower locations.

4.6 EMERGENCY EQUIPMENT

The emergency equipment described below will be available on the site during field operations.

4.6.1 Fire Extinguishers

Because of the potential threat of fire at hazardous waste sites, fire extinguishers will be readily available and at hand throughout the investigation. All fire extinguishers will be

Class ABC. The fire extinguisher will be kept with the field crew during any subsurface activity such as drilling or backhoe excavations.

4.6.2 First Aid Kits

An industrial first aid kit with sufficient supplies for five people will be kept in the support area. Smaller first aid kits will be kept in clean areas and with field crews. At least one individual at the site will be trained in First Aid and CPR.

4.6.3 Eye Wash

A portable eyewash (meeting the minimum requirements of ANSI Z358.1) and sufficient potable water for copious flushing will be readily available and at hand throughout the investigation. The eyewash unit is kept on-site in a support vehicle.

4.6.4 Emergency Showers

Emergency shower facilities will be located at DDMT. Coordination with the base will be obtained to use these facilities if necessary.

4.6.5 Communications

Emergency telephone numbers are provided in Section 6.1 of this SHERP, which will be readily available to any of the field crew. Emergency communication will be discussed in the safety briefings prior to initiating the field work. The location of the telephone closest to the site will be identified to each member to the field team. A telephone, for emergency use only, is located inside Building 230, in Section II of the Warehouse.

5.0 SITE OPERATING PROCEDURES

5.1 SAFETY PLAN RESPONSIBILITIES

The Project Manager is responsible for ensuring that each member of the field team is aware of all components of the safety plan. This plan covers all phases of operation at the site, including:

- Hazard identification and assessment
- Established work zones
- Level of personal protective equipment required in each zone
- Work practices
- Sampling procedures
- Entry and exit routes
- Decontamination procedures
- Accident/emergency response

5.2 ACCIDENT PREVENTION

The following items are requirements to protect the health and safety of field workers and will be discussed in the safety briefing prior to initiating work on the site.

5.2.1 General Safety Operating Procedures

- A buddy system will be used. Hand signals will be established, where necessary, to maintain communication.

- During site operations, each worker will consider himself as a safety backup to his partner. Off-site personnel provide emergency assistance. All personnel will be aware of dangerous situations that may develop.

- Visual contact will be maintained between buddies onsite when performing hazardous duties.

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of hazardous material is prohibited at the job site, and good hygiene is required before pursuing these activities away from the job site.

- Prescription drugs will not be taken by personnel where the potential for contact with toxic substances exist, unless specifically approved by a qualified physician. Alcoholic beverage intake is prohibited during the work day at the site.

- No excessive facial hair which interferes with the face to face piece seal of the respirator will be permitted on personnel required to wear such equipment. Each staff member will be fit-tested for respirators. Level D initially specified at the site does not require the use of respirators. However, half-faced respirators equipped with suitable cartridges for organic vapors, dusts, and mists, will be available on-site in the event that upgrading to Level C is necessary. The respirators and spare cartridges will be available on-site in a support vehicle.

- Work areas for various operational activities (equipment testing, decontamination) will be established if higher levels of protection are implemented at the site.

- Procedures for leaving any contaminated area will be planned and reviewed prior to going on-site.

- Work areas and decontamination procedures have been established based on prevailing site conditions and are subject to change if site conditions change.

- No personnel will be admitted to the site without the proper safety equipment and training.

- Proper decontamination procedures must be followed before leaving the site. Decontamination in the Level D mode of operation will consist of good personal hygiene and cleaning boots and gloves before leaving the site.

- All personnel must comply with established safety procedures. Any staff member who does not comply with safety policy, as established by the Health and Safety Officer or the Project Manager, will be immediately dismissed from the site.

- Any medical emergency supersedes routine safety requirements.

- The Field Safety Coordinator will make regular safety inspections of the site to insure that operations are being conducted in accordance with established Standard Operating Procedures.

5.2.2 Before Leaving Field Office

- Review site information (see Site Manager).

  - Expected hazards
  - Special conditions
  - Sampling procedures
  - Location of telephones and emergency equipment
  - Emergency medical information
  - Level of personnel protection required

- Check safety gear and equipment. The following equipment will be used at the site, or will be available for issue, depending on site-specific conditions. The safety gear and equipment will be available on-site in a support vehicle.

  - Steel-toed chemical-resistant safety boots
  - Neoprene or Nitrile rubber boots

- Standard Tyvek coveralls
- Hard-hat
- Goggles or Safety Glasses
- Viton gloves
- Half-face, air-purifying respirator with cartridges suitable for organic vapor, dusts, and mists
- Ziplock baggies, quart and gallon size, to keep spare equipment clean
- Field standard operating procedures
- Eyewash
- First Aid Kit(s)

- Backup equipment and spares will be maintained, including:

  - Extra Tyvek suits and gloves
  - Duct tape
  - Trash barrel for return transportation of contaminated gear and equipment
  - Extra respirator cartridges

5.2.3 Before Entering Site

- No eating/drinking/smoking except away from the work area. Use good sanitary practices and wash hands and face thoroughly before eating/drinking/smoking.

- Drink replacement fluids, especially during hot weather conditions, and carry drinks for use in support area.

- Place sample containers in field sample carrier (backpacks or carrier). Do not place containers or equipment on potentially contaminated surfaces.

- Check location of emergency eye wash supply and telephones.

- Check alternate safety gear.

  - Respirator (test even if you are not going to wear it immediately).
  - Hard-hat
  - Goggles or Safety Glasses

- Check gear for rips/tears/malfunctions.

- Set up buddy system prior to proceeding.

- Preliminary site survey.

  - Characterize physical conditions of site
  - Use as much <u>excess</u> caution as possible

- Use caution - go slowly.

5.2.4 <u>Sampling</u>

- No eating/drinking/smoking while sampling.

- Use standard, specified sampling techniques (see QC Plan or discuss with Site Manager).

- Use appropriate care in handling samples. If the sampling site is not accessible using your gear, don't take a sample. Confer with buddy and team leader about alternate sampling locations.

- Wipe off spills, dirt, and residue immediately.

- If any gear or equipment damage develops, immediately repair or replace.

- If any physical discomfort occurs, such as lightheadedness, stop work, notify your buddy, and return to the designated Support Zone.

5.3 DECONTAMINATION PROCEDURES

All personnel must complete appropriate decontamination procedures prior to leaving the site in a manner that is responsive to actual site conditions. A decontamination area will be set up at an appropriate site location. Receptacles will be provided for all disposable clothing. The receptacles will be conventional trash cans lined with heavy duty polyethylene trash bags. Wash tubs containing a detergent-water solution or an appropriate decon solution (see below) and soft-bristle brushes will be used to decontaminate reusable personal protective clothing and boots. Following the detergent-water washing, an intermediate rinse will be applied when necessary. Clean, potable water will be used for the final rinsing. Decontamination solutions will be disposed of on site in an area which allows the infiltration of the solutions into the soil. Each individual shall conduct proper personal hygiene which may include washing any exposed skin prior to eating, smoking, or leaving the site, consistent with site conditions. Initial decontamination procedures application at the site are for Level D. Decontamination procedures for higher levels of protection (i.e., Level C) are also discussed.

5.3.1 Level D Routine Decontamination

- Wash boots and gloves.
- Remove boots, gloves, and field clothes, and change into non-field clothes and street shoes.
- Place boots, gloves, and field clothes in specified storage area. Dispose of disposable suits and any other disposable

and/or uncleanable equipment in the proper receptacle on site. Check with team leader if uncertain.

- All field personnel must wash their face and hands thoroughly before leaving the site.

5.3.2 Level C Routine Decontamination

A proposed schematic for Level C decontamination is provided in Figure 5-2. The Site Manager may adjust the decontamination layout according to site conditions. Decontamination procedures for Level C will consist of the following:

- Field equipment should be placed at the first drop site. It will be appropriately decontaminated later.

- Boots and gloves should be washed with a detergent solution and rinsed in clear water.

- Gloves, glasses and hard hats can be removed and left at the second drop site.

- Respirators can be removed, washed and swabbed down with alcohol, and bagged for storage. Exhausted respirator cartridges can be removed and thrown away at this point. Respirators should be left at the third drop site.

- Boots and disposable clothing can now be removed. Boots are deposited at drop site number 2. Disposables are thrown away.

- Street shoes can be put on.

- All field personnel must wash their face and hands thoroughly before leaving the site.

5.3.3 Heavy Equipment Decontamination

If site conditions warrant, heavy equipment will be decontaminated prior to leaving the site. This will include manual removal of gross contamination with shovels, etc., followed by a steam or high pressure wash, paying particular attention to tracks, wheels, and undercarriages. If no significant contamination is encountered on site, then steam or high pressure wash is not required.

5.3.4 Decon Solutions

Decon solutions are prepared to react with, neutralize, or physically remove specific contaminants on a site. All decon solutions and rinse waters are collected in wash tubs and will be disposed of on site in an area which allows for the infiltration of the solutions in the soil.

Decon Solution 1 - for light contamination; liquinox-based

Decon Solution 2 - for organic contaminants; detergent-based

Decon Solution 3 - for most acids and alkalines; trisodium phosphate based

Decon Solution 4 - for organophosphates, cyanides; calcium hypochlorite based

It is anticipated (based on prior sampling results) that Decon Solution 1 will be sufficient for this site.

5.4 PERSONAL HYGIENE

A sufficient supply of clean, potable water and hand soap will be provided at the site for the personal hygiene of field personnel. Personal hygiene primarily entails washing and is not strictly considered decontamination.

6.0 EMERGENCY PROCEDURES

6.1 EMERGENCY TELEPHONE NUMBERS

The first contact in an emergency should be security office, extension 6677. This number may be called from any phone on DDMT. Emergency Response Team will meet at gate and provide an escort.

Ambulance:	Memphis	901/522-5252
Police:	Memphis Police	901/528-2222
Fire Department:	Memphis Fire Dept.	901/458-8281
Hospital:	Baptist Central Hospital 899 Madison Avenue	901/522-5252

Law Field Office:
LEI/Government Services Division
404/421-3400

Project Manager : John R. Absalon
Office 404/421-3408
Home 404/432-0767

Site Manager : Robert Manson
Office 404/421-3554
Home 404/591-1547

Health & Safety Officer : Jack Peng
Office 404/421-3536
Home 404/447-0544

6.2 HOSPITAL

Hospital emergency room personnel will be contacted and briefed regarding the scope of the study. The emergency route to the hospital will be discussed with all field investigation personnel prior to beginning any activities. The hospital is located approximately seven miles northwest of DDMT, at the intersection of Dunlapp and Union Avenue off from Highway 240 (as shown in Figure 6-1). Directions to the hospital and a route map will be available to all field personnel at the site.

6.3 ACCIDENTS/INJURIES

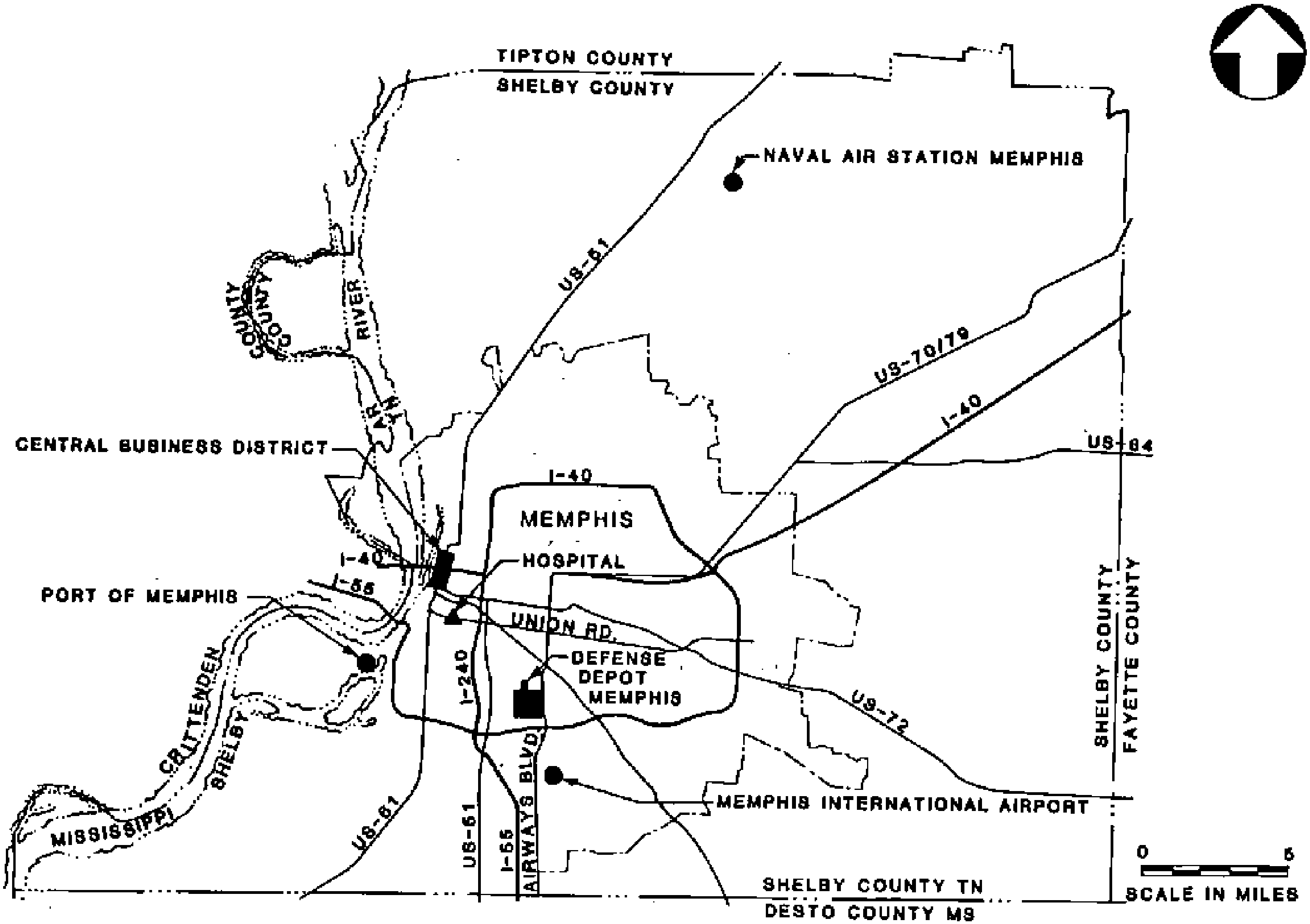
Depending on the severity of the injury, treatment may be given at the site by trained personnel, additional assistance may be required at the site (emergency medical technicians), or the victim may have to be transported to hospital.

In life threatening situations, care must begin WITHOUT considering decontamination. Outside protective clothing can be removed if it does not cause delays or aggravate the problem. Respirators must always be removed. Normal decontamination procedures should be followed when at all possible.

The Health and Safety Officer shall immediately notify the Contracting Office (CO) of any accident/incident. Within two working days of any reportable accident, the Health and Safety Officer shall complete and submit to the CO an Accident Report on ENG Form 3394 in accordance with USACE, EM 35-1-1, Appendix C and the USACE Supplement 1 to that regulation.

It will be the responsibility of the Health and Safety Officer to investigate thoroughly the details of any accident or injury. Based on his findings, he will recommend any corrective action relative to field procedures to prevent recurrence.

FIGURE 6-1
HOSPITAL LOCATION MAP



LAW ENVIRONMENTAL, INC.
GOVERNMENT SERVICES DIVISION

6.4 FIRE

The potential for fire is significant at many hazardous waste sites. During subsurface operations, explosimeters and photoionization detectors are used to monitor levels of potentially combustible gases and volatile organics. Fire extinguishers (Class ABC) will be kept on each drilling rig. The local fire department will also be alerted to the nature and location of any field investigation.

6.5 EXPLOSION

There is frequently the possibility of explosion during hazardous material investigations. Work will be stopped and the situation evaluated when readings in excess of 10% of the lower explosive limit are obtained on the MSA Explosimeter. Continuous monitoring will be performed as long as readings between 10% and 20% of the lower explosive limit are obtained. If measured readings are greater than 20%, the site will be evacuated until appropriate work procedures can be established.

6.6 SITE EVACUATION

Three stages of evacuation have been determined:

- Withdrawal from immediate work area
- Evacuation of site
- Evacuation of nearby area facilities

6.6.1 Withdrawal from Work Area

Withdrawal to a safe upwind location will be required if any of the following occur:

- If concentrations of volatile organics, combustible, or toxic gases exceed 10 ppm above background levels in the breathing zone or 10% of the lower explosive limit the work area will be temporarily evacuated for further assessment.

- If a minor accident occurs, Field operations will resume after first aid and/or decontamination procedures have been administered.
- Equipment malfunctions.

6.6.2 Evacuation of Site

The Site will be evacuated in the following cases:

- Explosive levels of combustible gases exceed 20 percent LEL.

- A major accident or injury occurs.

- Fire and/or explosion occurs.

- If measured organic levels of an unknown contaminant exceed 250 ppm as measured on a Photovac TIP photoionization detector (PID), the site will be evacuated, the USACE will be notified, and the contract will be modified to allow upgrades necessary to operate at the appropriate level.

6.6.3 Evacuation of Nearby Area Facilities

The Site Manager is responsible for determining if circumstances exist for area contamination, and should always assume worst-case conditions until proven otherwise. DDMT and local fire and police departments will be contacted. A list of their addresses and telephone numbers will be carried by the Site Manager.

6.7 SAFETY OF THIRD PARTIES

Work area access will controlled at the site and only verified team members, and previously approved personnel will be allowed in work areas or areas containing potentially hazardous materials or conditions. Work zones will be staked and flagged to deter access by third parties. No unauthorized personnel will be allowed in the designated work zones.

7.0 MEDICAL MONITORING PROGRAM

Each individual will undergo and pass a comprehensive physical examination prior to going to any hazardous site. LEGS employees participate in the program described below, under the direction of the Occupational Medicine Associates Center. Subcontractor personnel are required to furnish documentation of equally comprehensive examinations. Subcontractors will also furnish certification of annual medical surveillance.

The tests included in the LEGS medical examination are described in Table 7-1. Other tests can be added if warranted by special needs or exposure history. Examples of the medical history forms are shown in Appendix B.

7.1 INITIAL EXAMINATION

The initial examination is intended to determine each employee's complete medical history as well as the compatibility of the (bio)medical status with the job description. For example, minimum physical requirements must be met:

- Vision - Binocular vision is required, and must be correctable to 20/40 (Snellen) in one eye and 20/20 in the other. Normal depth perception and basic color distinction are required.

- Hearing - Hearing loss in either ear should be no more than 30 dB at 500, 1000 and 2000 hertz.

- Smell - Normal.

- Speech - No conditions causing indistinct speech.

- Other - No disease or condition which would interfere with the full performance of duties.

TABLE 7-1

Standard Biomedical Monitoring

Test	Initial Examination	Annual Examination
Full physical	X	X
EKG	X	(X)
Chest X-ray	X	(X)
Hematology evaluation (including complete blood count, differential and platelet count)	X	X
Hemoglobin and hematocrit	X	X
Urinalysis	X	X
Vision screen	X	X
Executive profile (SMA-22, CBC, thyroid profile)	X	X
Pulmonary function	X	X
Audiometry	X	(X)
Proctoscopic exam	(X)	(X)

(X) - Included at the discretion of the occupational medicine physician.

An electrocardiogram and spirometry are performed. The electrocardiogram is recorded as optional for annual re-examination. Employees over 35 years of age and employees with cardiac risk factors (overweight, smoking) are required to have annual EKGs.

Chest x-rays have, for the most part, been eliminated from the physical examination except for the initial baseline exam. The physician gives the patient a complete examination of the chest. This chest exam coupled with pulmonary function studies, gives the medical staff sufficient information relative to any potential pulmonary problems. If chest x-rays are indicated from the results of later examinations, they are then performed. This decision is left to the discretion of the examining physician.

In addition, an extensive battery of hematological and serum chemistry determinations are performed. Hematological tests include a full blood count with differential and platelet count.

The standard serum-enzyme chemistry is also performed for the following parameters:

- Alsanine aminotransferase (ALT, SGPT)
- Aspartate aminotransferase (AST, SGOT)
- Albumin
- Alkaline phosphatease
- Bilirubin (total)
- Blood Urea Nitrogen (BUN)
- BUN/Creatinine ratio
- Calcium
- CO_2 (Content)
- Cholesterol
- Chloride
- Creatinine
- Globulin
- Glucose
- Lactate dehydrogenase (LDH)

Phosphorus (Inorganic)
Potassium
Protein
Sodium
Triglycerides
Uric acid

A routine urine analysis is performed, including observation of color, specific gravity, and microscopic examination of formed elements and pathologically significant elements not normally present such as glucose, protein, blood, ketones, and bile acids. The majority of these parameters are indicative of kidney dysfunction.

Audiometry (hearing examination) is often included in the examination cycle if significant noise exposure is anticipated (i.e., working in close proximity to heavy equipment for extended periods of time).

7.2 QUARTERLY EXAMINATIONS

Quarterly examinations consist of blood chemistry and enzyme tests, focused on the detection of preclinical signs and imminent adverse health effects. These tests require serum and urine analysis only and can be performed by licensed paramedical personnel. Quarterly exams can be performed on all site members, as deemed necessary by the Health and Safety Officer and Occupational Medicine Associates, depending on frequency and duration of field work.

7.3 ANNUAL EXAMINATION

Annual examinations are a repeat of the initial examination. A number of the recommended biomedical tests for the establishment of baseline and sensitivity parameters can sometimes be dispensed with at this time. All personnel included in the initial exam program are given annual exams.

7.4 SPECIAL PARAMETERS

If indicated by the medical history and/or initial laboratory results, the examining physician will order additional tests. In addition, a host of parameters can be added to the parameters mentioned to account for prior and expected exposure conditions. An example would be exposure of heavy metals. If lead is a primary agent, a blood lead evaluation would be performed, including a quantitative blood lead determination. Other heavy metals could be analyzed in either blood or urine samples.

Summary reports of the examinations are provided and reviewed with each employee. Complete records are kept at the Occupational Medicine Associates offices.

*****

REFERENCES

HSDB, 1988. Hazardous Substances Data Base: 3,3',-Dimethylbenzidine, National Library of Medicine. Bethesda, MD.

Kearney, 1975. Herbicides, 2nd ed. Sited in HSDB: Trichloroacetic acid. National Library of Medicine. Bethesda, MD.

Worthing, 1979. Pesticide Manual, 6th ed. Sited in HSDB: Trichloroacetic acid. National Library of Medicine. Bethesda, MD.

APPENDIX A

PERSONAL PROTECTIVE AND SAFETY EQUIPMENT

APPENDIX A

A.1 PERSONAL PROTECTION AND SAFETY EQUIPMENT

The following levels of protection are recommended in Occupational Safety and Health Guidance Manual for Hazardous Waste Operations.

A.1.1 Protective Equipment and Selection Criteria

Level A

Level A is worn when the highest level of respiratory, skin, and eye protection is required.

Protective Equipment Required

- Pressure-demand (positive pressure) SCBA
- Fully encapsulating suit
- Gloves (inner)
- Gloves (outer) chemical-resistant, Neoprene
- Boots, chemical-resistant, steel toe and shank
- Hard-hat (optional)
- Two-way radio communication
- Disposable coverall chemical suit (optional)

Selection Criteria

Any of the following conditions warrants Level A protection:

- A chemical substance has been identified which requires the highest level of protection based on a measured (or potential) high concentration of atmospheric vapors, gases, or particulates; or work functions involve high potential for exposure to vapors, gases, or particulates.
- Extremely hazardous substances (e.g., dioxin, Department of Transportation (DOT) Class "A" poisons, concentrated

pesticides) are known or suspected, and skin contact is possible.

- The potential exists for contact with substances that destroy skin.
- Reading on the organic vapor analyzer meter exceeds 500 ppm.
- Operations are conducted in confined, poorly ventilated areas or unknown air quality hazards.

Level B

Level B safety gear is worn when the highest level of respiratory protection is required, but a lesser degree of skin protection is required.

Protection Equipment

- Pressure-demand (positive pressure) SCBA, NIOSH/OSHA approved
- Chemical-resistant splash suit or polycoated disposable chemical-resistant coveralls
- Gloves (inner)
- Gloves (outer), chemical-resistant (taped to sleeves)
- Boots, inner, chemical-resistant, steel toe and shank
- Boots, outer, disposable (taped to cuffs), optional
- Hard-hat
- Two-way radio communication

Selection Criteria

- Atmospheres with chemical concentrations considered Immediately Dangerous to Life and Health (IDLH) that do not represent a severe skin hazard.
- Atmospheres exceeding limits of protection afforded by a full-face, air-purifying respirator.
- Atmospheres containing substances with poor warning properties, substances for which air-purifying cartridges

do not exist, or have low removal efficiency.

- Atmosphere containing <19.5 percent oxygen.
- Conditions are such that small exposed areas about the head and neck will not be contacted by hazardous substances.

Level C

Level C safety equipment will be worn when the types and concentrations or airborne contaminants are known, and the criteria for using air-purifying respirators are met.

Protective Equipment

- Air-purifying respirator with suitable cartridges, fit tested
- Chemical-resistant suit or polycoated disposable chemical-resistant coveralls
- Gloves (inner)
- Gloves (outer), chemical-resistant
- Boots (inner), steel toe and shank
- Boots (disposable, optional)
- Hard-hat

Selection Criteria

- Atmospheric contaminant concentrations do not exceed IDLH levels.
- Air concentrations of identified substances will be reduced by the respirator to below the substance(s) exposure limit.
- Service limit of respirator cartridges will not be exceeded.
- Conditions are such that small exposed areas about the head and neck will not be contacted by hazardous substances.
- Job functions do not require SCBAs.

- Atmospheres contain between 19.5 and 25 percent oxygen.
- Individual has been successfully fit tested.

<u>Level D</u>

Level D safety equipment is the basic work uniform.

Protective Equipment

- Chemical-resistant suit or disposable chemical-resistant coveralls (optional)
- Gloves required with any site soil or water contact
- Boots (inner), steel toe and shank
- Hard-hats
- Safety goggles or glasses
- Face shield (optional)
- Disposal boot covers (optional)

Selection Criteria

- Contact with contaminated material is extremely unlikely, and no inhalable toxic substances are present.

APPENDIX B

MEDICAL FORMS

R. BURT PRATER, JR., M.D
PHILLIP R. ROGERS, M.D.
SCOTT D. HENDERSON, M.D.
MICHAEL P. SEYFRIED, M.D.
STEPHEN K. THOMPSON, M.D.
MEMBERS, AOMA

OCCUPATIONAL MEDICINE ASSOCIATES

O M Associates, Inc.

Specializing in Comprehensive Occupational Health Care Programs for Industry and Business Since 1969

LYNN A. HENDERSON, DIRECTOR
CHARNER BELLAMY, R.N., C.F.N.P.
ROBERT J. MUNOZ, P.A.C.
GINGER BOYKIN, R.N., C.F.N.P.

To the Person Being Examined:

As part of your company sponsored occupational health program, this Periodic Medical Monitoring Examination is a continuation of the comprehensive Medical Monitoring Program that began with a Baseline Examination and continues with regular Periodic Examinations.

This examination was carefully designed so that comparisons can be made between this examination and your Baseline Examination, as well as other Periodic Examinations you may have taken. Only by such careful attention to every detail can your health and safety be properly monitored. When you leave your current position, or when you no longer require medical monitoring, you will take this examination as your Exit Examination.

Please complete this questionnaire before your scheduled appointment time. If you are uncertain about a particular question, please ask your examiner during your appointment. The blood studies are an essential part of this examination, and require some preparation by you. On the night prior to having your blood drawn, you must not take any food or liquids (except water or black coffee) after 10:00 P.M. If you are a diabetic, you should omit this instruction and inform your examiner's staff at the beginning of your appointment. Excessive alcohol intake during the week prior to your examination may affect the results of your blood tests, so this is discouraged.

You will receive a letter regarding the results of the examination as you have in the past. You will be informed of any abnormalities, along with appropriate recommendations for retesting or job restrictions, if needed. You will also receive information about your personal health, such as your blood pressure and cholesterol. This examination is not meant to take the place of your regular health examinations with your personal physician.

Please take the time to fill this form out carefully and completely, because your attention to detail will help us help you.

Sincerely,

Scott D. Henderson, M.D.
Medical Director
O M Associates, Inc.

CHAMBLEE/DUNWOODY
4553 N. Shallowford Rd.
Suite 22-B
Atlanta, GA 30338
455-2008

PEACHTREE CORNERS
4028 Holcomb Bridge Rd.
Suite 200
Norcross, GA 30092
449-9014

OCCUPATIONAL MEDICINE ASSOCIATES

09 234

BASELINE MEDICAL MONITORING EXAM

CONTACT SHEET

NAME OF PERSON EXAMINED ______________________________ SOC.SEC.# ____________

ADDRESS ______________________ CITY ____________ STATE ________ ZIP ________

HOME PHONE ( ) __________ DATE OF BIRTH ____/____/____ SEX: M F

EMPLOYER ______________________________ EMPLOYER'S PHONE ( ) __________

EMPLOYER'S ADDRESS ____

CITY ______________ STATE ____________ ZIP __________

NAME OF CONTACT PERSON ______________________ TITLE ______________

PRINTED NAME OF EXAMINING PHYSICIAN ______________________________

ASSOCIATED PRACTICE, CLINIC, OR HOSPITAL ______________________________

PHYSICIAN'S ADDRESS ____

CITY ______________ STATE ____________ ZIP __________

PHYSICIAN'S TELEPHONE ( ) __________

APPOINTMENT DATE ____/____/____

APPOINTMENT TIME __________

OM#12

R. BURT PRATER, JR., M.D.
PHILLIP R. ROGERS, M.D.
SCOTT D. HENDERSON, M.D.
MICHAEL P. SEYFRIED, M.D.
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GINGER BOYKIN, R.N., C.F.N.P.

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N O T I C E   T O   E M P L O Y E E

____
(name)

You are scheduled for a ( ) Baseline Exam, or a ( ) Periodic Annual Exam, or a ( ) Exit Exam

on ______________________ at ____________________
(date) (time)

at the following location of OMA: ( ) Chamblee Dunwoody
( ) Peachtree Corners

The new BASELINE QUESTIONNAIRE is necessary on all employees as a starting point for our computer data. Therefore, although you may be scheduled for a Periodic Annual, or an Exit Exam, you will be given the Baseline Questionnaire initially.

If you wear contact lenses or glasses, it is important that you bring them to your appointment (also bring your contact lens case and fluid). Without these items, we will be unable to test your uncorrected vision.

Thanks for your cooperation.

CHAMBLEE/DUNWOODY
4553 N. Shallowford Rd.
Suite 22-B
Atlanta, GA 30338
455-7008

PEACHTREE CORNERS
4028 Holcomb Bridge Rd.
Suite 200
Norcross, GA 30092
449-9014

OCCUPATIONAL MEDICINE ASSOCIATES

AUTHORIZATION FOR RELEASE OF INFORMATION
TO PRIVATE PHYSICIAN

Do you have a private physician: Yes( ) No( )

If yes, do you request that Occupational Medicine Associates send the results of your examination to him/her: Yes( ) No( )

PRIVATE PHYSICIAN
NAME: ______________________ Phone __________

ADDRESS: ______________________

____

____

____
Your Name Date

____
Company

BASELINE MEDICAL MONITORING QUESTIONNAIRE

'9 237

I. A. What is your marital status?

1. single
2. married
3. widowed
4. separated
5. divorced

B. What is your race?

1. White
2. Black
3. Asian
4. Hispanic
5. American Indian
6. Other (specify) ____________________

C. Is this a Pre - placement exam? YES NO

D. If this is not a Pre - placement exam, how long have you worked for this company?

(write in answer) ____________________

E. If this is not a Pre - placement exam, how long have you worked in your current position?

(write in answer) ____________________

F. What is your current or proposed job title? ____________________

G. Please give a brief description of this job. ____________________

____

In order to evaluate your health and safety at the worksite, information about your current or proposed job requirements is needed. Please circle all requirements listed in the section below that apply to your current or proposed job. If you are unaware of your job requirements, have your supervisor complete this section before your examination.

H. FUNCTIONAL REQUIREMENTS

1. Heavy lifting, 45 pounds or over.
2. Moderate lifting, 15-44 pounds.
3. Light lifting, under 15 pounds.
4. Heavy carrying, 45 pounds or over.
5. Moderate carrying, 15-44 pounds.
6. Light carrying, under 15 pounds.
7. Straight pulling.
8. Pulling hand over hand.
9. Pushing.
10. Reaching above shoulder.
11. Use of fingers.
12. Both hands required.
13. Walking, greater than one hour.
14. Standing, greater than one hour.
15. Repeated crawling.
16. Repeated kneeling.
17. Repeated bending.
18. Climbing, legs only.
19. Climbing, use of legs and arms.
20. Both legs required.
21. Operation of motor vehicle.
22. Ability for rapid mental and muscular coordination simultaneously.
23. Near vision correctable at 13 to 16 inches to Jaeger 1 to 4.
24. Far vision correctable one eye to 20/20 and to 20/40 in the other.
25. Far vision correctable in both eyes to 20/40
26. Both eyes required.
27. Depth perception.
28. Ability to distinguish basic colors.
29. Ability to distinguish shades of colors.
30. Hearing (aid permitted).
31. Hearing without aid.
32. Use of respirator for more than 30 days per year.
33. Use of respirator for less than 30 days per year.
34. Other (Specify) ____________________

____

K. Are you required to wear a respirator in the performance of your job? YES NO

If you are required to wear a respirator, please answer the following.

1. Indicate level of work while wearing a respirator.
   a. Light.
   b. Moderate.
   c. Heavy.
   d. Strenuous.

2. Indicate type of respirator(s) to be used.
   a. Air Purifying with mechanical filter for removing particulates.
   b. Air Purifying with canister or cartridge for removing gas and vapor.
   c. Air Purifying with combination of mechanical filter and canister or cartridge.
   d. Supplied Air pressure demand.
   e. Supplied Air demand.
   f. Supplied Air continuous flow (Airline).
   g. Self-Contained Breathing Apparatus (SCBA).
   h. Other (specify) ______________________________

3. Indicate extent of usage.
   a. On a daily basis.
   b. Occasionally, but more than once a week.
   c. Once a week.
   d. A few times a month.
   e. Once a month.
   f. Once every few months.
   g. A few times a year.
   h. Rarely.
   i. Emergency situations only.

4. How many hours do you normally use a respirator when you must use it? (Write in Number) ______________________________

II. Please answer all of the following questions. If you have ever had any of the listed conditions, mark in the "YES" column, and give the approximate date the condition occurred. Use the space at the end of each page to explain any "YES" answers.

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			YES	NO	DATE
1.	A.	Unexplained fever			
	B.	Unexplained weight loss			
	C.	Unexplained weight gain			
	D.	Loss of energy/ fatigue			
	E.	Drenching night sweats			
	F.	Heat intolerance			
	G.	Persistent unexplained itching			
	H.	Any illness within last two weeks			
2.	A.	Poor vision			
	B.	Poor night vision			
	C.	Do you wear glasses or contacts			
	D.	Color blindness			
	E.	Double vision			
	F.	Injury to eye			
	G.	Cataract			
	H.	Glaucoma			
3.	A.	Ear infection			
	B.	Hole in the eardrum			
	C.	Mastoid surgery			
	D.	Loss of hearing			
	E.	Ringing in the ears			
	F.	Use a hearing aid			

			YES	NO	DATE
	G.	Loss of smell or taste			
4.	A.	Hay fever			
	B.	Sinus trouble			
	C.	Frequent sore throat			
	D.	Frequent hoarseness			
	E.	Dental problems			
5.	A.	Tuberculosis			
	B.	Abnormal chest X-ray			
	C.	Chest surgery			
	D.	Lung collapse			
	E.	Asthma			
	F.	Pneumonia			
	G.	Bronchitis			
	H.	Chronic cough			
	I.	Wheezing			
	J.	Emphysema			
	K.	Shortness of breath			
6.	A.	High blood pressure			
	B.	Heart murmur			
	C.	Enlarged heart			
	D.	Heart failure			
	E.	Heart palpitations			

Please explain any "YES" answer. Indicate the number and letter of the condition when giving your explanation. ____________________

____

____

____

____

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			YES	NO	DATE
11.	A.	Headaches			
	B.	Head injury			
	C.	Loss of consciousness			
	D.	Fainting spells			
	E.	Epilepsy or seizures			
	F.	Dizziness (lightheadedness)			
	G.	Vertigo (spinning sensation)			
	H.	Frequent or persistent numbness			
	I.	Frequent or persistent weakness			
	J.	Stroke			
	K.	Anxiety or trouble with nerves			
	L.	Panic attacks			
	M.	Claustrophobia(fear of being closed in)			
	N.	Depression			
	O.	Mental illness			
12.	A.	Kidney stones			
	B.	Bladder infection			
	C.	Blood in urine			
	D.	Difficulty urinating			

			YES	NO	DATE
		MALES ONLY			
13.	A.	Prostate abnormality			
	B.	Testicle abnormality			
	C.	Infertility			
	D.	Inability to have an erection			
	E.	Discharge from the penis			
	F.	Spouse had miscarriage or stillbirth			
		FEMALES ONLY			
14.	A.	Irregular periods			
	B.	Last menstrual period			
	C.	Menopause			
	D.	Abnormal Pap smear			
	E.	Hysterectomy			
	F.	Are you pregnant			
	G.	Are you currently attempting pregnancy			
	H.	Difficulty becoming pregnant			
	I.	Previous miscarriage or stillbirth			
	J.	Recent PAP smear			

Please explain any "YES" answer. Indicate the number and letter of the condition when giving your explanation. ______________________________

1. Please complete the following chart to the best of your knowledge.

Provide information about your spouse and blood relatives, including those who have died.

FAMILY MEMBER	Check if Deceased ( )	Current Age or Age at Death	Significant Medical Problems and/or Cause(s) of Death
Father			
Mother			
Husband/Wife			
Brothers/ Sisters			
Children			
Other blood relatives			

2. Have any of your blood relatives (parents, grandparents, brothers or sisters) had any of the following?

AT ANY AGE?

	YES	NO			YES	NO	
a.	☐	☐	Anemia or blood disorder	g.	☐	☐	Other cancer or Leukemia
b.	☐	☐	Emphysema (severe breathing difficulty)	h.	☐	☐	Diabetes (sugar)
c.	☐	☐	Glaucoma	i.	☐	☐	Epilepsy (convulsions)
d.	☐	☐	Hay fever, asthma or allergy	j.	☐	☐	Kidney disease
e.	☐	☐	Intestinal cancer	k.	☐	☐	Heart attack or angina (severe chest pain)
f.	☐	☐	Breast cancer	l.	☐	☐	A stroke

V. SOCIAL HISTORY

1. Have you smoked cigarettes in the past? (NO means less than 20 packs of cigarettes or 12 onces of tobacco in a lifetime or less than 1 cigarette a day for a year) YES NO

2. Do you now smoke cigarettes? YES NO

3. If you smoked in the past, at what age did you quit? (write in age) ____________

4. If you now smoke or smoked in the past, how many years total have you smoked? (Write in number) ____________

5. If you now smoke or have smoked in the past, how many packs per day do/did you smoke on the average? (Chose the closest answer)

   A. ☐ Less than 1/2
   B. ☐ 1
   C. ☐ 1 1/2
   D. ☐ 2
   E. ☐ 2 1/2
   F. ☐ 3
   G. ☐ More than 3

6. Do you now or did you ever smoke a pipe? (YES means more than 12 ounces of tobacco in a lifetime - the standard pouch of pipe tobacco contains 1 1/2 ounces) YES NO

7. Do you now smoke a pipe? YES NO

8. If you now smoke a pipe or smoked in the past, how many years total have you smoked? (write in number) ____________

9. Do you now or did you ever smoke cigars? (YES means at least greater than one cigar per week for one year) YES NO

10. Do you now smoke cigars? YES NO

11. If you now smoke cigars or smoked in the past, how many years total have you smoked? (Write in number) ____________

12. Do you currently use chewing tobacco? YES NO

13. If you use chewing tobacco, how much do you use in a week? (Write in an answer) ____________

14. Do you regularly drink alcoholic beverages? YES NO

15. If YES, how many drinks, beers, or glasses of wine do you drink daily?
    A. Less than 1
    B. 1-2
    C. 3-4
    D. 5-6
    E. 7-8
    F. More than 8

16. Have you ever been diagnosed as being alcoholic or received treatment for alcoholism? YES NO
    If YES, Please explain ____________

VI. OCCUPATIONAL WORK HISTORY

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Please list all the jobs you have had prior to your present job.

NAME OF COMPANY	DATES EMPLOYED	JOB DESCRIPTION	PROTECTIVE WEAR	KNOWN EXPOSURE
			YES NO	
			YES NO	
			YES NO	
			YES NO	
			YES NO	
			YES NO	

Please answer all questions. If you need more space to explain your answer, use the space provided at the end of each page

1. Have you ever changed your residence because of a health problem? YES NO
   If YES, please explain ______
2. Have you ever lived near large industrial plants or areas of heavy pollution? YES NO
   If YES, please explain ______
3. Have you ever lived outside the United States for greater than nine months? YES NO
   If YES, where and when? ______
4. Does anyone in your household have contact with chemicals, dusts or other hazards during work or leisure activities? YES NO
   If YES, what hazard? ______
5. Do you have another job? YES NO
   If YES, what? ______
6. Do you have animals at home or in the workplace? YES NO
   If YES, please explain ______
7. Have you ever developed symptoms or an illness which you think was related to work? YES NO
   If YES, please explain ______
8. Have you ever worked with a substance which made your nose, chest or sinuses congested? YES NO
   If YES, please explain ______

Please use this space to explain any "YES" answers. Indicate the number of the question when giving your explanation.

______

______

______

VII. TOXIC EXPOSURE HISTORY

A. Have you ever worked with or been around any of the following:

	YES	NO		YES	NO
1. Assembly line	☐	☐	16. Medical facilities	☐	☐
2. Ceramics	☐	☐	17. Mining	☐	☐
3. Chemicals	☐	☐	18. Painting	☐	☐
4. Dry Cleaning	☐	☐	19. Petroleum	☐	☐
5. Electronics	☐	☐	20. Plastic Manufacture	☐	☐
6. Farming	☐	☐	21. Plating	☐	☐
7. Foundry/Smelter	☐	☐	22. Plumbing/Pipefitting	☐	☐
8. Grain elevator/silo	☐	☐	23. Printing	☐	☐
9. Grinding	☐	☐	24. Refineries	☐	☐
10. Hazardous Waste	☐	☐	25. Refinishing	☐	☐
11. Heavy equipment Operation	☐	☐	26. Sandblasting	☐	☐
12. Insulation	☐	☐	27. Sawmill	☐	☐
13. Jewelry	☐	☐	28. Shipyards	☐	☐
14. Laboratory	☐	☐	29. Textiles	☐	☐
15. Machinery	☐	☐	30. Welding	☐	☐

Please explane any "YES" answers. Indicate the number of the industry when giving your explanation: ______________________________

____

____

____

____

____

____

	Now	Past
43. Ethylene Oxide		
44. Fiberglass		
45. Flouride		
46. Formaldehyde		
47. Freon		
48. <u>Herbicides</u>		
A. 2,4-D		
B. 2,4,5-T		
C. Dioxin		
49. Hexane		
50. Hydrazine		
51. Hydrogen Sulfide		
52. <u>Insecticide</u>		
(organophosphates)		
A. Diazinon		
B. Dichlorovos		
C. Dimethoate		
D. Malathion		
E. Methylparathion		
F. Parathion		
G. Trichlorfon		
(carbamates)		
H. Aldicarb		
I. Baygon		
J. Zectran		

	Now	Past
(organochlorines)		
K. Aldrin		
L. Chlordane		
M. DDT		
N. Dieldrin		
O. Endrin		
P. Lindane		
53. Lead		
54. Mercury		
55. Manganese		
56. MEK (MethylEthyl Ketone)		
57. Methanol		
58. Methyl Chloride		
59. Methyl Chloroform		
60. Methylene Chloride		
61. Naptha		
62. Beta Napthylamine		
63. Nickel		
64. Nitrobenzene		
65. Oil Mist		

Please explain any "NOW" or "PAST" answers. Indicate the number of the substance when giving your explanation.

____

____

____

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R. BURT PRATER, JR., M.D
PHILLIP R. ROGERS, M.D
SCOTT D. HENDERSON, M.D
MICHAEL P. SEYFRIED, M.D
STEPHEN K. THOMPSON, M.D
MEMBERS, AOMA

OCCUPATIONAL MEDICINE ASSOCIATES

O M Associates, Inc.

Specializing in Comprehensive Occupational Health Care Programs for Industry and Business Since 1969

LYNN A. HENDERSON, DIRECTOR
CHARNER BELLAMY, R.N., C.F.N.P.
ROBERT J. MUNOZ, P.A.C.
GINGER BOYKIN, R.N., C.F.N.P.

To the Examining Physician,

Please review the preceding Periodic Medical Monitoring Questionnaire very carefully. If you find that a section has not been completed, please be sure that it is completed at the time of the examination. If you find that certain answers require elaboration, please do so in the spaces provided.

You will receive the appropriate protocols regarding which tests are to be performed and with what frequency. If certain tests are not indicated at the time of the examination, but have been performed in the recent past, please indicate the results and dates in the appropriate sections, and include copies of all laboratory studies.

The physical examination section is divided into two parts. Part A may be performed by your nursing or support staff. Please verify that all information is correct and properly recorded. Part B is to completed and signed by you. Please provide a brief description of any abnormal findings. Pay special attention to those physical attributes that might affect this person's ability to wear a respirator, drive a motor vehicle safety or perform their proposed or current job safely. Please assure that legible copies of all laboratory work are included before returning this booklet.

You will receive a report with a summary of the entire examination as well as a summary of any recommendations made to the company.

Sincerely,

Scott D. Henderson, M.D.
Medical Director
O M Associates, Inc.

CHAMBLEE/DUNWOODY
4553 N. Shallowford Rd.
Suite 22-B
Atlanta, GA 30338
455-7008

PEACHTREE CORNERS
4028 Holcomb Bridge Rd.
Suite 200
Norcross, GA 30092
449-9014

PART B. This section is to be completed and signed by the physician.

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1. Most recent chest X-ray. Date performed ___/___/___.
   a. Normal
   b. Other (Describe) ______________________________

2. Most recent EKG (if indicated). Date performed ___/___/___.
   A. Normal.
   B. Other (Describe) ______________________________

3. Check each of the following items in the appropriate columns.

Enter "NE" if not evaluated	Normal	Abnormal	Comments and Description of Abnormal Findings
a. EYES (Including pupils, EOMs, ophthalmoscopic)			
b. EARS (Including canals, TMs)			
c. NOSE AND SINUSES			
d. MOUTH, TEETH, PHARYNX			
e. FACIAL FEATURES (Including facial hair affecting respirator usage)			
f. NECK (Including ROM, thyroid, cervical lymph nodes)			
g. LUNGS AND CHEST			
h. BREASTS			
i. HEART			
j. PERIPHERAL VASCULAR			
k. LYMPHATICS			
l. ABDOMEN, LIVER, SPLEEN			
m. INGUINAL AND FEMORAL RINGS, HERNIA CHECK			
n. GENITALIA			
o. RECTAL			
p. FECAL (occult blood test)			
q. MUSCULOSKELETAL, GENERAL			
r. BACK			
s. EXTREMITIES			
t. SKIN			
u. NEUROLOGIC (including DTR's, motor and sensory exam)			
v. PSYCHIATRIC			

______________ DATE

______________ PHYSICIAN SIGNATURE

OCCUPATIONAL
MEDICINE
ASSOCIATES

AUTHORIZATION FOR RELEASE OF INFORMATION
TO PRIVATE PHYSICIAN

Do you have a private physician: Yes( ) No( )

If yes, do you request that Occupational Medicine Associates send the results of your examination to him/her: Yes( ) No( )

PRIVATE PHYSICIAN
NAME: ______________________ Phone ____________

ADDRESS: ______________________

____

____

____
Your Name Date

____
Company

APPENDIX C

ACCIDENT REPORTING AND RECORD KEEPING

APPENDIX C
ACCIDENT REPORTING AND RECORD KEEPING

C.1 GENERAL

C.1.1 All accidents which occur incident to an operation, project, or facility for which this manual is applicable, will be investigated, reported and analyzed as prescribed by the designated authority.

C.1.2 On contract operations, the prime contractor shall be responsible for recording and reporting all accident exposure and experience incident to the work. (This includes exposure and experience of the prime contractor and of his sub-contractors.) As a minimum these records shall include exposure work-hours and a log of occupational injuries and illnesses (OSHA Form 200 or equivalent as prescribed by 29 CFR 1904).

All diagnosed occupational illnesses and injuries that result in a fatality or a lost work day shall be investigated and reported to the designated authority in accordance with the requirements of the agency having jurisdiction.

C.1.3 On contract operations, the prime contractor shall keep a record of employee exposure to toxic materials and harmful physical agents. Also, the prime contractor shall notify the designated authority and the employee of any excessive exposure and the hazard control measures that will be taken.

C.1.4 An accident with any of the consequences listed below shall be immediately reported to the designated authority. These accidents will be investigated in-depth to identify all causes and to recommend hazard control measures. Except for rescue and emergency measures, the accident scene shall not be disturbed until it has been released by the investigating official. The consequences requiring an in depth investigation are:

a) Fatal injury
b) Five or more persons admitted to a hospital.
c) Property damage in an amount specified by the designated authority.

Normally investigative officials, having expertise in areas related to the incident, will be selected from operating elements other than the element involved. The format for the investigation report will be as specified by the designated authority.

C.1.5 A daily record of all first aid treatments not otherwise reportable shall be maintained on prescribed forms and furnished to the designated authority upon request.

C.1.6 Injured persons are responsible for reporting all injuries as soon as possible to their employer or immediate supervisor. No supervisor shall decline to accept a report of injury from a subordinate.

Source: USCOE, EM 35-1-1.

APPENDIX D

CHRIS CHEMICAL DATA SHEETS

Sources:

Chemical Hazards Response Information System (CHRIS), 1984. DOT/USCG. Washington, DC: U.S. Printing Office.

ACETONE

ACT

Common Synonyms	Watery liquid	Colorless	Sweet odor
Dimethyl ketone Propanone 2-Propanone	Floats and mixes with water. Flammable, irritating vapor is produced.		

[illegible]
Shut off ignition sources and call fire department. Keep people away.
Stop discharge if possible.
Isolate and remove discharged material.
Avoid contact with liquid and vapor.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Extinguish with dry chemical, alcohol 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, may 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 eyes.
Not irritating to skin.
IF IN EYES, hold eyelids open and flush with plenty of water.

Water Pollution

Dangerous to aquatic life in high concentrations.
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)
Issue warning-high flammability
Disperse and flush

2. LABEL
2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS
3.1 CG Compatibility Class: Ketone
3.2 Formula: CH_3COCH_3
3.3 IMO/UN Designation: 3.1/1090
3.4 DOT ID No.: 1090
3.5 CAS Registry No.: 67-64-1

4. OBSERVABLE CHARACTERISTICS
4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Sweetish; pleasant, resembling that of mint or fruit; pungent; sharp, penetrating; residual; ketonic; pleasant, non-residual

5. HEALTH HAZARDS
5.1 Personal Protective Equipment: Organic vapor canister or air-supplied mask; synthetic rubber gloves; chemical safety goggles or face screen shield.
5.2 Symptoms Following Exposure: INHALATION: vapor irritating to eyes and mucous membranes; acts as an anesthetic in very high concentrations. INGESTION: low order of toxicity but very irritating to mucous membranes. SKIN: prolonged excessive contact causes defatting of the skin, possibly leading to dermatitis.
5.3 Treatment of Exposure: INHALATION: if victim is overcome, remove to fresh air and call a physician; administer artificial respiration if breathing is irregular or stopped. INGESTION: if victim has swallowed large amounts and is conscious and not having convulsions, induce vomiting and get medical help promptly; no specific antidote known. SKIN: wash well with water. EYES: flush with water immediately for at least 15 min. Consult a physician.
5.4 Threshold Limit Value: 750 ppm
5.5 Short Term Inhalation Limits: 1000 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 1; LD_{50} = 5 to 15 g/kg (dog)
5.7 Late Toxicity: Not pertinent
5.8 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors cause moderate irritation of the eyes or respiratory system. Effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: No appreciable hazard. Practically harmless to the skin because it is very volatile and evaporates quickly from the skin.
5.10 Odor Threshold: 100 ppm
5.11 IDLH Value: 20000 ppm

6. FIRE HAZARDS
6.1 Flash Point: 4°F O.C.; 0°F C.C.
6.2 Flammable Limits in Air: 2.6%-12.8%
6.3 Fire Extinguishing Agents: Alcohol foam, dry chemical, carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water in straight hose stream will scatter and spread fire and should not be used.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 869°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 3.9 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: 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: 18

8. WATER POLLUTION
8.1 Aquatic Toxicity:
14,250 ppm/24 hr/sunfish/killed/tap water
13,000 ppm/48 hr/mosquito fish/TL_m/turbid water
8.2 Waterfowl Toxicity: Not pertinent
8.3 Biological Oxygen Demand (BOD): (Theor) 122%, 5 days
8.4 Food Chain Concentration Potential: None noted

9. SHIPPING INFORMATION
9.1 Grades of Purity: Technical 99.5% plus 0.5% water; Reagent 99.5% plus 0.5% water
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-P-Q-R-S

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	0
Poisons	0
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	1
Aesthetic Effect	1
Reactivity	
Other Chemicals	1
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: 58.08
12.3 Boiling Point at 1 atm: 133°F = 56.1°C = 329.3°K
12.4 Freezing Point: −138°F = −94.7°C = 178.5°K
12.5 Critical Temperature: 455°F = 235°C = 508°K
12.6 Critical Pressure: 682 psia = 46.4 atm = 4.70 MN/m²
12.7 Specific Gravity: 0.791 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: 2.0
12.11 Ratio of Specific Heats of Vapor (Gas): 1.127
12.12 Latent Heat of Vaporization: 220 Btu/lb = 122 cal/g = 5.11×10^5 J/kg
12.13 Heat of Combustion: −12,250 Btu/lb = −6808 cal/g = -285.0×10^5 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: 23.42 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 7.75 psia

NOTES

ACT

ACETONE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
−120	58.350	34	.507	30	1.193		N
−110	55.980	38	.508	35	1.184		O
−100	55.620	38	.508	40	1.174		T
−90	55.250	40	.509	45	1.164		
−80	54.880	42	.510	50	1.155		P
−70	54.520	44	.511	55	1.145		E
−60	54.150	46	.512	60	1.135		R
−50	53.780	48	.513	65	1.126		T
−40	53.400	50	.514	70	1.116		I
−30	53.030	52	.514	75	1.106		N
−20	52.650	54	.515	80	1.097		E
−10	52.280	56	.516	85	1.087		N
0	51.900	58	.517	90	1.077		T
10	51.520	60	.518	85	1.068		
20	51.140	62	.519	100	1.058		
30	50.760	64	.519	105	1.048		
40	50.380	66	.520				
50	50.000	68	.521				
60	48.610	70	.522				
70	48.230	72	.523				
80	48.840	74	.524				
90	48.450	76	.525				
100	48.070	78	.525				
110	47.680	80	.526				
120	47.280	82	.527				
		84	.528				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	M	−20	.245	−20	.00302	0	.275
	I	−10	.354	−10	.00426	25	.286
	S	0	.501	0	.00590	50	.296
	C	10	.698	10	.00804	75	.307
	I	20	.956	20	.01079	100	.317
	B	30	1.291	30	.01427	125	.327
	L	40	1.719	40	.01862	150	.337
	E	50	2.260	50	.02399	175	.347
		60	2.935	60	.03056	200	.357
		70	3.770	70	.03851	225	.367
		80	4.791	80	.04803	250	.377
		90	6.029	90	.05934	275	.386
		100	7.516	100	.07266	300	.395
		110	9.290	110	.08823	325	.405
		120	11.390	120	.10630	350	.414
		130	13.850	130	.12710	375	.423
		140	16.720	140	.15090	400	.431
		150	20.060	150	.17800	425	.440
		150	23.890	160	.20860	450	.449
		170	28.290	170	.24310	475	.457
		180	33.300	180	.28170	500	.466
		190	38.980	190	.32460	525	.474
						550	.482
						575	.490
						600	.498

Common Synonyms	Solid crystals, or solution	Light to dark brown	Mild chemical odor
1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethanonaphthalene. HHDN	Solid sinks in water; solution floats on water.		

AVOID CONTACT WITH LIQUID OR SOLID. KEEP PEOPLE AWAY.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stop discharge if possible.
Call fire department if solution is discharged.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Solid is not flammable but usually is dissolved in a combustible liquid.
POISONOUS GASES ARE PRODUCED WHEN HEATED.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Extinguish with water, dry chemical, foam or carbon dioxide.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

SOLID OR SOLUTION
POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.
Irritating to skin, eyes.
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

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-poison, water contaminant; liquid forms are flammable
Mechanical containment (of liquid forms)
Should be removed

2. LABEL
2.1 Category: Poison
2.2 Class: 6

3. CHEMICAL DESIGNATIONS
3.1 CG Compatibility Class: Not listed
3.2 Formula: $C_{12}H_8Cl_6$
3.3 IMO/UN Designation: 6.1/1542
3.4 DOT ID No.: 1542
3.5 CAS Registry No.: 309-00-2

4. OBSERVABLE CHARACTERISTICS
4.1 Physical State (as shipped): Solid
4.2 Color: Tan to dark brown
4.3 Odor: Mild chemical

5. HEALTH HAZARDS
5.1 Personal Protective Equipment: During prolonged exposure to mixing and loading operations, wear clean synthetic rubber gloves and mask or respirator of the type passed by the U.S. Bureau of Mines for aldrin protection.
5.2 Symptoms Following Exposure: Ingestion, inhalation, or skin absorption of a toxic dose will induce nausea, vomiting, hyperexcitability, tremors, epileptiform convulsions, and ventricular fibrillation. Aldrin may cause temporarily reversible kidney and liver injury. Symptoms may be seen after ingestion of less than 1 gram in an adult; ingestion of 25 mg has caused death in children.
5.3 Treatment of Exposure: SKIN CONTACT: wash with soap and running water. If material gets into eyes, wash immediately with running water for at least 15 minutes; get medical attention. INGESTION: call physician immediately; induce vomiting immediately. Repeat until vomit fluid is clear. Never give anything by mouth to an unconscious person. Keep patient prone and quiet. PHYSICIAN: administer barbiturates as anti-convulsant therapy. Observe patient carefully because repeated treatment may be necessary.
5.4 Threshold Limit Value: 0.25 mg/m³
5.5 Short Term Inhalation Limits: 1 mg/m³ for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} 50 to 500 mg/kg (rat)
5.7 Late Toxicity: Chronic exposure produces benign tumors in mice.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause slight smarting of the eyes or respiratory system if present in high concentrations. 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: Data not available
5.11 IDLH Value: 100 mg/m3

6. FIRE HAZARDS
6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not pertinent
6.3 Fire Extinguishing Agents: Water spray, dry chemical, foam or carbon dioxide for fires involving solutions of aldrin in hydrocarbon solvents.
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Irritating fumes of hydrochloric acid and chlorinated decomposition products are given off.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Not pertinent
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not pertinent
6.10 Adiabatic Flame Temperature: Not pertinent

(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: Data not available

8. WATER POLLUTION
8.1 Aquatic Toxicity:
0.130 ppm/24 hr/bluegill/LC_{50}/fresh water
0.05 ppm/24 hr/goldfish/LC_{50}/fresh water
0.01 ppm/24 hr/oyster/sublethal effects/salt water
8.2 Waterfowl Toxicity: 520 mg/kg
8.3 Biological Oxygen Demand (BOD): Not pertinent
8.4 Food Chain Concentration Potential: High

9. SHIPPING INFORMATION
9.1 Grades of Purity: 20-95% alone, 5-60% inert ingredients. Several solutions in hydrocarbon solvents.
9.2 Storage Temperature: Data not available
9.3 Inert Atmosphere: Data not available
9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE
(See Hazard Assessment Handbook)

II

11. HAZARD CLASSIFICATIONS
11.1 Code of Federal Regulations: Poison, B
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	0
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	3
Water Pollution	
Human Toxicity	4
Aquatic Toxicity	4
Aesthetic Effect	4
Reactivity	
Other Chemicals	2
Water	2
Self Reaction	0

11.3 NFPA Hazard Classification:

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

12. PHYSICAL AND CHEMICAL PROPERTIES
12.1 Physical State at 15°C and 1 atm: Solid
12.2 Molecular Weight: 364.93
12.3 Boiling Point at 1 atm: Not pertinent
12.4 Freezing Point: 219°F = 104°C = 377°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.6 at 20°C (solid)
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

6. FIRE HAZARDS (Continued)
6.11 Stoichiometric Air to Fuel Ratio: Not pertinent
6.12 Flame Temperature: Not pertinent

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
	NOT PERTINENT		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	.000		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

n-BUTYL ACETATE 49 256 | BCN

Common Synonyms	Watery liquid	Colorless	Pleasant fruity odor
Acetic acid, n-butyl ester Butyl acetate Butyl ethanoate	Floats on water. Flammable irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Avoid contact with liquid and vapor.
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. 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, dizziness, headache 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. 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, 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. Fouling to shoreline. 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)

Issue warning-flammability
Mechanical containment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Ester
3.2 Formula: $CH_3COO(CH_2)_3CH_3$
3.3 IMO/UN Designation: 3.2/1123
3.4 DOT ID No.: 1123
3.5 CAS Registry No.: 123-86-4

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Characteristic; agreeable fruity (in low conc.), disagreeable (in higher conc.); nonresidual

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: All-purpose canister mask, chemical safety goggles, rubber gloves.
5.2 Symptoms Following Exposure: SKIN: prolonged or frequently repeated exposures may lead to drying. INHALATION: headaches, dizziness, nausea, irritation of respiratory passages and eyes.
5.3 Treatment of Exposure: EYES: in case of contact, flush with water for at least 15 min. INHALATION: remove from exposure immediately. Call a physician. If breathing is irregular or stopped, start resuscitation, administer oxygen. INGESTION: induce vomiting and call a physician.
5.4 Threshold Limit Value: 150 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
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: 10 ppm
5.11 IDLH Value: 10,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 84°F O.C.; 75°F C.C.
6.2 Flammable Limits in Air: 1.7%-7.6%
6.3 Fire Extinguishing Agents: Foam, dry chemical, carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water in straight hose stream will scatter and spread fire and should not be used.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 760°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 4.4 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: 34

8. WATER POLLUTION

8.1 Aquatic Toxicity: 44 ppm/48 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0.15 to 0.5 lb/lb, 5 days (theor.) 52%, 5 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Urethane, 99.5%; pure 88%; commercial 90-92%
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: 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	2
Aquatic Toxicity	0
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	1
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: 116.16
12.3 Boiling Point at 1 atm: 258°F = 126°C = 399°K
12.4 Freezing Point: −100°F = −73.5°C = 199.7°K
12.5 Critical Temperature: 582.6°F = 305.9°C = 579.1°K
12.6 Critical Pressure: 455 psia = 31 atm = 3.1 MN/m²
12.7 Specific Gravity: 0.875 at 20°C (liquid)
12.8 Liquid Surface Tension: 14.5 dynes/cm = 0.0145 N/m at 25°C
12.9 Liquid Water Interfacial Tension: (est.) 57 dynes/cm = 0.057 N/m at 22°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.058
12.12 Latent Heat of Vaporization: 133 Btu/lb = 73.9 cal/g = 3.09 × 10⁵ J/kg
12.13 Heat of Combustion: −13,130 Btu/lb = −7294 cal/g = −305.4 × 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: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.5 psia

NOTES

JUNE 1985

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
35	55.760	35	.449	30	.879	55	.784
40	55.590	40	.450	40	.871	60	.761
45	55.420	45	.452	50	.863	65	.740
50	55.240	50	.453	60	.855	70	.719
55	55.070	55	.455	70	.847	75	.700
60	54.900	60	.456	80	.840	80	.681
65	54.720	65	.458	90	.832	85	.663
70	54.550	70	.460	100	.824	90	.646
75	54.380	75	.461	110	.816	95	.630
80	54.200	80	.463	120	.808	100	.614
85	54.030	85	.464	130	.800	105	.599
90	53.860	90	.466	140	.792	110	.584
95	53.680	95	.467	150	.784	115	.571
100	53.510	100	.469	160	.776	120	.557
105	53.340	105	.470	170	.768	125	.545
110	53.160	110	.472	180	.761	130	.532
115	52.990	115	.473	190	.753	135	.521
120	52.820	120	.475	200	.745	140	.509
		125	.476				
		130	.478				
		135	.478				
		140	.481				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	1.000	35	.065	35	.00143	0	.282
		40	.078	40	.00168	25	.294
		45	.092	45	.00197	50	.305
		50	.109	50	.00231	75	.316
		55	.128	55	.00269	100	.327
		60	.150	60	.00313	125	.338
		65	.176	65	.00363	150	.349
		70	.205	70	.00420	175	.360
		75	.238	75	.00484	200	.370
		80	.277	80	.00556	225	.380
		85	.321	85	.00638	250	.390
		90	.370	90	.00729	275	.400
		95	.426	95	.00832	300	.410
		100	.489	100	.00946	325	.420
		105	.561	105	.01074	350	.429
		110	.640	110	.01217	375	.439
		115	.730	115	.01375	400	.448
		120	.830	120	.01550	425	.457
						450	.466
						475	.475
						500	.483
						525	.492
						550	.500
						575	.509
						600	.517

CARBON TETRACHLORIDE 9 258 | CBT

Common Synonyms	Watery liquid	Colorless	Sweet odor
Carbon Tet Tetrachloromethane Benzinoform Necatorina Perchloromethane	Sinks in water. Poisonous vapor is produced.		

Avoid contact with liquid and vapor. Keep people away.
Wear goggles and self-contained breathing apparatus.
Stop discharge if possible.
Stay upwind and use water spray to "knock down" vapor.
Notify local health and pollution control agencies.

Fire	Not flammable. POISONOUS AND IRRITATING GASES ARE PRODUCED WHEN HEATED. Wear goggles and self-contained breathing apparatus.
Exposure	CALL FOR MEDICAL AID. VAPOR POISONOUS IF INHALED. Irritating to eyes. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID POISONOUS IF SWALLOWED. Irritating to skin and eyes. 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 pollution control officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-poison
Restrict access
Should be removed

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: CCl_4
3.3 IMO/UN Designation: 6.1/1846
3.4 DOT ID No.: 1846
3.5 CAS Registry No.: 56-23-5

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Sweetish, aromatic, moderately strong ethereal, somewhat resembling that of chloroform

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor canister with full face mask, protective clothing, rubber gloves.
5.2 Symptoms Following Exposure: Dizziness, incoordination, anesthesia; may be accompanied by nausea and liver damage. Kidney damage also occurs, often producing decrease or stopping of urinary output.
5.3 Treatment of Exposure: EYES AND SKIN: flush with plenty of water; for eyes, get medical attention. Remove contaminated clothing and wash before reuse. INHALATION: immediately remove to fresh air, keep patient warm and quiet and get medical attention promptly. Start artificial respiration if breathing stops. INGESTION: induce vomiting and get medical attention promptly. No specific antidote known.
5.4 Threshold Limit Value: 5 ppm
5.5 Short Term Inhalation Limits: 25 ppm for 30 min
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg (rat)
5.7 Late Toxicity: Causes severe liver damage and death if ingested
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: Greater than 10 ppm
5.11 IDLH Value: 300 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: Forms poisonous phosgene gas when exposed to open flames
6.6 Behavior in Fire: Decomposes to form chlorine and phosgene
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: 36

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: Commercial, technical, USP
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	2
Liquid or Solid Irritant	1
Poisons	[illegible]
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

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

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 153.83
12.3 Boiling Point at 1 atm: 170°F = 76.5°C = 349.7°K
12.4 Freezing Point: −9.4°F = −23.0°C = 250.2°K
12.5 Critical Temperature: 541°F = 283°C = 556°K
12.6 Critical Pressure: 660 psia = 45 atm = 4.6 MN/m²
12.7 Specific Gravity: 1.59 at 20°C (liquid)
12.8 Liquid Surface Tension: 27.0 dynes/cm = 0.027 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 45.0 dynes/cm = 0.045 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 5.3
12.11 Ratio of Specific Heats of Vapor (Gas): 1.111
12.12 Latent Heat of Vaporization: 84.2 Btu/lb = 46.8 cal/g = 1.958 × 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: 5.09 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 3.6 psia

NOTES

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
35	101.700
40	101.400
45	101.099
50	100.700
55	100.400
60	100.099
65	99.750
70	99.410
75	99.080
80	98.740
85	98.410
90	98.070
95	97.730
100	97.389
105	97.059
110	96.719
115	96.379
120	96.040

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
35	.201
40	.203
45	.206
50	.208
55	.210
60	.212
65	.215
70	.217
75	.219
80	.221
85	.223
90	.226
95	.228
100	.230
105	.232
110	.235
115	.237
120	.239
125	.241
130	.243
135	.246
140	.248

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
30	.724
40	.715
50	.707
60	.698
70	.690
80	.682
90	.673
100	.665
110	.656
120	.648
130	.640
140	.631
150	.623
160	.615
170	.606

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
35	1.307
40	1.247
45	1.192
50	1.140
55	1.091
60	1.045
65	1.001
70	.961
75	.922
80	.886
85	.852
90	.820
95	.790
100	.761
105	.734
110	.708
115	.683
120	.660
125	.638
130	.617
135	.597
140	.578

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
77.02	.080

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
40	.815
50	1.088
60	1.435
70	1.874
80	2.422
90	3.102
100	3.937
110	4.956
120	6.190
130	7.672
140	9.442
150	11.540
160	14.010
170	16.910
180	20.300
190	24.210
200	28.740
210	33.930

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
40	.02339
50	.03059
60	.03958
70	.05069
80	.06431
90	.08087
100	.10080
110	.12470
120	.15300
130	.18650
140	.22560
150	.27130
160	.32410
170	.38500
180	.45470
190	.53410
200	.62430
210	.72610

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.123
25	.126
50	.128
75	.130
100	.132
125	.134
150	.136
175	.138
200	.139
225	.141
250	.143
275	.144
300	.145
325	.147
350	.148
375	.149
400	.150
425	.151
450	.152
475	.152
500	.153
525	.153
550	.154
575	.154
600	.155

CHLORDANE

'9 260

CDN

Common Synonyms	Liquid	Brown	Sharp odor
Chlordan 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene Toxichlor, Octa-klor Velsicol 1068	Sinks in water		

AVOID CONTACT WITH LIQUID. KEEP PEOPLE AWAY.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stop discharge if possible.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Not flammable but solution may be combustible. POISONOUS GASES MAY BE PRODUCED IN FIRE. Extinguish with dry chemical, foam or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID. LIQUID OR SOLUTION POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED. Irritating to skin and eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. DO NOT RUB AFFECTED AREAS. 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	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-poison
Restrict access
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: $C_{10}H_6Cl_8$
3.3 IMO/UN Designation: 6.1/2762
3.4 DOT ID No.: 2762
3.5 CAS Registry No.: 57-74-9

4. OBSERVABLE CHARACTERISTICS
4.1 Physical State (as shipped): Liquid
4.2 Color: Brown
4.3 Odor: Penetrating, aromatic; slightly pungent, like chlorine

5. HEALTH HAZARDS
5.1 Personal Protective Equipment: Respirator for sprays, fogs, or dust; goggles; rubber gloves.
5.2 Symptoms Following Exposure: Moderately irritating to eyes and skin. Ingestion, absorption through skin, or inhalation of mist or dust may cause excitability, convulsions, nausea, vomiting, diarrhea, and some local irritation of the gastrointestinal tract.
5.3 Treatment of Exposure: INHALATION: administer oxygen and give fluid therapy; do not give epinephrine, since it may induce ventricular fibrillation; arrange complete rest. EYES: flush with water for at least 15 min. SKIN: wash off skin with adequate quantities of soap and water; do NOT scrub. INGESTION: induce vomiting and follow with gastric lavage and administration of saline cathartics; ether and barbiturates may be used to control convulsions; oxygen and fluid therapy are also recommended; do NOT give epinephrine. Since no specific antidotes are known, symptomatic therapy must be accompanied by complete rest.
5.4 Threshold Limit Value: 0.5 mg/m³
5.5 Short Term Inhalation Limits: 2 mg/m³ for 30 min.
5.6 Toxicity by Ingestion: Grade 3; oral LD_{50} = 283 mg/kg (rat)
5.7 Late Toxicity: Possible liver damage; loss of appetite and weight
5.8 Vapor (Gas) Irritant Characteristics: Data not available
5.9 Liquid or Solid Irritant Characteristics: Data not available
5.10 Odor Threshold: Data not available
5.11 IDLH Value: 500 mg/m³

6. FIRE HAZARDS
6.1 Flash Point: Solution: 225°F O.C.; 132°F C.C. Solid is not flammable
6.2 Flammable Limits in Air: 0.7%–5% (kerosene solution)
6.3 Fire Extinguishing Agents: Dry chemical, foam, carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective on solution fire
6.5 Special Hazards of Combustion Products: Irritating and toxic hydrogen chloride and phosgene gases may be formed when kerosene solution of compound burns
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 410°F (kerosene solvent)
6.8 Electrical Hazard: Data not available
6.9 Burning Rate: Not pertinent

(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 to 180°F
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: 0.5 ppm/96 hr/guppies/TL_m/fresh water
8.2 Waterfowl Toxicity: LD_{50} = 1,200 mg/kg
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: High

9. SHIPPING INFORMATION
9.1 Grades of Purity: Technical; a variety of dusts, powders, and solutions in kerosene containing 2–80% chlordane are shipped
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester)

6. FIRE HAZARDS (Continued)
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

10. HAZARD ASSESSMENT CODE
(See Hazard Assessment Handbook)
A-X-Y

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: Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES
12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 409.8
12.3 Boiling Point at 1 atm: Decomposes
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.6 at 25°C (liquid)
12.8 Liquid Surface Tension: (est.) 25 dynes/cm = 0.025 N/m at 20°C
12.9 Liquid Water Interfacial Tension: (est.) 30 dynes/cm = 0.03 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: Not pertinent
12.13 Heat of Combustion: (est.) −4,000 Btu/lb = −2,200 cal/g = −93 × 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: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

*Properties refer to undiluted technical-grade chlordane

CDN — CHLORDANE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot (estimate)	Temperature (degrees F)	British thermal unit per pound-F (estimate)	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F (estimate)	Temperature (degrees F)	Centipoise (estimate)
52	100.400	60	.300	60	1.209	130	58.980
54	100.400	61	.300	61	1.209	140	51.140
56	100.299	62	.300	62	1.209	150	44.560
58	100.200	63	.300	63	1.209	160	38.990
60	100.200	64	.300	64	1.209	170	34.270
62	100.099	65	.300	65	1.209	180	30.240
64	100.000	66	.300	66	1.209	190	26.780
66	99.940	67	.300	67	1.209	200	23.810
68	99.879	68	.300	68	1.209	210	21.240
70	99.809	69	.300	69	1.209	220	19.020
72	99.740	70	.300	70	1.209	230	17.080
74	99.669	71	.300	71	1.209	240	15.390
76	99.599	72	.300	72	1.209	250	13.900
78	99.530	73	.300	73	1.209	260	12.590
80	99.459	74	.300	74	1.209	270	11.440
82	99.389	75	.300	75	1.209	280	10.420
84	99.320	76	.300	76	1.209	290	9.516
86	99.250	77	.300	77	1.209	300	8.710

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	INSOLUBLE	215	.000	215	.00001		NOT PERTINENT
		220	.000	220	.00001		
		225	.000	225	.00002		
		230	.000	230	.00002		
		235	.001	235	.00003		
		240	.001	240	.00005		
		245	.001	245	.00007		
		250	.002	250	.00009		
		255	.002	255	.00012		
		260	.003	260	.00017		
		265	.004	265	.00023		
		270	.006	270	.00031		
		275	.008	275	.00042		
		280	.011	280	.00056		
		285	.015	285	.00074		
		290	.019	290	.00099		
		295	.026	295	.00131		
		300	.035	300	.00174		
		305	.046	305	.00228		
		310	.060	310	.00300		
		315	.079	315	.00391		
		320	.104	320	.00510		
		325	.136	325	.00662		
		330	.177	330	.00856		
		335	.230	335	.01104		
		340	.297	340	.01418		

CHLOROFORM

CRF

Common Synonyms	Watery liquid	Colorless	Sweet odor
Trichloromethane	Sinks in water. Irritating vapor is produced.		

Avoid contact with liquid and vapor. Keep people away.
Wear goggles and self-contained breathing apparatus.
Stop discharge if possible. Keep people away.
Notify local health and pollution control agencies.

Fire

Not flammable.
POISONOUS AND IRRITATING GASES ARE PRODUCED WHEN HEATED.
Wear goggles and self-contained breathing apparatus.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause headache, nausea, dizziness, 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 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 pollution control officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-air contaminant
Restrict access
Should be removed

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: $CHCl_3$
3.3 IMO/UN Designation: 6.1/1888
3.4 DOT ID No.: 1888
3.5 CAS Registry No.: 67-66-3

4. OBSERVABLE CHARACTERISTICS

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

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Chemical goggles. 50 ppm to 2%: organic full-face gas mask. Above 2%: suitable self-contained system.
5.2 Symptoms Following Exposure: Headache, nausea, dizziness, drowsiness, narcosis.
5.3 Treatment of Exposure: INHALATION: if ill effects develop, get victim to fresh air, keep him warm and quiet, and get medical attention. If breathing stops, start artificial respiration. INGESTION: induce vomiting and get medical attention. No known antidote; treat symptoms. EYES: flush with plenty of water for at least 15 minutes and get medical attention. SKIN: wash with soap and water, remove contaminated clothing and free of chemical.
5.4 Threshold Limit Value: 10 ppm
5.5 Short Term Inhalation Limits: 50 ppm for 10 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: 1,000 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: Poisonous and irritating gases are produced when heated.
6.6 Behavior in Fire: Decomposes, producing toxic gases
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: 36

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: Technical, USP
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

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	1
Health	
Vapor Irritant	2
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	2
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)	0
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 119.38
12.3 Boiling Point at 1 atm: 142°F = 61.2°C = 334.4°K
12.4 Freezing Point: −82.3°F = −63.5°C = 209.7°K
12.5 Critical Temperature: 505°F = 263.2°C = 536.4°K
12.6 Critical Pressure: 790 psia = 54 atm = 5.5 MN/m²
12.7 Specific Gravity: 1.49 at 20°C (liquid)
12.8 Liquid Surface Tension: 27.1 dynes/cm = 0.0271 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 32.8 dynes/cm = 0.0328 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 4.1
12.11 Ratio of Specific Heats of Vapor (Gas): 1.148
12.12 Latent Heat of Vaporization: 106.7 Btu/lb = 59.3 cal/g = 2.483 X 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: 17.62 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 6.35 psia

NOTES

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
−50	100.789
−40	100.200
−30	99.549
−20	98.910
−10	98.259
0	97.610
10	96.950
20	96.299
30	95.639
40	94.980
50	94.320
60	93.650
70	92.990
80	92.320
90	91.650
100	90.980
110	90.309
120	89.829
130	88.950
140	88.270

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.218
10	.217
20	.219
30	.221
40	.222
50	.224
60	.226
70	.227
80	.229
90	.231
100	.232
110	.234
120	.236
130	.237
140	.239

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
−70	.938
−60	.929
−50	.920
−40	.911
−30	.902
−20	.893
−10	.884
0	.875
10	.866
20	.857
30	.848
40	.839
50	.830
60	.821
70	.812
80	.804
90	.795
100	.786
110	.777
120	.768
130	.759
140	.750

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
0	.847
10	.791
20	.741
30	.697
40	.656
50	.620
60	.586
70	.556
80	.528
90	.503
100	.478
110	.458
120	.438
130	.420
140	.403

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
77.02	.800

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
−30	.150
−20	.217
−10	.309
0	.433
10	.598
20	.818
30	1.099
40	1.462
50	1.924
60	2.505
70	3.229
80	4.124
90	5.220
100	6.551
110	8.157
120	10.080

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
−30	.00387
−20	.00548
−10	.00763
0	.01047
10	.01417
20	.01892
30	.02496
40	.03255
50	.04198
60	.05361
70	.06781
80	.08499
90	.10560
100	.13020
110	.15830
120	.19340

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.123
25	.126
50	.129
75	.131
100	.134
125	.137
150	.139
175	.142
200	.144
225	.146
250	.148
275	.150
300	.152
325	.154
350	.156
375	.158
400	.160
425	.161
450	.162
475	.164
500	.165
525	.166
550	.167
575	.168
600	.169

Common Synonyms	Solid	Colorless	Odorless
Dichlorodiphenyltrichloroethane p, p' - DDT 1, 1, 1-Trichloro-2, 2-bis(p-chlorophenyl) ethane	Sinks in water.		

Avoid contact with solid.
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 water, dry chemical, foam, or carbon dioxide.
Exposure	CALL FOR MEDICAL AID. SOLID Irritating to skin and eyes. If swallowed, will cause nausea, vomiting, headache, 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.
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

2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not listed
3.2 Formula: $(p\text{-}ClC_6H_4)_2CHCCl_3$
3.3 IMO/UN Designation: 9/2761
3.4 DOT ID No.: 2761
3.5 CAS Registry No.: 50-29-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Solid
4.2 Color: White
4.3 Odor: None

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Data not available
5.2 Symptoms Following Exposure: Very large doses are followed promptly by vomiting, due to local gastric irritation; delayed vomiting or diarrhea may occur. With smaller doses, symptoms usually appear 2-3 hours after ingestion. These include tingling of lips, tongue, and face; malaise, headache, sore throat, fatigue, coarse tremors of neck, head, and eyelids; apprehension, ataxia, and confusion. Convulsions may alternate with periods of coma and partial paralysis. Vital signs are essentially normal, but in severe poisoning the pulse may be irregular and abnormally slow; ventricular fibrillation and sudden death may occur at any time during acute phase. Pulmonary edema usually indicates solvent intoxication.
5.3 Treatment of Exposure: INGESTION: treatment should be done by a physician. It usually includes gastric lavage and administration of saline cathartic, phenobarbital, and parenteral fluids. Patient should be kept quiet and under observation for at least 24 hours.
5.4 Threshold Limit Value: 1 mg/m³
5.5 Short Term Inhalation Limits: 3 mg/m³
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg (rat)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Not pertinent
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: Not pertinent
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 162°F-171°F C.C.
6.2 Flammable Limits in Air: Not pertinent
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: Toxic and irritating gases may be generated
6.6 Behavior in Fire: Melts and burns
6.7 Ignition Temperature: Data not available
6.8 Electrical Hazards: 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:
0.0006 ppm/24 hr/bass/TL_m/fresh water
0.0018 ppm/96 hr/bass/TL_m/fresh water
0.0028 ppm/48 hr/bluegill/50% kill/salt water
8.2 Waterfowl Toxicity: 2240 mg/kg
8.3 Biological Oxygen Demand (BOD): Not pertinent
8.4 Food Chain Concentration Potential: High

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical
9.2 Storage Temperature: Data not available
9.3 Inert Atmosphere: Data not available
9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

II

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
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: 354.5
12.3 Boiling Point at 1 atm: Not pertinent
12.4 Freezing Point: 226°F = 108°C = 381°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.56 at 15°C (solid)
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

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12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
	NOT PERTINENT		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	INSOLUBLE		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

Common Synonyms	Oily liquid	Colorless	Chloroform-like ethereal odor
Ethylidene chloride Ethylidene dichloride Chlorinated hydrochloric ether	Sinks and mixes with water.		

[illegible]

[illegible]

Shut off ignition sources and call fire department.

Avoid contact with liquid.

[illegible]

Notify local health and pollution control agencies.

Fire

Flammable.

POISONOUS GAS MAY BE PRODUCED IN FIRE OR WHEN HEATED

Containers may explode in fire.

Wear goggles and self-contained breathing apparatus.

Extinguish with alcohol foam, carbon dioxide or dry chemical.

Water may be ineffective on fire.

Exposure

CALL FOR MEDICAL AID.

LIQUID

If swallowed may cause nausea, vomiting and faintness.

Irritating to skin and eyes.

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 induce vomiting.

Water Pollution

Dangerous to aquatic life in high 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.

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_3CHCl_2

3.3 IMO/UN Designation: Not listed

3.4 DOT ID No.: 2362

3.5 CAS Registry No.: 75-34-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Oily liquid

4.2 Color: Colorless

4.3 Odor: Chloroform

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: In areas of poor ventilation or high concentration, a self-contained breathing apparatus with full face mask should be worn. Chemical workers goggles, rubber gloves, and protective clothing should be worn.

5.2 Symptoms Following Exposure: INHALATION: irritation of respiratory tract. Salivation, sneezing, coughing, dizziness, nausea, and vomiting. EYES: irritation, lacrimation, and reddening of conjunctiva. SKIN: irritation. Prolonged or repeated skin contact can produce a slight burn. INGESTION: ingestion incidental to industrial handling is not considered to be a problem. Swallowing of substantial amounts could cause nausea, vomiting, faintness, drowsiness, overdose, and respiratory failure.

5.3 Treatment of Exposure: Call a doctor. INHALATION: Remove from contaminated area; keep warm and quiet. If breathing has stopped, give artificial respiration. Administer oxygen. EYES: Flush with large amounts of water or weak bicarbonate of soda solution. SKIN: Dose with large amounts of water. Remove contaminated clothing. INGESTION: Attempt to empty stomach; dilute by administering fluids (tap water, soapy water, salt water, or milk).

5.4 Threshold Limit Value: 200 ppm

5.5 Short Term Inhalation Limits: 250 ppm

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

5.7 Late Toxicity: Chronic exposure may cause liver damage and dermatitis. Animal experimentation has shown the compound to be slightly embryo-toxic and to retard fetal development.

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 skin.

5.10 Odor Threshold: Data not available

5.11 IDLH Value: 4,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 57°F O.C. = 22°F C.C.

6.2 Flammable Limits in Air: 5.6% to 11.4%

6.3 Fire Extinguishing Agents: Alcohol foam, water, foam, CO_2, dry chemical, carbon tetrachloride

6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective

6.5 Special Hazards of Combustion Products: When heated to decomposition emits highly toxic fumes of phosgene.

6.6 Behavior in Fire: Explosion hazard

6.7 Ignition Temperature: 856°F

6.8 Electrical Hazard: Data not available

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: Data not available

7.3 Stability During Transport: Data not available

7.4 Neutralizing Agents for Acids and Caustics: Data not available

7.5 Polymerization: Data not available

7.6 Inhibitor of Polymerization: Data not available

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

7.8 Reactivity Group: 36

8. WATER POLLUTION

8.1 Aquatic Toxicity:

TL_m (Marine prawn) 250 to 275 mg/l

24-hour TL_m Brine shrimp: 320 mg/l

24-hour TL_m Pinperch: 180 mg/l

8.2 Waterfowl Toxicity: Data not available

8.3 Biological Oxygen Demand (BOD): Percent, 0.05 g/g for 10 days Percent, 0.002 g/g for 5 days

8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Data not available

9.2 Storage Temperature: Cool

9.3 Inert Atmosphere: Data not available

9.4 Venting: Data not available

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-Q-R-S

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Not listed

11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed

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: 98.97

12.3 Boiling Point at 1 atm: 135.14°F = 57.3°C = 330.5°K

12.4 Freezing Point: −142.32°F = −97.4°C = 175.75°K

12.5 Critical Temperature: 502.7°F = 261.5°C = 534.65°K

12.6 Critical Pressure: 734.6 psia = 50 atm = 5.063 MN/m²

12.7 Specific Gravity: 1.174 at 20°C

12.8 Liquid Surface Tension: 24.75 dynes/cm = 0.02475 N/m at 20°C

12.9 Liquid Water Interfacial Tension: Data not available

12.10 Vapor (Gas) Specific Gravity: 3.42

12.11 Ratio of Specific Heats of Vapor (Gas): 1.126 at 20°C (68°F)

12.12 Latent Heat of Vaporization: 131.6 Btu/lb = 73.1 cal/g = 3.06 x 10^5 J/kg

12.13 Heat of Combustion: −4,774 Btu/lb = −2,652 cal/g = −111 x 10^5 J/kg

12.14 Heat of Decomposition: Data not available

12.15 Heat of Solution: Data not available

12.16 Heat of Polymerization: Data not available

12.25 Heat of Fusion: Data not available

12.26 Limiting Value: Data not available

12.27 Reid Vapor Pressure: 7.3 psia

NOTES

DICHLOROETHANE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
35	75.198
40	74.929
45	74.660
50	74.389
55	74.120
60	73.851
65	73.580
70	73.311
75	73.042
80	72.771
65	72.502

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
	DATA NOT AVAILABLE

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
35	.804
40	.799
45	.795
50	.791
55	.786
60	.782
65	.778
70	.773
75	.769
80	.765
85	.760
90	.756
95	.752
100	.747
105	.743
110	.739

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
35	.617
40	.595
45	.574
50	.555
55	.537
60	.520
65	.504
70	.489
75	.475
80	.462
85	.449
90	.437
95	.426
100	.415
105	.405
110	.395
115	.386
120	.377

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
68	.500

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
−70	−1.334
−60	−1.944
−50	−.555
−40	.835
−30	.225
−20	.386
−10	.996
0	1.607
10	2.217
20	2.827
30	3.438
40	4.048
50	4.658
60	5.269
70	5.879
80	6.489
90	7.100
100	7.710
110	8.321
120	8.831
130	9.541

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
−100	.07407
−80	.05000
−60	.02594
−40	.00187
−20	.02219
0	.04626
20	.07032
40	.09439
60	.11845
80	.14252
100	.16658
120	.19065
140	.21471
160	.23878

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
	DATA NOT AVAILABLE

Common Synonyms	Liquid	Colorless	Sweet pleasant odor
Acetylene dichloride sym-dichloroethylene Dioform cis-1, 2-dichloroethylene trans-1, 2-dichloroethylene	Sinks in water. Flammable, irritating vapor is produced.		

Wear goggles and self-contained breathing apparatus.
Shut off ignition sources. Call fire department.
Stop discharge if possible. Keep people away.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	FLAMMABLE POISONOUS GASES MAY BE PRODUCED IN FIRE. Containers may explode in fire. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Extinguish with dry chemicals, foam or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID VAPOR If inhaled will cause dizziness, nausea, vomiting, or difficult breathing. Move victim to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. LIQUID Harmful if swallowed. 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)
Issue warning-high flammability
Restrict access
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: Not listed
3.2 Formula: $ClCH=CHCl$
3.3 IMO/UN Designation: 3.2/1150
3.4 DOT ID No.: 1150
3.5 CAS Registry No.: 540-59-0

4. OBSERVABLE CHARACTERISTICS
4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Ethereal, slightly acrid; pleasant, chloroform-like

5. HEALTH HAZARDS
5.1 Personal Protective Equipment: Rubber gloves; safety goggles; air supply mask or self-contained breathing apparatus.
5.2 Symptoms Following Exposure: Inhalation causes nausea, vomiting, weakness, tremor, epigastric cramps, central nervous depression. Contact with liquid causes irritation of eyes and (on prolonged contact) skin. Ingestion causes slight depression to deep narcosis.
5.3 Treatment of Exposure: INHALATION: remove from further exposure; if breathing is difficult, give oxygen; if victim is not breathing, give artificial respiration, preferably mouth-to-mouth; give oxygen when breathing is resumed; call a physician. EYES: flush with water for at least 15 min. SKIN: wash well with soap and water. INGESTION: give gastric lavage and cathartics.
5.4 Threshold Limit Value: 200 ppm
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; oral LD_{50} = 770 mg/kg (rat)
5.7 Late Toxicity: Produces liver and kidney injury in experimental animals
5.8 Vapor (Gas) Irritant Characteristics: Data not available
5.9 Liquid or Solid Irritant Characteristics: Data not available
5.10 Odor Threshold: Data not available
5.11 IDLH Value: 4,000 ppm

6. FIRE HAZARDS
6.1 Flash Point: 37°F C.C.
6.2 Flammable Limits in Air: 9.7%–12.8%
6.3 Fire Extinguishing Agents: Dry chemical, foam, carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: Phosgene and hydrogen chloride fumes may form in fires.
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: 860°F
6.8 Electrical Hazard: Data not available
6.9 Burning Rate: 2.6 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: Will not occur under ordinary conditions of shipment. The reaction is not vigorous.
7.6 Inhibitor of Polymerization: None used
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): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION
9.1 Grades of Purity: Commercial
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: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

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

12. PHYSICAL AND CHEMICAL PROPERTIES
12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 97.0
12.3 Boiling Point at 1 atm:
cis: 140°F = 60°C = 333°K
trans: 118°F = 48°C = 321°K
12.4 Freezing Point:
cis: −114°F = −81°C = 192°K
trans: −58°F = −50°C = 223°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.27 at 25°C (liquid)
12.8 Liquid Surface Tension: 24 dynes/cm = 0.024 N/m at 20°C
12.9 Liquid Water Interfacial Tension: (est.) 30 dynes/cm = 0.030 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: 3.34
12.11 Ratio of Specific Heats of Vapor (Gas): 1.1468
12.12 Latent Heat of Vaporization: 130 Btu/lb = 72 cal/g = 3.0×10^5 J/kg
12.13 Heat of Combustion: −4,817.2 Btu/lb = −2,692.8 cal/g = -112.67×10^5 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

6. FIRE HAZARDS (Continued)
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

DEL	1,2-DICHLOROETHYLENE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
35	81.020	35	.193	65	.907	40	.478
40	80.820	40	.196	70	.894	50	.454
45	80.610	45	.198	75	.882	60	.432
50	80.400	50	.200	80	.869	70	.411
55	80.190	55	.202	85	.857	80	.393
60	79.980	60	.204	90	.844	90	.376
65	79.780	65	.207	95	.832	100	.360
70	79.570	70	.209	100	.819	110	.345
75	79.360	75	.211	105	.807	120	.331
80	79.150	80	.213	110	.794	130	.319
85	78.940	85	.216	115	.782	140	.307
90	78.740	90	.218	120	.769	150	.296
95	78.530	95	.220	125	.757	160	.286
100	78.320	100	.222	130	.744	170	.276
105	78.110	105	.224			180	.267
110	77.900	110	.227			190	.259
115	77.690	115	.229			200	.251
120	77.490	120	.231			210	.244
125	77.280	125	.233				
130	77.070	130	.236				
135	76.860	135	.238				
140	76.650	140	.240				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68	.630	55	3.009	55	.05284	0	.150
		60	3.396	60	.05906	20	.153
		65	3.824	65	.06587	40	.156
		70	4.297	70	.07330	60	.159
		75	4.817	75	.08141	80	.162
		80	5.389	80	.09023	100	.165
		85	6.016	85	.09980	120	.167
		90	6.702	90	.11020	140	.170
		95	7.453	95	.12140	160	.173
		100	8.272	100	.13360	180	.176
		105	9.164	105	.14660	200	.179
		110	10.130	110	.16070	220	.182
		115	11.190	115	.17590	240	.185
		120	12.330	120	.19220	260	.188
		125	13.560	125	.20960	280	.191
		130	14.800	130	.22830	300	.194
		135	16.340	135	.24820	320	.197
		140	17.890	140	.26960	340	.200
						360	.203
						380	.205
						400	.208
						420	.211
						440	.214

DIELDRIN '9 270 DED

Common Synonyms	Solid	Light brown	Mild chemical odor
HEOD endo,exo-1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4:5,8-dimethanonaphthalene	Sinks in water.		

AVOID CONTACT WITH SOLID AND DUST. KEEP PEOPLE AWAY.
Wear goggles, dust respirator and rubber overclothing (including gloves).
Stop discharge if possible.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Not flammable POISONOUS GASES MAY BE PRODUCED WHEN HEATED.
Exposure	CALL FOR MEDICAL AID DUST POISONOUS IF INHALED OR IF SKIN IS EXPOSED. If inhaled will cause headache, dizziness, or loss of consciousness. If in eyes, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. SOLID POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED. If swallowed will cause headache, nausea, dizziness, 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 and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.
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
Restrict access
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: $C_{12}H_8Cl_6O$
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: 2761
3.5 CAS Registry No.: 60-57-1

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Solid
4.2 Color: Buff to light brown
4.3 Odor: Mild chemical

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: U. S. Bu. Mines approved respirator; clean rubber gloves; goggles or face shield
5.2 Symptoms Following Exposure: Inhalation, ingestion, or skin contact causes irritability, convulsions and/or coma, nausea, vomiting, headache, fainting, tremors. Contact with eyes causes irritation.
5.3 Treatment of Exposure: INHALATION: move to fresh air; give oxygen and artificial respiration as required. INGESTION: induce vomiting and get medical attention. EYES: flush with plenty of water; get medical attention. SKIN: flush with plenty of water.
5.4 Threshold Limit Value: 0.25 mg/m³
5.5 Short Term Inhalation Limits: 1 mg/m³ for 30 min.
5.6 Toxicity by Ingestion: Grade 4; oral LD_{50} = 46 mg/kg (rat), 65 mg/kg (dog)
5.7 Late Toxicity: Banned by EPA in October 1974 because of alleged "imminent hazard to human health" as a potential carcinogen in man.
5.8 Vapor (Gas) Irritant Characteristics: Data not available
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: 0.041 ppm
5.11 IDLH Value: 450 mg/m³

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: Data not available
6.5 Special Hazards of Combustion Products: Toxic and irritating hydrogen chloride fumes may form in fire.
6.6 Behavior in Fire: Data not available
6.7 Ignition Temperature: Not pertinent
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: Data not available
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:
0.0079 mg/l/96 hr/bluegill/TL_m/fresh water
.037 ppm/96 hr/goldfish/TL_m/fresh water
0.050 ppm/8 hr/mullet/100% kill/salt water
0.035-.050 ppm/48 hr/brown shrimp/TL_m/ salt water
8.2 Waterfowl Toxicity: LD_{50} 381.0 mg/kg
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: High

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical, 85+% HEOD; 15% emulsifiable concentrate in petroleum hydrocarbons, which are combustible.
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open (flame arrester) (for liquid form)

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

II

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
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: 380.93
12.3 Boiling Point at 1 atm: Not pertinent (decomposes)
12.4 Freezing Point: 349°F = 176°C = 449°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.75 at 20°C (solid)
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: Data not available
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

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
	NOT PERTINENT		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	INSOLUBLE		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

2,4-DICHLOROPHENOXYACETIC ACID

DCA

Common Synonyms	Solid	White to tan	Odorless
	Sinks in water.		

Keep people away.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Combustible. POISONOUS GASES MAY BE PRODUCED IN FIRE. Wear goggles and self-contained breathing apparatus. Flood discharge area with water.
Exposure	CALL FOR MEDICAL AID. SOLID POISONOUS IF SWALLOWED. 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	Dangerous to aquatic life in high 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-poison, water contaminant
Restrict access
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: 2, 4-$Cl_2C_6H_3OCH_2COOH$
3.3 IMO/UN Designation: 6.1/1809
3.4 DOT ID No.: 1809
3.5 CAS Registry No.: 94-75-7

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Solid
4.2 Color: White to tan
4.3 Odor: None

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Protective dust mask; rubber gloves; chemical goggles.
5.2 Symptoms Following Exposure: Dust may irritate eyes. Ingestion causes gastroenteric distress, diarrhea, mild central nervous system depression, dysphagia, and possible transient liver and kidney injury.
5.3 Treatment of Exposure: EYES: flush with water for at least 15 min. SKIN: wash well with soap and water. INGESTION: induce vomiting and follow with gastric lavage and supportive therapy.
5.4 Threshold Limit Value: 10 mg/m³
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 3; oral rat LD_{50} = 375 mg/kg (rat), 80 mg/kg (human)
5.7 Late Toxicity: Causes birth defects in some laboratory animals
5.8 Vapor (Gas) Irritant Characteristics: Not pertinent
5.9 Liquid or Solid Irritant Characteristics: Data not available
5.10 Odor Threshold: Not pertinent
5.11 IDLH Value: 500 mg/m³

6. FIRE HAZARDS

6.1 Flash Point: Not pertinent (combustible solid)
6.2 Flammable Limits in Air: Not pertinent
6.3 Fire Extinguishing Agents: Water, foam
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic and irritating hydrogen chloride or phosgene gases may form.
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Not pertinent
6.8 Electrical Hazard: Data not available
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: Flush with water, rinse with sodium bicarbonate or lime solution.
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:
5 ppm/48 hr/mullet/50% kill/salt water
375 mg/l/48 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: LD_{50} = ~2000 mg/kg
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: No buildup in food chain

9. SHIPPING INFORMATION

9.1 Grades of Purity: 98+%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

(illegible)

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: ORM-A
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: 221.0
12.3 Boiling Point at 1 atm: Very high
12.4 Freezing Point: 286°F = 141°C = 314°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.563 at 20°C (solid)
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: (est.) −7,700 Btu/lb = −4,300 cal/g = −180 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: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Data not available

NOTES

DCA — 2,4-DICHLOROPHENOXYACETIC ACID

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
	NOT PERTINENT		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
77	.070		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

HYDROFLUORIC ACID

HFA

Common Synonyms	Watery liquid — Colorless to green — Irritating odor
	Sinks and mixes with water. Harmful vapor is produced.

Avoid contact with liquid and vapor. Keep people away.
Wear chemical protective suit with self-contained breathing apparatus.
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	Not flammable. Flammable gas may be produced on contact with metals. Wear chemical protective suit with self-contained breathing apparatus.
Exposure	CALL FOR MEDICAL AID. VAPOR: Will burn eyes, nose and throat. Harmful if inhaled. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. IF IN EYES, hold eyelids open and flush with plenty of water. LIQUID: Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-corrosive
Restrict access
Disperse and flush

2. LABEL

2.1 Category: Corrosive
2.2 Class: 8

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Non-oxidizing mineral acid
3.2 Formula: $HF\text{-}H_2O$
3.3 IMO/UN Designation: 8.0/1790
3.4 DOT ID No.: 1790
3.5 CAS Registry No.: 7664-39-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless to slightly yellow
4.3 Odor: Pungent, irritating

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Proper protective clothing must be worn that encapsulates the body including the face. All persons handling the product must be familiar with and must observe all the precautions contained in the Manufacturing Chemists' Association Chemical Safety Data Sheet SD-25. A shower and an eye wash must be available.
5.2 Symptoms Following Exposure: Serious and painful burns of eyes and skin.
5.3 Treatment of Exposure: INGESTION: have victim drink water or milk; do NOT induce vomiting. SKIN: if victim has come in contact with liquid or vapor, put him in a shower and call a physician. EYES: flush with water for at least 15 min. and consult physician.
5.4 Threshold Limit Value: 3 ppm
5.5 Short Term Inhalation Limits: 50 ppm for 60 min
5.6 Toxicity by Ingestion: Data not available
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause severe irritation of eye and throat and can cause eye and lung injury. They cannot be tolerated even at low concentrations.
5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second and third-degree burns on short contact; very injurious to the eyes.
5.10 Odor Threshold: Data not available
5.11 IDLH Value: 20 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 and irritating vapors are generated when heated
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: Will attack glass, concrete and certain metals containing silica, such as cast iron. Will attack natural rubber, leather, and many organic materials. May generate flammable hydrogen in contact with some metals.
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Flush with water, apply powdered limestone, slaked lime, soda ash, or sodium bicarbonate
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: 1

8. WATER POLLUTION

8.1 Aquatic Toxicity: 60 ppm/*/fish/lethal/fresh water *Time period not specified
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: Reagent: 48-51%; technical: 52-55%; 70% grade
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-P

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Corrosive material
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	0
Health	
Vapor Irritant	4
Liquid or Solid Irritant	4
Poisons	4
Water Pollution	
Human Toxicity	4
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	3
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	4
Flammability (Red)	0
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: 152°F = 67°C = 340°K
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.258 at 25°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: 649 Btu/lb = 361 cal/g = 15.1×10^5 J/kg
12.13 Heat of Combustion: Not pertinent
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: −66.6 Btu/lb = −37.0 cal/g = -1.55×10^5 J/kg
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 54.7 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: Varies

*Physical properties apply to 70% solution

NOTES

HFA	HYDROFLUORIC ACID

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
15	80.429	34	.702		N O T P E R T I N E N T	32.02	.850
20	80.280	36	.704				
25	80.120	38	.707				
30	79.958	40	.709				
35	79.809	42	.711				
40	79.650	44	.713				
45	79.490	46	.715				
50	79.339	48	.718				
55	79.179	50	.720				
60	79.030	52	.722				
65	78.870	54	.724				
70	78.709	56	.727				
75	78.559	58	.729				
80	78.400	60	.731				
85	78.250	62	.733				
		64	.735				
		66	.738				
		68	.740				
		70	.742				
		72	.744				
		74	.747				
		76	.749				
		78	.751				
		80	.753				
		82	.755				
		84	.758				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	M I S C I B L E		D A T A N O T A V A I L A B L E		D A T A N O T A V A I L A B L E		N O T P E R T I N E N T

MALATHION

MLT

Common Synonyms	Liquid	Yellow to dark brown	Skunk-like odor
Cythion insecticide	Sinks in water. Freezing point is 37°F.		

AVOID CONTACT WITH LIQUID. Keep people away.
Wear chemical protective suit with self-contained breathing apparatus.
Stop discharge if possible.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Combustible. POISONOUS GASES ARE PRODUCED IN FIRE AND WHEN HEATED. Containers may explode in fire. Wear chemical protective suit with self-contained breathing apparatus. Extinguish with dry chemical, carbon dioxide, water or foam. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID. LIQUID POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED. Irritating to eyes. 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	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-poison, water contaminant
Restrict access
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: $C_{10}H_{19}O_6PS_2$
3.3 IMO/UN Designation: 6.1/2783
3.4 DOT ID No.: 2783
3.5 CAS Registry No.: 121-75-5

4. OBSERVABLE CHARACTERISTICS
4.1 Physical State (as shipped): Liquid
4.2 Color: Yellow to dark brown
4.3 Odor: Characteristic skunk-like mercaptan

5. HEALTH HAZARDS
5.1 Personal Protective Equipment: Wear self-contained breathing apparatus (or respirator for organophosphorus pesticides) and rubber clothing while fighting fires of malathion with chlorine bleach solution. All clothing contaminated by fumes and vapors must be decontaminated.
5.2 Symptoms Following Exposure: Exposure to fumes from a fire or to liquid causes headache, blurred vision, constricted pupils of the eyes, weakness, nausea, cramps, diarrhea, and tightness in the chest. Muscles twitch and convulsions may follow. The symptoms may develop over a period of 8 hours.
5.3 Treatment of Exposure: Speed is essential. INHALATION: in the nonbreathing victim immediately institute artificial respiration, using the mouth-to-mouth, the mouth-to-nose, or the mouth-to-oropharyngeal method. Call physician. INGESTION: administer milk, water or salt-water and induce vomiting repeatedly. SKIN OR EYE CONTACT: flood and wash exposed skin areas thoroughly with water. Remove contaminated clothing under a shower. Administer atropine, 2 mg (1/30 gr) intramuscularly or intravenously as soon as any local or systemic signs or symptoms of an intoxication are noted; repeat the administration of atropine every 3-8 min. until signs of atropinization (flushness, dry mouth, rapid pulse, hot and dry skin) occur; initiate treatment in children with 1 mg of atropine. Watch respiration, and remove bronchial secretions if they appear to be obstructing the airway; intubate if necessary. Give 2-PAM (Pralidoxime, Protopam), 2.5 gm in 100 ml of sterile water or in 5% dextrose and water, intravenously, slowly, in 15-30 min.; if sufficient fluid is not available, give 1 gm of 2-PAM in 3 ml of distilled water by deep intramuscular injection; repeat this every half hour if respiration weakens or if muscle fasciculation or convulsions recur.
5.4 Threshold Limit Value: 10 mg/m³
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)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: None likely
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.

(Continued)

6. FIRE HAZARDS
6.1 Flash Point: > 325°F
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Dry chemical, carbon dioxide, water spray, foam
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Vapors and fumes from fires are hazardous. They include sulfur dioxide and phosphoric acid
6.6 Behavior in Fire: Gives off hazardous fumes. Area surrounding fire should be diked to prevent water runoff.
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

(Continued)

7. CHEMICAL REACTIVITY
7.1 Reactivity With Water: None
7.2 Reactivity with Common Materials: No hazardous reaction
7.3 Stability During Transport: Not pertinent
7.4 Neutralizing Agents for Acids and Caustics: Liquid bleach solution for decontamination
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:
0.09 ppm/96 hr/bluegill/TL_m/fresh water
0.003-0.080 ppm/96 hr/marine crustacean/LC_{50}
8.2 Waterfowl Toxicity: LD_{50} = 1485 mg/kg
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION
9.1 Grades of Purity: CYTHION insecticide, Malathion ULV Concentrate insecticide. Many powders, dusts, and spray solutions are sold under a variety of trade names.
9.2 Storage Temperature: Below 120°F. Decomposition (non-hazardous) occurs at higher temperatures.
9.3 Inert Atmosphere: Data not available
9.4 Venting: Data not available

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: Not listed
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: 330.36
12.3 Boiling Point at 1 atm: Very high
12.4 Freezing Point: 37°F = 2.8°C = 276°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.234 at 25°C (liquid)
12.8 Liquid Surface Tension: 37.1 dynes/cm = 0.0371 N/m at 24°C
12.9 Liquid Water Interfacial Tension: 19 dynes/cm = 0.019 N/m at 24°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: Not pertinent
12.13 Heat of Combustion: Data not available
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

5. HEALTH HAZARDS (Continued)
5.10 Odor Threshold: Data not available
5.11 IDLH Value: 5000 mg/m³

6. FIRE HAZARDS (Continued)
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

MLT	MALATHION

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot (estimate)	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
77	77.089	85	.380		NOT PERTINENT	70	45.270
78	77.089	90	.384			72	42.680
79	77.089	95	.389			74	40.260
80	77.089	100	.393			76	37.990
81	77.089	105	.398			78	35.870
82	77.089	110	.402			80	33.880
83	77.089	115	.406			82	32.020
84	77.089	120	.411			84	30.270
85	77.089	125	.415			86	28.620
86	77.089	130	.420			88	27.080
87	77.089	135	.424			90	25.630
88	77.089	140	.429			92	24.270
89	77.089	145	.433			94	22.990
90	77.089	150	.438			96	21.760
91	77.089					98	20.650
92	77.089					100	19.580
93	77.089					102	18.580
94	77.089					104	17.630
95	77.089					106	16.740
96	77.089					108	15.900
97	77.089					110	15.100
98	77.089					112	14.350
99	77.089					114	13.650
100	77.089					116	12.980
101	77.089					118	12.350
102	77.089					120	11.750

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
77.02	.014		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

METHYL BROMIDE

MTB

Common Synonyms	Liquefied gas	Colorless	Odorless to sweet odor
Bromomethane Embafume M-B-C Fumigant Monobromomethane	Sinks and boils in water. Poisonous vapor cloud is formed. Boiling point is 38°F.		

AVOID CONTACT WITH LIQUID AND VAPOR. Keep people away.
Wear goggles, self-contained breathing apparatus, and protective impervious overclothing (including gloves).
Stop discharge if possible. Call fire department.
Evacuate area in case of large leaks.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Combustible. POISONOUS AND IRRITATING GASES ARE PRODUCED IN FIRE. Wear goggles, self-contained breathing apparatus, and protective overclothing (including gloves). EXTINGUISH WITH WATER, FOAM, OR CARBON DIOXIDE. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID VAPOR POISONOUS IF INHALED. Irritating to eyes. Move to fresh air. If breathing has stopped, give artificial respiration (but NOT mouth-to-mouth). 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. DO NOT RUB AFFECTED AREAS 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	Not harmful to aquatic life. 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-poison
Restrict access

2. LABEL

2.1 Category: Poison
2.2 Class: 6

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: CH_3Br
3.3 IMO/UN Designation: 2.0/1062
3.4 DOT ID No.: 1062
3.5 CAS Registry No.: 74-83-9

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquefied gas
4.2 Color: Colorless
4.3 Odor: Relatively odorless; sweet, chloroform-like

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Self-contained breathing apparatus; goggles.
5.2 Symptoms Following Exposure: Inhalation of vapor causes lung congestion and pulmonary edema. Higher concentrations cause rapid narcosis and death. Contact with liquid irritates eyes and burns skin.
5.3 Treatment of Exposure: INHALATION: remove victim to fresh air; give artificial respiration if needed. SKIN OR EYES: flush with water for at least 15 min.
5.4 Threshold Limit Value: 5 ppm
5.5 Short Term Inhalation Limits: 20 ppm for 5 min.
5.6 Toxicity by Ingestion: Data not available
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapor is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations.
5.9 Liquid or Solid Irritant Characteristics: Fairly severe skin irritant; may cause pain and second-degree burns after a few minutes' contact.
5.10 Odor Threshold: Odorless
5.11 IDLH Value: 2,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: Practically not flammable
6.2 Flammable Limits in Air: 10%-15%
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 and irritating gases are generated when exposed to fire or heat
6.6 Behavior in Fire: Containers may explode
6.7 Ignition Temperature: 998°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: None
8.2 Waterfowl Toxicity: None
8.3 Biological Oxygen Demand (BOD): None
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Commercial: not less than 99.5%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Safety relief

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-B-C-I-J

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Poison B
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	1
Health	
Vapor Irritant	3
Liquid or Solid Irritant	3
Poisons	4
Water Pollution	
Human Toxicity	0
Aquatic Toxicity	1
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

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

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Gas
12.2 Molecular Weight: 94.95
12.3 Boiling Point at 1 atm: 38.5°F = 3.6°C = 276.8°K
12.4 Freezing Point: −135°F = −93°C = 180°K
12.5 Critical Temperature: 376°F = 191°C = 464°K
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.68 at 20°C (liquid)
12.8 Liquid Surface Tension: 24.5 dynes/cm = 0.0245 N/m at 15°C
12.9 Liquid Water Interfacial Tension: Not pertinent
12.10 Vapor (Gas) Specific Gravity: 3.3
12.11 Ratio of Specific Heats of Vapor (Gas): 1.247
12.12 Latent Heat of Vaporization: 108 Btu/lb = 59.7 cal/g = 2.50×10^5 J/kg
12.13 Heat of Combustion: −3188 Btu/lb = −1771 cal/g = -74.15×10^5 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: 15.05 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 45 psia

NOTES

METHYL BROMIDE

MTB

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
35	107.700

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
−35	.194
−30	.195
−25	.195
−20	.195
−15	.195
−10	.196
−5	.196
0	.196
5	.196
10	.197
15	.197
20	.197
25	.198
30	.198
35	.198

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
−90	.795
−80	.787
−70	.779
−60	.771
−50	.764
−40	.756
−30	.748
−20	.740
−10	.732
0	.724
10	.716
20	.708
30	.700

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
	NOT PERTINENT

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
68.02	.090

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
−70	.651
−60	.944
−50	1.340
−40	1.864
−30	2.547
−20	3.424
−10	4.532
0	5.914
10	7.616
20	9.694
30	12.200
40	15.190
50	18.730
60	22.880
70	27.710
80	33.300
90	39.710
100	47.020
110	55.300
120	64.639

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
−70	.01479
−60	.02090
−50	.02893
−40	.03929
−30	.05244
−20	.06888
−10	.08914
0	.11380
10	.14350
20	.17880
30	.22030
40	.26880
50	.32500
60	.38940
70	.46270
80	.54570
90	.63900
100	.74310
110	.85870
120	.98640

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.098
25	.101
50	.104
75	.106
100	.109
125	.112
150	.114
175	.117
200	.120
225	.122
250	.125
275	.127
300	.129
325	.132
350	.134
375	.137
400	.139
425	.141
450	.144
475	.146
500	.148
525	.150
550	.153
575	.155
600	.157

METHYL ETHYL KETONE

MEK

Common Synonyms	Liquid	Colorless	Sweet odor
MEK 2-Butanone Ethyl methyl ketone	Floats and mixes with 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. Extinguish with dry chemical, alcohol 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 is difficult, give oxygen. LIQUID Will burn 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	Dangerous to aquatic life in high 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
Disperse and flush

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Ketone
3.2 Formula: $CH_3COCH_2CH_3$
3.3 IMO/UN Designation: 3.2/1193
3.4 DOT ID No.: 1193
3.5 CAS Registry No.: 78-93-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Like acetone; pleasant pungent

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic canister or air pack; plastic gloves; goggles or face shield.
5.2 Symptoms Following Exposure: Liquid causes eye burn. Vapor irritates eyes, nose, and throat; can cause headache, dizziness, nausea, weakness, and loss of consciousness.
5.3 Treatment of Exposure: INHALATION: remove victim to fresh air; if breathing is irregular or has stopped, start resuscitation and administer oxygen. EYES: wash with plenty of water for at least 15 min. and call physician.
5.4 Threshold Limit Value: 200 ppm
5.5 Short Term Inhalation Limits: 590 mg/m³ for 60 min.
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg (rat)
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: 10 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 22°F C.C.; 22°F O.C.
6.2 Flammable Limits in Air: 1.8%-11.5%
6.3 Fire Extinguishing Agents: Alcohol 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: 961°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 4.1 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: 18

8. WATER POLLUTION

8.1 Aquatic Toxicity: 5640 mg/l/48 hr/bluegill/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 214%, 5 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: 99.5+%
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-P-Q-R-S

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	2
Aquatic Toxicity	1
Aesthetic Effect	1
Reactivity	
Other Chemicals	2
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: 72.11
12.3 Boiling Point at 1 atm: 175.3°F = 79.6°C = 352.8°K
12.4 Freezing Point: −123.3°F = −86.3°C = 186.9°K
12.5 Critical Temperature: 504.5°F = 262.5°C = 535.7°K
12.6 Critical Pressure: 603 psia = 41.0 atm = 4.15 MN/m²
12.7 Specific Gravity: 0.805 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: 2.5
12.11 Ratio of Specific Heats of Vapor (Gas): 1.075
12.12 Latent Heat of Vaporization: 191 Btu/lb = 106 cal/g = 4.44×10^5 J/kg
12.13 Heat of Combustion: −13,480 Btu/lb = −7491 cal/g = -313.6×10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: (est.) −9 Btu/lb = −5 cal/g = -0.2×10^5 J/kg
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: 3.5 psia

NOTES

MEK — METHYL ETHYL KETONE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
35	51.460	—35	.501	10	1.073		NOT PERTINENT
40	51.280	—30	.502	15	1.068		
45	51.110	—25	.503	20	1.063		
50	50.940	—20	.504	25	1.058		
55	50.760	—15	.505	30	1.053		
60	50.590	—10	.507	35	1.048		
65	50.420	—5	.508	40	1.043		
70	50.240	0	.509	45	1.038		
75	50.070	5	.510	50	1.033		
80	49.900	10	.511	55	1.028		
85	49.720	15	.512	60	1.023		
90	49.550	20	.513	65	1.018		
95	49.380	25	.514	70	1.013		
100	49.200	30	.516	75	1.008		
105	49.030	35	.517	80	1.003		
110	48.860	40	.518	85	.998		
115	48.680	45	.518	90	.993		
120	48.510	50	.520	95	.988		
		55	.521	100	.983		
		60	.522	105	.978		
		65	.523				
		70	.524				
		75	.526				
		80	.527				
		85	.528				
		90	.529				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	27.000	0	.148	0	.00216	0	.352
		10	.216	10	.00310	25	.368
		20	.310	20	.00435	50	.384
		30	.437	30	.00599	75	.399
		40	.604	40	.00812	100	.414
		50	.823	50	.01085	125	.429
		60	1.104	60	.01427	150	.444
		70	1.461	70	.01853	175	.458
		80	1.909	80	.02376	200	.472
		90	2.465	90	.03012	225	.486
		100	3.147	100	.03778	250	.500
		110	3.977	110	.04690	275	.513
		120	4.977	120	.05768	300	.526
		130	6.171	130	.07030	325	.538
		140	7.586	140	.08498	350	.551
		150	9.250	150	.10190	375	.563
		160	11.180	160	.12130	400	.575
		170	13.450	170	.14350	425	.586
		180	16.050	180	.16850	450	.596
		190	19.030	190	.19670	475	.609
		200	22.420	200	.22830	500	.620
		210	26.270	210	.26350	525	.630
		220	30.610	220	.30250	550	.640
		230	35.480	230	.34560	575	.650
		240	40.930	240	.39290	600	.660

MORPHOLINE

MPL

Common Synonyms	Oily liquid	Colorless	Fishy, ammonia odor
Tetrahydro-2H-1, 4-oxazine Tetrahydro-p-oxazine Diethylenimide oxide Diethylene imidoxide Diethylene oximide	Floats and mixes with water. Irritating vapor is produced		

Stop discharge if possible
Avoid contact with liquid and vapor.
Call fire department
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.
Extinguish with water, dry chemical, or carbon dioxide
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, headache, 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.
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)
Disperse and flush

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aliphatic amine
3.2 Formula: $OCH_2CH_2NHCH_2CH_2$
3.3 IMO/UN Designation: 3.3/2054
3.4 DOT ID No.: 2054
3.5 CAS Registry No.: 110-91-8

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Fishy; ammoniacal

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor canister or self-contained breathing apparatus; rubber boots and gloves; goggles or face shield
5.2 Symptoms Following Exposure: Liquid causes skin and eye burns. Breathing vapors or absorption through skin may cause nausea and headache
5.3 Treatment of Exposure: INHALATION: if ill effects occur, move patient to fresh air, keep him quiet and warm, and call a physician; if breathing stops, start artificial respiration. INGESTION: force milk or water, then immediately induce vomiting; treat symptomatically; no known antidote. SKIN OR EYES: immediately flush with plenty of water for at least 15 min.; for eyes get medical attention promptly
5.4 Threshold Limit Value: 20 ppm
5.5 Short Term Inhalation Limits: 20 ppm for 15 min
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg (guinea pig, rat)
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: 0.01 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 100°F O.C.
6.2 Flammable Limits in Air: 1.8%-10.8%
6.3 Fire Extinguishing Agents: Water fog, alcohol 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 vapors are generated when heated.
6.6 Behavior in Fire: Vapor is heavier than air and may travel some distance to source of ignition and flash back.
6.7 Ignition Temperature: 590°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 1.5 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: Flush with water
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: 7

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): (theor.) 0.9%, 5 days; 3.1%, 20 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Several grades available, most above 99%.
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-Q

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	1
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	1
Aesthetic Effect	1
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: 87.12
12.3 Boiling Point at 1 atm: 262.8°F = 128.2°C = 401.4°K
12.4 Freezing Point: 23.4°F = −4.8°C = 268.4°K
12.5 Critical Temperature: 653°F = 345°C = 618°K
12.6 Critical Pressure: 794 psia = 54 atm = 5.47 MN/m²
12.7 Specific Gravity: 1.00 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): (est.) 1.081
12.12 Latent Heat of Vaporization: 182.9 Btu/lb = 101.6 cal/g = 4.254×10^5 J/kg
12.13 Heat of Combustion: Data not available
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Data not available
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: 0.55 psia

6. FIRE HAZARDS (Continued)

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

169-147 0 - 86 - 47 : QL 3

MPL	MORPHOLINE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
35	63.740	70	.476		N O T P E R T I N E N T		N O T P E R T I N E N T
40	63.550	75	.477				
45	63.360	80	.478				
50	63.170	85	.480				
55	62.980	90	.481				
60	62.790	95	.482				
65	62.600	100	.484				
70	62.410	105	.485				
75	62.220	110	.486				
80	62.030	115	.488				
85	61.840	120	.489				
90	61.650	125	.490				
95	61.450	130	.492				
100	61.260	135	.493				
105	61.070	140	.494				
110	60.880	145	.496				
115	60.690	150	.497				
120	60.500	155	.498				
		160	.499				
		165	.501				
		170	.502				
		175	.503				
		180	.505				
		185	.506				
		190	.507				
		195	.508				

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F (estimate)
	M I S C I B L E	—30	.002	—30	.00003	50	.274
		—20	.003	—20	.00005	52	.274
		—10	.005	—10	.00009	54	.274
		0	.008	0	.00014	56	.274
		10	.013	10	.00023	58	.274
		20	.021	20	.00036	60	.274
		30	.033	30	.00054	62	.274
		40	.049	40	.00080	64	.274
		50	.073	50	.00117	66	.274
		60	.106	60	.00166	68	.274
		70	.152	70	.00232	70	.274
		80	.213	80	.00320	72	.274
		90	.294	90	.00434	74	.274
		100	.401	100	.00581	76	.274
		110	.538	110	.00767	78	.274
		120	.714	120	.00989	80	.274
		130	.936	130	.01288	82	.274
		140	1.213	140	.01641	84	.274
		150	1.556	150	.02071		
		160	1.976	160	.02588		
		170	2.487	170	.03205		
		180	3.102	180	.03936		
		190	3.838	190	.04795		
		200	4.712	200	.05797		
		210	5.742	210	.06959		
		220	6.849	220	.08297		

NAPHTHA: COAL TAR

NCT

Common Synonyms	Watery liquid	Colorless to pale yellow	Gasoline-like odor
Mixture of benzene, toluene, xylenes	Floats on water. Irritating vapor is produced.		

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

Fire	Combustible. Extinguish with foam, dry chemical or carbon dioxide. 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	Effect of low concentrations on aquatic life is unknown. 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: Data not available
3.3 IMO/UN Designation: 3.2/2553
3.4 DOT ID No.: 2553
3.5 CAS Registry No.: M18030-31-7

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless to pale yellow
4.3 Odor: Like benzene, toluene, and xylene

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Hydrocarbon vapor canister or air pack; plastic gloves; goggles or face shield
5.2 Symptoms Following Exposure: Primarily a narcotic, causing unconsciousness in high concentrations. The symptoms of acute benzene poisoning are not likely, since the compound has components other than benzene.
5.3 Treatment of Exposure: Remove from exposure. Support respiration. Call physician.
5.4 Threshold Limit Value: 100 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: 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: 4.68 ppm
5.11 IDLH Value: 10,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 107°F C.C.
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Foam, carbon dioxide, or dry chemical
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 900—950°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: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Purity varies with coal used and distillation range taken.
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-V-W

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: Not listed

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: 200—500°F = 93—260°C = 366-533°K
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 0.86—0.89 at 20°C (liquid)
12.8 Liquid Surface Tension: (est.) 20 dynes/cm = 0.020 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: Data not available
12.11 Ratio of Specific Heats of Vapor (Gas): (est.) 1.030
12.12 Latent Heat of Vaporization: (est.) 101 Btu/lb = 56.2 cal/g = 2.35×10^5 J/kg
12.13 Heat of Combustion: (est.) —18,200 Btu/lb = —10,100 cal/g = —424 × 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: 0.13 psia

NOTES

NCT — NAPHTHA: COAL TAR

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot (estimate)	Temperature (degrees F)	British thermal unit per pound-F (estimate)	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F (estimate)	Temperature (degrees F)	Centipoise (estimate)
50	53.680	50	.478	50	1.040	50	9.343
52	53.680	52	.478	52	1.040	52	8.841
54	53.680	54	.478	54	1.040	54	8.370
56	53.680	56	.478	56	1.040	56	7.927
58	53.680	58	.478	58	1.040	58	7.511
60	53.680	60	.478	60	1.040	60	7.119
62	53.680	62	.478	62	1.040	62	6.751
64	53.680	64	.478	64	1.040	64	6.404
66	53.680	66	.478	66	1.040	66	6.078
68	53.680	68	.478	68	1.040	68	5.770
70	53.680	70	.478	70	1.040	70	5.481
72	53.680	72	.478	72	1.040	72	5.207
74	53.680	74	.478	74	1.040	74	4.950
76	53.680	76	.478	76	1.040	76	4.707
78	53.680	78	.478	78	1.040	78	4.477
80	53.680	80	.478	80	1.040	80	4.260
82	53.680	82	.478	82	1.040	82	4.056
84	53.680	84	.478	84	1.040	84	3.862
86	53.680	86	.478	86	1.040	86	3.679
88	53.680	88	.478	88	1.040	88	3.506
90	53.680	90	.478	90	1.040	90	3.342
92	53.680	92	.478	92	1.040	92	3.187
94	53.680	94	.478	94	1.040	94	3.040
96	53.680	96	.478	96	1.040	96	2.901
98	53.680	98	.478	98	1.040	98	2.770
100	53.680	100	.478	100	1.040	100	2.645

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch (estimate)	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	INSOLUBLE	90	.094		NOT PERTINENT		DATA NOT AVAILABLE
		100	.124				
		110	.163				
		120	.211				
		130	.272				
		140	.347				
		150	.440				
		160	.553				
		170	.691				
		180	.858				
		190	1.054				
		200	1.290				
		210	1.569				
		220	1.897				
		230	2.281				
		240	2.728				
		250	3.247				
		260	3.846				
		270	4.535				
		280	5.323				
		290	6.221				
		300	7.241				
		310	8.394				
		320	9.695				
		330	11.160				
		340	12.790				

OCTANOL

OTA

Common Synonyms	Thick liquid	Colorless	Sweet odor
1-Octanol Octyl alcohol Heptylcarbinol Alcohol C-8	Floats on water.		

Stop discharge if possible. Keep people away.
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, or carbon dioxide. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID LIQUID Irritating to skin. Will burn eyes. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water.
Water Pollution	Effect of low concentrations on aquatic life is unknown. 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: Alcohol, glycol
3.2 Formula: $CH_3(CH_2)_6CH_2OH$
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: Data not available
3.5 CAS Registry No.: 111-87-5

4. OBSERVABLE CHARACTERISTICS

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

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Chemical gloves and chemical goggles.
5.2 Symptoms Following Exposure: Irritates skin and eyes.
5.3 Treatment of Exposure: Flush with copious amounts of water.
5.4 Threshold Limit Value: Data not available
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 1; oral rat $LD_{50} > 3.2$ g/kg
5.7 Late Toxicity: None
5.8 Vapor (Gas) Irritant Characteristics: Vapors are nonirritating to the eyes and throat.
5.9 Liquid or Solid Irritant Characteristics: No appreciable hazard. Practically harmless to the skin.
5.10 Odor Threshold: 0.48 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 178°F C.C.
6.2 Flammable Limits in Air: Data not available
6.3 Fire Extinguishing Agents: Foam, carbon dioxide, or dry chemical
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: Data not available
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 3.7 mm/min. (approx.)
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: 20

8. WATER POLLUTION

8.1 Aquatic Toxicity: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 100%, 5 days
8.4 Food Chain Concentration Potential: None

9. SHIPPING INFORMATION

9.1 Grades of Purity: Data not available
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: Not listed
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	1
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: 130.23
12.3 Boiling Point at 1 atm: 383°F = 195°C = 468°K
12.4 Freezing Point: 5°F = −15°C = 258°K
12.5 Critical Temperature: 725°F = 385°C = 658°K
12.6 Critical Pressure: 400 psia = 27 atm = 2.7 MN/m²
12.7 Specific Gravity: 0.826 at 20°C (liquid)
12.8 Liquid Surface Tension: 27.5 dynes/cm = 0.0275 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 8.52 dynes/cm = 0.00852 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.044
12.12 Latent Heat of Vaporization: 176 Btu/lb = 97.5 cal/g = 4.08 X 10^5 J/kg
12.13 Heat of Combustion: −16,130 Btu/lb = −8,963 cal/g = −375.3 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

OTA | OCTANOL

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
35	52.660
40	52.520
45	52.380
50	52.240
55	52.100
60	51.960
65	51.820
70	51.680
75	51.540
80	51.400
85	51.260
90	51.120
95	50.980
100	50.840
105	50.700
110	50.560
115	50.420
120	50.280
125	50.130
130	49.990
135	49.850
140	49.710

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F (estimate)
68	.499
69	.499
70	.499
71	.499
72	.499
73	.499
74	.499
75	.499
76	.499
77	.499
78	.499
79	.499
80	.499
81	.499
82	.499
83	.499
84	.499
85	.498

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
95	1.113
100	1.110
105	1.107
110	1.104
115	1.101
120	1.098
125	1.095
130	1.092
135	1.089
140	1.086
145	1.083
150	1.080
155	1.077
160	1.074
165	1.071
170	1.068

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
55	11.840
60	10.630
65	9.555
70	8.609
75	7.772
80	7.028
85	6.368
90	5.781
95	5.257
100	4.789
105	4.369
110	3.993
115	3.654
120	3.350
125	3.075
130	2.827
135	2.603
140	2.400

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
68.02	.600

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
80	.002
100	.005
120	.013
140	.032
160	.070
180	.144
200	.275
220	.497
240	.654
260	1.404
280	2.219
300	3.386
320	5.018
340	7.225
360	10.150
380	13.950
400	18.790
420	24.850
440	32.320
460	41.400
480	52.300

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
80	.00004
100	.00011
120	.00028
140	.00065
160	.00138
180	.00273
200	.00507
220	.00888
240	.01481
260	.02367
280	.03639
300	.05410
320	.07805
340	.10960
360	.15030
380	.20180
400	.26520
420	.34280
440	.43590
460	.54620
480	.67530

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.328
25	.342
50	.355
75	.369
100	.382
125	.396
150	.409
175	.422
200	.435
225	.447
250	.460
275	.472
300	.485
325	.497
350	.509
375	.521
400	.532
425	.544
450	.555
475	.567
500	.578
525	.589
550	.600
575	.611
600	.621

PARATHION

PTO

Common Synonyms	Liquid	Light to dark brown
Ethyl parathion Phosphorothioic acid, O, O-diethyl O-p-nitrophenyl ester O, O Diethyl O-(p-nitrophenyl) phosphorothioate	Sinks in water. Freezing point is 43°F.	

AVOID CONTACT WITH LIQUID AND VAPOR. KEEP PEOPLE AWAY.
Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves).
Stop discharge if possible.
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.

LIQUID
POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.
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

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-poison, water contaminant
Restrict access
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Poison
2.2 Class: B

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Not applicable
3.2 Formula: $(C_2H_5O)_2PSOC_6H_4NO_2$
3.3 IMO/UN Designation: 6.1/2784
3.4 DOT ID No.: 2784
3.5 CAS Registry No.: 56-38-2

4. OBSERVABLE CHARACTERISTICS

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

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Neoprene-coated gloves; rubber work shoes or overshoes; latex rubber apron; goggles; respirator or mask approved for toxic dusts and organic vapors.
5.2 Symptoms Following Exposure: Inhalation of mist, dust, or vapor (or ingestion, or absorption through the skin) cause dizziness, usually accompanied by constriction of the pupils, headache, and tightness of the chest. Nausea, vomiting, abdominal cramps, diarrhea, muscular twitchings, convulsions and possibly death may follow. An increase in salivary and bronchial secretions may result which simulate severe pulmonary edema. Contact with eyes causes irritation.
5.3 Treatment of Exposure: Call a doctor for all exposures to this compound. INHALATION: remove victim from exposure immediately; have physician treat with atropine injections until full atropinization; 2-PAM may also be administered by physician. EYES: flush with water immediately after contact for at least 15 min. SKIN: remove all clothing and shoes immediately, quickly wipe off the affected area with a clean cloth; follow immediately with a shower, using plenty of soap. If a complete shower is impossible, wash the affected skin repeatedly with soap and water. INGESTION: if victim is conscious, induce vomiting and repeat until vomit fluid is clear; make victim drink plenty of milk or water; have him lie down and keep warm.
5.4 Threshold Limit Value: 0.1 mg/m³
5.5 Short Term Inhalation Limits: 0.3 mg/m³ for 30 min.
5.6 Toxicity by Ingestion: Grade 4; oral LD_{50} = 3 mg/kg (rat)
5.7 Late Toxicity: Birth defects in chick embryos
5.8 Vapor (Gas) Irritant Characteristics: Data not available
5.9 Liquid or Solid Irritant Characteristics: Data not available
5.10 Odor Threshold: 0.04 ppm
5.11 IDLH Value: 20 mg/m³

6. FIRE HAZARDS

6.1 Flash Point: Not flammable
6.2 Flammable Limits in Air: Not flammable
6.3 Fire Extinguishing Agents: Water on adjacent fires
6.4 Fire Extinguishing Agents Not to be Used: High-pressure water hoses may scatter parathion from broken containers, increasing contamination hazard.
6.5 Special Hazards of Combustion Products: Fumes from decomposing material may contain oxides of sulfur and nitrogen.
6.6 Behavior in Fire: Containers may explode when heated.
6.7 Ignition Temperature: Not pertinent
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not pertinent
6.10 Adiabatic Flame Temperature: Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: Slow reaction, not considered hazardous
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:
1.6 ppm/96 hr/minnow/TL_m/fresh water
0.43 ppm/≤24 hr/shrimp/lethal/salt water
8.2 Waterfowl Toxicity: LD_{50} = 2.13 mg/kg
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: No buildup in food chain

9. SHIPPING INFORMATION

9.1 Grades of Purity: 98.5+%. Sometimes distributed as solutions emulsifiable in water.
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-O-X-Y

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Poison, B
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	4
Flammability (Red)	1
Reactivity (Yellow)	2

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 291.3
12.3 Boiling Point at 1 atm: Very high; decomposes
12.4 Freezing Point: 43°F = 6°C = 279°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.269 at 25°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: −9,240 Btu/lb = −5,140 cal/g = −215 × 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

6. FIRE HAZARDS (Continued)

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

PTO | PARATHION

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
65	79.379
70	79.209
75	79.049
80	78.879
85	78.719
90	78.559
95	78.400
100	78.240
105	78.080
110	77.929
115	77.770
120	77.620
125	77.459

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
65	.338
70	.339
75	.341
80	.343
85	.345
90	.347
95	.348
100	.350
105	.352
110	.354
115	.356
120	.358
125	.359
130	.361

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F (estimate)
60	.967
61	.967
62	.967
63	.967
64	.967
65	.967
66	.967
67	.967
68	.967
69	.967
70	.967
71	.967
72	.967
73	.967
74	.967
75	.967
76	.967
77	.967

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
65	20.340
70	18.290
75	16.480
80	14.880
85	13.460
90	12.200
95	11.070
100	10.070
105	8.173
110	8.370
115	7.649
120	7.001
125	6.417

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
	INSOLUBLE ... REACTS SLOWLY

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
	NOT PERTINENT

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
	NOT PERTINENT

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
	NOT PERTINENT

PENTACHLOROPHENOL

PCP

Common Synonyms	Solid beads or flakes White to light brown
Dowicide 7 Penta Santophen 20	Sinks in water

Avoid contact with solid and dust. Keep people away.
Wear goggles and self-contained breathing apparatus.
Stop discharge if possible.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Not flammable.
Exposure	CALL FOR MEDICAL AID. **DUST** Irritating to eyes, nose and throat. If inhaled, will cause coughing or difficult breathing. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. **SOLID** **POISONOUS IF SWALLOWED.** Will burn skin and eyes. 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	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-poison
Restrict access
Should be removed

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_6Cl_5OH
3.3 IMO/UN Designation: 6.1/2020
3.4 DOT ID No.: 2020
3.5 CAS Registry No.: 87-86-5

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Solid
4.2 Color: Colorless to light brown
4.3 Odor: Very weak

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Respirator for dust; goggles; protective clothing.
5.2 Symptoms Following Exposure: Dust or vapor irritates skin and mucous membranes, causing coughing and sneezing. Ingestion causes loss of appetite, respiratory difficulties, anesthesia, sweating, coma. Overexposure can cause death.
5.3 Treatment of Exposure: Call a doctor! INGESTION: induce vomiting at once. EYES: flush with water for 15-20 min. SKIN: wash well with soap and water.
5.4 Threshold Limit Value: 0.5 mg/m³
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg (rat)
5.7 Late Toxicity: Data not available
5.8 Vapor (Gas) Irritant Characteristics: Vapor is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations.
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: Data not available
5.11 IDLH Value: 150 mg/m³

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: Generates toxic and irritating vapors
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: 5 ppm/?/hr/trout/lethal/fresh water
8.2 Waterfowl Toxicity: 4500 ppm/LC_{50}/mallards
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: 86-100%
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:

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

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Solid
12.2 Molecular Weight: 266.35
12.3 Boiling Point at 1 atm: 590°F = 310°C = 583°K
12.4 Freezing Point: 370°F = 188°C = 461°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.98 at 15°C (solid)
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

PCP PENTACHLOROPHENOL

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
	NOT PERTINENT		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
77.02	.100		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

POLYCHLORINATED BIPHENYL

PCB

Common Synonyms			
PCB Chlorinated biphenyls Arochlor Halogenated waxes Polychloropolyphenyls	Oily liquid to solid powder Sinks in water.	Light yellow liquid, or white powder	Weak odor

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. Extinguish with water, foam, dry chemical, or carbon dioxide.
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 Color: 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/m^3
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/m^3

6. FIRE HAZARDS

6.1 Flash Point: > 284°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 solid) 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

PCB — POLYCHLORINATED BIPHENYL

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot (estimate)	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
68	81.150		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT
69	81.150						
70	81.150						
71	81.150						
72	81.150						
73	81.150						
74	81.150						
75	81.150						
76	81.150						
77	81.150						
78	81.150						
79	81.150						
80	81.150						
81	81.150						
82	81.150						
83	81.150						
84	81.150						
85	81.150						

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	INSOLUBLE		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

TETRACHLOROETHANE

TEC

Common Synonyms	Liquid	Colorless to pale yellow	Sweet odor
1, 1, 2, 2-Tetrachloroethane Acetylene tetrachloride	Sinks in water.		

AVOID CONTACT WITH LIQUID AND VAPOR. KEEP PEOPLE AWAY.
Wear rubber overclothing (including gloves).
Stop discharge if possible.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	Not flammable. Poisonous gases may be produced when heated.
Exposure	CALL FOR MEDICAL AID **VAPOR** Irritating to eyes, nose and throat. Harmful if inhaled. If in eyes, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. **LIQUID** POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED. Irritating to skin and eyes. If swallowed will cause nausea and 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 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)

Issue warning-poison, air contaminant
Restrict access
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: $Cl_2CHCHCl_2$
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: 1702
3.5 CAS Registry No.: 79-34-5

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless yellowish green
4.3 Odor: Chloroform-like, pleasant, like carbon tetrachloride; mild, sweetish, similar to several other chlorinated hydrocarbons.

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Chemical safety goggles, plastic face shield; air or oxygen-supplied mask; safety hat with brim; solvent-proof apron; synthetic rubber gloves.
5.2 Symptoms Following Exposure: Compound is a powerful narcotic and liver poison; may also cause changes in blood composition and neurological disturbances. Repeated exposure by inhalation can be fatal. Ingestion causes vomiting, diarrhea, severe intestinal injury, liver necrosis, cyanosis, unconsciousness, loss of reflexes, and death. Contact with eyes causes irritation and lachrymation. Can be absorbed through the skin and may produce severe skin lesions.
5.3 Treatment of Exposure: INHALATION: remove victim from exposure; begin artificial respiration if breathing has ceased. INGESTION: induce vomiting; call a physician. EYES: irrigate with water for 15 min. SKIN: remove clothing; wash skin thoroughly with warm water and soap.
5.4 Threshold Limit Value: 1 ppm
5.5 Short Term Inhalation Limits: 10 ppm, 30 min.
5.6 Toxicity by Ingestion: Grade 3; oral LD_{50} = 200 mg/kg (rat)
5.7 Late Toxicity: Liver poisoning, nervous disorders
5.8 Vapor (Gas) Irritant Characteristics: Vapor is moderately irritating such that personnel will not usually tolerate moderate or high vapor concentrations.
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: 1.5 ppm
5.11 IDLH Value: 150 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: Irritating hydrogen chloride vapor may form in fire.
6.6 Behavior in Fire: Data not available
6.7 Ignition Temperature: Not pertinent
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: May attack some forms of plastics
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: Data not available
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Data not available
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Technical, 98%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

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: Not listed
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: 167.85
12.3 Boiling Point at 1 atm: 295.3°F = 146.3°C = 419.5°K
12.4 Freezing Point: −46.8°F = −43.8°C = 229.4°K
12.5 Critical Temperature: Data not available
12.6 Critical Pressure: Data not available
12.7 Specific Gravity: 1.595 at 20°C (liquid)
12.8 Liquid Surface Tension: 37.85 dynes/cm = 0.03785 N/m at 20°C
12.9 Liquid Water Interfacial Tension: Data not available
12.10 Vapor (Gas) Specific Gravity: 5.79
12.11 Ratio of Specific Heats of Vapor (Gas): 1.090 at 25°C
12.12 Latent Heat of Vaporization: 99.2 Btu/lb = 55.1 cal/g = 2.30×10^5 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: 0.5 psia

NOTES

TEC TETRACHLOROETHANE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
34	101.400
36	101.299
38	101.200
40	101.099
42	101.000
44	100.900
46	100.799
48	100.599
50	100.500
52	100.400
54	100.299
56	100.200
58	100.099
60	100.000
62	99.910
64	99.799
66	99.690
68	99.589
70	99.480
72	99.378
74	99.270
76	99.160
78	99.059
80	98.950
82	98.849
84	98.740

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
52	.210
54	.210
56	.210
58	.210
60	.210
62	.210
64	.210
66	.210
68	.210
70	.210
72	.210
74	.210
76	.210
78	.210
80	.210
82	.210
84	.210
86	.210

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
30	.791
40	.784
50	.777
60	.770
70	.763
80	.756
90	.748
100	.741
110	.734
120	.727
130	.720
140	.713
150	.706
160	.699
170	.692
180	.685
190	.678
200	.671

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
34	2.527
36	2.473
38	2.422
40	2.371
42	2.322
44	2.275
46	2.229
48	2.184
50	2.140
52	2.098
54	2.057
56	2.017
58	1.977
60	1.939
62	1.902
64	1.866
66	1.831
68	1.797
70	1.764
72	1.732
74	1.700
76	1.669
78	1.639
80	1.610
82	1.582
84	1.554

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
34	.251
36	.252
38	.254
40	.256
42	.258
44	.259
46	.261
48	.263
50	.265
52	.266
54	.268
56	.270
58	.272
60	.273
62	.275
64	.277
66	.279
68	.280
70	.282
72	.284
74	.286
76	.287
78	.289
80	.291
82	.293
84	.294

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
80	.161
90	.218
100	.285
110	.374
120	.485
130	.624
140	.798
150	1.008
160	1.265
170	1.578
180	1.954
190	2.403
200	2.938
210	3.570
220	4.313
230	5.182
240	6.194
250	7.366
260	8.719
270	10.270
280	12.050
290	14.070

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
80	.00468
90	.00614
100	.00797
110	.01026
120	.01309
130	.01655
140	.02076
150	.02584
160	.03193
170	.03918
180	.04776
190	.05784
200	.06964
210	.08335
220	.09922
230	.11750
240	.13840
250	.16230
260	.18940
270	.22010
280	.25470
290	.29350

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
90	.145
100	.146
110	.148
120	.149
130	.150
140	.151
150	.153
160	.154
170	.155
180	.156
190	.157
200	.159
210	.160
220	.161
230	.162
240	.164
250	.165
260	.166

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: 6.0/1897
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

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	99.910
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	96.668
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
80	.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	.758
100	.736
105	.716
110	[illegible]
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	2.448
160	3.042
170	3.756
180	4.607
180	5.618
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	.06189
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	.54780

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

TETRAHYDROFURAN

THF

Common Synonyms	Liquid	Colorless	Faint fruity odor
Diethylene oxide Tetramethylene oxide THF	Floats and mixes with 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 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, headache 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)

Issue warning-high flammability
Disperse and flush

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Ether
3.2 Formula: $CH_2CH_2CH_2CH_2O$
3.3 IMO/UN Designation: 3.1/2056
3.4 DOT ID No.: 2056
3.5 CAS Registry No.: 109-99-9

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Ether-like; similar to acetone

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Self-contained breathing apparatus; goggles or face shield; rubber or plastic gloves.
5.2 Symptoms Following Exposure: Vapors cause nausea, dizziness, headache, and anesthesia. Liquid can de-fat the skin and cause irritation. Liquid also irritates eyes.
5.3 Treatment of Exposure: INHALATION: remove victim from contaminated area; administer artificial respiration and oxygen if necessary. INGESTION: gastric lavage and saline cathartics are usually helpful; subsequent treatment is symptomatic and supportive. SKIN OR EYE CONTACT: wash with copious amounts of water.
5.4 Threshold Limit Value: 200 ppm
5.5 Short Term Inhalation Limits: 500 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/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: 20-50 ppm
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 6°F C.C.; −4°F O.C.
6.2 Flammable Limits in Air: 1.8%-11.8%
6.3 Fire Extinguishing Agents: 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: Irritating vapor is generated when heated
6.6 Behavior in Fire: May explode. Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 610°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 4.7 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 unless 0.1% of peroxides has accumulated because of prolonged storage in presence of air. When concentrated by evaporation of solution, they explode.
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: 0.025% butylated hydroxytoluene (BHT) present to prevent peroxide formation.
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 41

8. WATER POLLUTION

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

9. SHIPPING INFORMATION

9.1 Grades of Purity: Data not available
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: Padded
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-Q-R-S

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	1
Water Pollution	
Human Toxicity	2
Aquatic Toxicity	2
Aesthetic Effect	0
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	3

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: 72.10
12.3 Boiling Point at 1 atm: 151°F = 66°C = 339°K
12.4 Freezing Point: −163.3°F = −108.5°C = 164.7°K
12.5 Critical Temperature: 512.6°F = 267.0°C = 540.2°K
12.6 Critical Pressure: 753 psia = 51.2 atm = 5.19 MN/m²
12.7 Specific Gravity: 0.889 at 20°C (liquid)
12.8 Liquid Surface Tension: 26.4 dynes/cm = 0.0264 N/m at 20°C
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): (est.) 1.083
12.12 Latent Heat of Vaporization: 170 Btu/lb = 95 cal/g = 4.1 × 10⁵ J/kg
12.13 Heat of Combustion: −14,390 Btu/lb = −8000 cal/g = −334.8 × 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: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 7.7 psia

6. FIRE HAZARDS (Continued)

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

THF — TETRAHYDROFURAN

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
35	58.750	0	.372		NOT PERTINENT		NOT PERTINENT
40	58.560	10	.376				
45	58.370	20	.380				
50	58.180	30	.384				
55	55.990	40	.388				
60	55.800	50	.392				
65	55.610	60	.397				
70	55.420	70	.401				
75	55.230	80	.405				
80	55.040	90	.409				
85	54.650	100	.413				
90	54.650	110	.417				
95	54.460	120	.422				
100	54.270	130	.426				
105	54.080	140	.430				
110	53.890	150	.434				
115	53.700						
120	53.510						

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F (estimate)
	MISCIBLE	0	.336	0	.00481	100	.375
		5	.397	5	.00574	120	.384
		10	.467	10	.00668	140	.393
		15	.547	15	.00774	160	.402
		20	.638	20	.00895	180	.411
		25	.744	25	.01031	200	.420
		30	.864	30	.01185	220	.428
		35	.999	35	.01357	240	.437
		40	1.153	40	.01550	260	.445
		45	1.327	45	.01766	280	.454
		50	1.522	50	.02006	300	.462
		55	1.742	55	.02273	320	.470
		60	1.988	60	.02570	340	.478
		65	2.264	65	.02898	360	.486
		70	2.571	70	.03260	380	.494
		75	2.913	75	.03660	400	.501
		80	3.293	80	.04099	420	.509
		85	3.714	85	.04580	440	.516
		90	4.180	90	.05108		
		95	4.694	95	.05684		
		100	5.261	100	.06313		
		105	5.884	105	.06999		
		110	6.568	110	.07744		
		115	7.317	115	.08552		
		120	8.137	120	.09428		
		125	9.032	125	.10380		

TRICHLOROETHANE

TCE

Common Synonyms	Watery liquid	Colorless	Sweet odor
1,1,1-Trichloroethane Methylchloroform Aerothene Chlorothene	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 rubber 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: 932°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate (est.): 2.0 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/*/[illegible]/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: 4.6 psia

NOTES

TCE — TRICHLOROETHANE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
0	85.419
10	84.870
20	84.309
30	83.759
40	83.200
50	82.650
60	82.089
70	81.540
80	80.981
90	80.429
100	79.870
110	79.320
120	78.759
130	78.209
140	77.650
150	77.099
160	76.540

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
55	.240
60	.242
65	.244
70	.246
75	.248
80	.250
85	.252
90	.254
95	.256
100	.258
105	.260
110	.262
115	.264
120	.266
125	.268
130	.270
135	.272
140	.274

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
15	1.363
20	1.295
25	1.231
30	1.172
35	1.117
40	1.065
45	1.017
50	.972
55	.929
60	.889
65	.852
70	.817
75	.784
80	.753
85	.723

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
68.02	.070

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
70	2.099
75	2.364
80	2.657
85	2.980
90	3.335
95	3.725
100	4.152
105	4.619
110	5.130
115	5.686
120	6.292
125	6.950
130	7.663
135	8.437
140	9.273
145	10.180
150	11.150
155	12.200
160	13.330
165	14.540
170	15.840
175	17.240
180	18.730
185	20.330
190	22.030

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
70	.04925
75	.05495
80	.06119
85	.06799
90	.07540
95	.08346
100	.09220
105	.10170
110	.11190
115	.12300
120	.13490
125	.14770
130	.16150
135	.17630
140	.19220
145	.20920
150	.22730
155	.24670
160	.26730
165	.28930
170	.31270
175	.33760
180	.36390
185	.39180
190	.42140

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.146
25	.150
50	.155
75	.159
100	.163
125	.167
150	.171
175	.175
200	.179
225	.183
250	.186
275	.190
300	.193
325	.196
350	.199
375	.202
400	.205
425	.208
450	.210
475	.213
500	.215
525	.217
550	.219
575	.222
600	.223

TRICHLOROETHYLENE

TCL

Common Synonyms	Watery liquid	Colorless	Sweet odor
Trichloroethene Tricene; Algylen Chlorylen Germalgene Triclene Trichloran; Trilene	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 nausea, vomiting, 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, difficult breathing, 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 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: $CHCl=CCl_2$
3.3 IMO/UN Designation: 6.0/1710
3.4 DOT ID No.: 1710
3.5 CAS Registry No.: 79-01-6

4. OBSERVABLE CHARACTERISTICS

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

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or vinyl gloves; chemical safety goggles; face-shield; neoprene safety shoes; neoprene suit or apron for splash protection.
5.2 Symptoms Following Exposure: INHALATION: symptoms range from irritation of the nose and throat to nausea, an attitude of irresponsibility, blurred vision, and finally disturbance of central nervous system resulting in cardiac failure. Chronic exposure may cause organic injury. INGESTION: symptoms similar to inhalation. SKIN: defatting action can cause dermatitis. EYES: slightly irritating sensation and lacrimation.
5.3 Treatment of Exposure: Do NOT administer adrenalin or epinephrine; get medical attention for all cases of overexposure. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting; repeat three times; then give 1 tablespoon epsom salts in water. EYES: flush thoroughly with water. SKIN: wash thoroughly with soap and warm water.
5.4 Threshold Limit Value: 50 ppm
5.5 Short Term Inhalation Limits: 200 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/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: 50 ppm
5.11 IDLH Value: 1,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 90°F C.C.; practically nonflammable
6.2 Flammable Limits in Air: 8.0%–10.5%
6.3 Fire Extinguishing Agents: Water fog
6.4 Fire Extinguishing Agents Not to be Used: Not pertinent
6.5 Special Hazards of Combustion Products: Toxic and irritating gases are produced in fire situations
6.6 Behavior in Fire: Not pertinent
6.7 Ignition Temperature: 770°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: Not pertinent
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichometric 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: 660 mg/l/48 hr/daphnia/LC50/fresh 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: Technical; dry cleaning; degreasing; extraction
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	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	1

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: 131.39
12.3 Boiling Point at 1 atm: 189°F = 87°C = 360°K
12.4 Freezing Point: −123.5°F = −86.4°C = 186.8°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.46 at 20°C (liquid)
12.8 Liquid Surface Tension: 29.3 dynes/cm = 0.0293 N/m at 20°C
12.9 Liquid Water Interfacial Tension: 34.5 dynes/cm = 0.0345 N/m at 24°C
12.10 Vapor (Gas) Specific Gravity: 4.5
12.11 Ratio of Specific Heats of Vapor (Gas): 1.116
12.12 Latent Heat of Vaporization: 103 Btu/lb = 57.2 cal/g = 2.4×10^5 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: 2.5 psia

NOTES

TCL	TRICHLOROETHYLENE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
0	94.669
5	94.410
10	94.150
15	93.889
20	93.629
25	93.370
30	93.110
35	92.848
40	92.589
45	92.330
50	92.070
55	91.809
60	91.549
65	91.290
70	91.030
75	90.770
80	90.509
85	90.250
90	89.890
95	89.730
100	89.469
105	89.209
110	88.950
115	88.690
120	88.429
125	88.169

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.220
10	.221
20	.223
30	.225
40	.226
50	.228
60	.230
70	.231
80	.233
90	.235
100	.236
110	.238
120	.240
130	.241
140	.243
150	.245
160	.246
170	.248

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
15	.800
20	.775
25	.750
30	.727
35	.705
40	.684
45	.664
50	.645
55	.627
60	.610
65	.593
70	.577
75	.562
80	.548
85	.534
90	.521
95	.508
100	.496
105	.485
110	.474
115	.463
120	.453

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
77.02	.110

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
40	.508
50	.678
60	.894
70	1.166
80	1.507
90	1.929
100	2.448
110	3.081
120	3.846
130	4.765
140	5.862
150	7.163
160	8.695
170	10.490
180	12.580
190	15.010
200	17.810
210	21.020

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
40	.01245
50	.01628
60	.02105
70	.02695
80	.03418
90	.04296
100	.05354
110	.06619
120	.08120
130	.09891
140	.11960
150	.14380
160	.17180
170	.20390
180	.24080
190	.28280
200	.33040
210	.38420

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.136
25	.139
50	.143
75	.146
100	.149
125	.152
150	.155
175	.157
200	.160
225	.162
250	.165
275	.167
300	.169
325	.172
350	.174
375	.176
400	.177
425	.179
450	.181
475	.182
500	.184
525	.185
550	.186
575	.187
600	.188

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: 600 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; 38% (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	3
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 = 3.61×10^5 J/kg
12.13 Heat of Combustion: −17,430 Btu/lb = −9686 cal/g = -405.5×10^5 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: 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

TOL	TOLUENE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
−30	57.180
−20	56.870
−10	56.550
0	56.240
10	55.930
20	55.620
30	55.310
40	54.990
50	54.680
60	54.370
70	54.060
80	53.750
90	53.430
100	53.120
110	52.810
120	52.500

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.398
5	.397
10	.399
15	.400
20	.402
25	.403
30	.404
35	.406
40	.407
45	.409
50	.410
55	.411
60	.413
65	.414
70	.415
75	.417
80	.418
85	.420
90	.421
95	.422
100	.424
105	.425
110	.427
115	.428
120	.429
125	.431

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
0	1.026
10	1.015
20	1.005
30	.994
40	.983
50	.972
60	.962
70	.951
80	.940
90	.929
100	.919
110	.908
120	.897
130	.886
140	.876
150	.865
160	.854
170	.843
180	.833
190	.822
200	.811
210	.800

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipose
0	1.024
5	.978
10	.935
15	.894
20	.857
25	.821
30	.788
35	.757
40	.727
45	.700
50	.673
55	.649
60	.625
65	.603
70	.582
75	.562
80	.544
85	.526
90	.509
95	.493
100	.477

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
68.02	.050

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
0	.038
10	.057
20	.084
30	.121
40	.172
50	.241
60	.331
70	.448
80	.600
90	.792
100	1.033
110	1.332
120	1.700
130	2.148
140	2.690
150	3.338
160	4.109
170	5.018
180	6.083
190	7.323
200	8.758
210	10.410

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
0	.00070
10	.00103
20	.00150
30	.00212
40	.00298
50	.00405
60	.00547
70	.00727
80	.00954
90	.01237
100	.01584
110	.02007
120	.02518
130	.03127
140	.03850
150	.04700
160	.05691
170	.06840
180	.08162
190	.09675
200	.11400
210	.13340

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.228
25	.241
50	.255
75	.268
100	.281
125	.294
150	.306
175	.319
200	.331
225	.343
250	.355
275	.367
300	.378
325	.389
350	.400
375	.411
400	.422
425	.432
450	.443
475	.453
500	.462
525	.472
550	.482
575	.491
600	.500

VINYLIDENE CHLORIDE

VCI

Common Synonyms	Watery liquid	Colorless	Sweet odor
1,1-Dichloroethylene unsym-Dichloroethylene	Sinks in water. Flammable, irritating vapor is produced. Boiling point is 89°F.		

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.
Evacuate area in case of large discharge.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	FLAMMABLE. POISONOUS GAS IS PRODUCED IN FIRE. Containers may explode in fire. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear self-contained breathing apparatus. Combat fires from safe distance or protected location. Extinguish with dry chemical, foam, or carbon dioxide. 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.
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)

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: Vinyl halides
3.2 Formula: $CH_2=CCl_2$
3.3 IMO/UN Designation: 3.1/1303
3.4 DOT ID No.: 1303
3.5 CAS Registry No.: 75-35-4

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Sweet; like carbon tetrachloride or chloroform

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; rubber gloves and boots.
5.2 Symptoms Following Exposure: Vapor can cause dizziness and drunkenness; high levels cause anesthesia. Liquid irritates eyes and skin.
5.3 Treatment of Exposure: INHALATION: if any illness develops, remove person to fresh air promptly, keep warm and quiet, and get medical attention; if breathing stops, start artificial respiration. INGESTION: not likely a problem; no known antidote; treat symptomatically. EYES OR SKIN: flush with plenty of water for at least 15 min; get medical attention for eyes; remove contaminated clothing and wash before reuse.
5.4 Threshold Limit Value: 10 ppm
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; Oral LD_{50} = 24 hr = 84 mg/kg (adrenalectomized 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: Data not available
5.11 IDLH Value: Data not available

6. FIRE HAZARDS

6.1 Flash Point: 0°F O.C.
6.2 Flammable Limits in Air: 7.3%-16.0%
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: Toxic hydrogen chloride and phosgene are generated in fires.
6.6 Behavior in Fire: May explode in fire due to polymerization. Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 85[illegible]—1031°F
6.8 Electrical Hazard: Not pertinent
6.9 Burning Rate: 2.7 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: Copper and aluminum can cause polymerization.
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Can occur if exposed to sunlight, air, copper, aluminum, heat.
7.6 Inhibitor of Polymerization: 200 ppm methyl ether of hydroquinone, 0.6-0.8% phenol
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 35

8. WATER POLLUTION

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

9. SHIPPING INFORMATION

9.1 Grades of Purity: 99%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: Padded
9.4 Venting: Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y-Z

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	0
Aquatic Toxicity	1
Aesthetic Effect	2
Reactivity	
Other Chemicals	2
Water	0
Self Reaction	3

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	1
Flammability (Red)	4
Reactivity (Yellow)	2

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 96.95
12.3 Boiling Point at 1 atm: 89.1°F = 31.5°C = 304.8°K
12.4 Freezing Point: —187.6°F = 122.0°C = 151.2°K
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 1.21 at 20°C (liquid)
12.8 Liquid Surface Tension: 24 dynes/cm = 0.024 N/m at 15°C
12.9 Liquid Water Interfacial Tension: 37 dynes/cm = 0.037 N/m at 22.1°C
12.10 Vapor (Gas) Specific Gravity: 3.3
12.11 Ratio of Specific Heats of Vapor (Gas): Data not available
12.12 Latent Heat of Vaporization: 130 Btu/lb = 72 cal/g = 3.0×10^5 J/kg
12.13 Heat of Combustion: —4800 Btu/lb = —2700 cal/g = -113.0×10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: —333 Btu/lb = —185 cal/g = -7.75×10^5 J/kg
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 18.2 psia

6. FIRE HAZARDS (Continued)

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

VCI — VINYLIDENE CHLORIDE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
−20	81.450	0	.262		NOT PERTINENT	−20	.478
−15	81.129	10	.268			−15	.466
−10	80.799	20	.273			−10	.455
−5	80.469	30	.279			−5	.443
0	80.139	40	.284			0	.433
5	79.809	50	.290			5	.423
10	79.480	60	.295			10	.413
15	79.150	70	.301			15	.404
20	78.820	80	.307			20	.395
25	78.490					25	.387
30	78.160					30	.378
35	77.830					35	.371
40	77.500					40	.363
45	77.169					45	.356
50	76.839					50	.349
55	76.509					55	.342
60	76.179					60	.336
65	75.849					65	.330
70	75.520					70	.324
75	75.200					75	.318
80	74.870					80	.313
85	74.540					85	.307

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F (estimate)
68.02	.500	40	5.115	40	.09246	100	.169
		50	6.473	50	.11470	120	.172
		60	8.106	60	.14090	140	.175
		70	10.060	70	.17150	160	.178
		80	12.380	80	.20690	180	.181
		90	15.070	90	.24760	200	.184
		100	18.220	100	.29410	220	.186
		110	21.870	110	.34670	240	.189
		120	26.060	120	.40600	260	.192
		130	30.850	130	.47250	280	.194
		140	36.290	140	.54650	300	.197
		150	42.430	150	.62860	320	.199
		160	49.340	160	.71820	340	.202
		170	57.070	170	.81860	360	.204
		180	65.669	180	.92720	380	.206
		190	75.209	190	1.04500	400	.209
		200	85.750	200	1.17400	420	.211
		210	97.339	210	1.31300	440	.213
						460	.215
						480	.217
						500	.219
						520	.221
						540	.223
						560	.225
						580	.227
						600	.229

ZINC CHROMATE

ZCR

Common Synonyms	Solid	Yellow	Odorless
Zinc chromate (VI) hydroxide Zinc yellow Buttercup yellow	Sinks in water.		

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

Fire	Not flammable.
Exposure	CALL FOR MEDICAL AID **DUST** Irritating to eyes, nose and throat. If inhaled will cause coughing or difficult breathing. If in eyes, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. **SOLID** Irritating to skin and eyes. If swallowed will cause nausea and 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 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: Not listed
3.2 Formula: (approx.)
$4ZnO \cdot K_2O \cdot 4CrO_3 \cdot 3H_2O$
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: Data not available
3.5 CAS Registry No.: 1328-67-2

4. OBSERVABLE CHARACTERISTICS
4.1 Physical State (as shipped): Solid
4.2 Color: Yellow
4.3 Odor: None

5. HEALTH HAZARDS
5.1 Personal Protective Equipment: Suitable respirator (for dust); rubber gloves; chemical goggles or face shield.
5.2 Symptoms Following Exposure: Inhalation of dust causes irritation of nose and throat. Ingestion can cause irritation or corrosion of the alimentary tract, circulatory collapse, and toxic nephritis. Contact with eyes or skin causes irritation.
5.3 Treatment of Exposure: INHALATION: move to fresh air; if exposure has been severe, get medical attention. INGESTION: induce vomiting, followed by gastric lavage, cathartics, and demulcents. EYES: flush with water. SKIN: wash thoroughly with soap and water.
5.4 Threshold Limit Value: 0.05 mg/m³
5.5 Short Term Inhalation Limits: Data not available
5.6 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5-5 g/kg
5.7 Late Toxicity: Possible lung cancer.
5.8 Vapor (Gas) Irritant Characteristics: Data not available
5.9 Liquid or Solid Irritant Characteristics: Data not available
5.10 Odor Threshold: Odorless
5.11 IDLH Value: 500 mg/m³

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: Not pertinent
6.6 Behavior in Fire: Data not available
6.7 Ignition Temperature: Not pertinent
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: Data not available
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: Both chromium and zinc are concentrated by some organisms but are not considered to be bioaccumulative in a spill situation.

9. SHIPPING INFORMATION
9.1 Grades of Purity: Commercial, 100%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No requirement
9.4 Venting: Open

10. HAZARD ASSESSMENT CODE
(See Hazard Assessment Handbook)
GG

11. HAZARD CLASSIFICATIONS
11.1 Code of Federal Regulations: Not listed
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: 874 (approx.)
12.3 Boiling Point at 1 atm: Not pertinent (decomposes)
12.4 Freezing Point: Not pertinent
12.5 Critical Temperature: Not pertinent
12.6 Critical Pressure: Not pertinent
12.7 Specific Gravity: 3.43 at 20°C (solid)
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

ZCR — ZINC CHROMATE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
	NOT PERTINENT		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68	.100		NOT PERTINENT		NOT PERTINENT		NOT PERTINENT

CHAPTER 2

AGENT INFORMATION

2-1. Classification and description. a. Classification. H, HD, and HT are persistent blistering agents. They are classified as Class A Poisons by Department of Transportation (DOT) and as Chemical Group A agents by DARCOM.

b. Description. The commonly used name for agents H, HD, and HT is "mustard." H is used to identify agent made by the Levinstein process which contains up to 30 percent sulfur compounds as impurities. HD indicates agent which has been refined by distillation to remove impurities. HT is a mixture of 60 percent HD and 40 percent T. T is a sulfur and chlorine compound similar in chemical structure to HD.

2-2. Physical and Chemical Properties[1]. a. Properties of HD.

(1) Chemical name - 2,2' dichloro-diethyl sulfide.

(2) Molecular Wt. - 159.08.

(3) Specific gravity - 1.27 at 20°C.

(4) Vapor density (compared to air) - 5.48.

(5) Melting point - 14.5°C.

(6) Boiling point - 217°C.

(7) Flash point - 105°C. (Class III B combustible liquid)

(8) Decomposition temperature - 149° to 177°C.

(9) Vapor pressure - 0.072mm Hg at 20°C.

(10) Solubility. Only slightly soluble in water (.06 to .09% by weight at 25°C). Soluble in all proportions in most oils and organic solvents.

[1]Properties vary with the purity of the material. The properties given are based on minimum specifications grade agent.

(11) Hydrolysis. Reacts with water to give as final products, hydrogen chloride and thiodiglycol. Once dissolved in water the hydrolysis is rapid; however, the solubility rate is so low that hydrolysis of agent is very slow. Because of its temperature dependency, the solubility rate is fairly rapid at 100°C and at 5°C no reaction occurs.

(12) Physical characteristics. Mustard agent is a clear to amber or dark brown liquid having an odor similar to garlic.

b. Properties of H. The properties of H are essentially the same as for HD. The color of the liquid may vary from amber to dark brown and the odor is more pronounced than HD. Because of the sulfur impurities, a sediment may form in containers after long periods of storage.

c. Properties of HT Mixture (60/40). Agent properties are similar to HD except as noted below.

(1) Melting point - Approximately 0°C.

(2) Specific gravity - Approximately 1.26 at 20°C.

2-3. Physiological effects. a. General. Mustard agent has been identified as carcinogenic, mutagenic, and tetragenic. Chronic exposures (10-20 years) are considered to be a health hazard, therefore, certain health minimums must be met if workers are exposed. For these reasons monitoring of work areas and medical surveillance must be carefully controlled and adequate records maintained. To protect the health and welfare of workers no unprotected worker may be exposed to mustard agent vapor levels equal to or greater than 0.4 mg/m^3. Mustard will produce physiological effects as a result of liquid or vapor contamination of the body. The severity of the effects is dependent on the degree of liquid contamination and on the vapor concentration and associated exposure time. The mustard agents as liquid contamination on surfaces may persist for long periods because of their low volatilities. Agent on contaminated surfaces may be transferred to personnel by contact.

b. Physiological effects of mustard.

(1) Eye effect. The eye is most vulnerable to mustard either by liquid or vapor contact. Conjunctivitis (red eye) can occur following an exposure to a vapor concentration barely detectable by odor. Long exposures to low concentrations or exposures to high concentrations can result in permanent eye damage.

(2) Skin effects. The initial effect after skin contact with either vapor or liquid is a reddening of the skin similar to sunburn; except with mild vapor burns, the reddening progresses to blistering and tissue destruction. The initial exposure is not accompanied by any sensation but as symptoms develop there may be an itching or burning sensation.

(3) Respiratory effect. Inhalation of mustard vapor or aerosol causes damage to the mucous tissues of the upper respiratory tract. Damage develops slowly and may not reach maximum severity for several days following exposure. The symptoms are hoarseness, sore throat, and coughing. In cases of severe exposure there is a predisposition to secondary infection such as bronchial pneumonia.

(4) Cumulative effects. The rate of detoxification for mustard is very low. Very small repeated dosages are cumulative in their effect and even more serious because of the tendency toward sensitization. Exposure to vapors from spilled mustard may, in the first instance, cause only minor symptoms such as "red eye." Repeated exposures to such vapor may produce severe respiratory symptoms.

c. Method of operation. Mustard is an insidious agent. The agent's odor quickly becomes unnoticeable after the first detection, because the agent causes the olfactory nerves to become insensitive. Another indication of the insidiousness is the absence of pain for a period possibly of hours after liquid or vapor contact with the skin, and for many minutes even after eye contact with the liquid. With regard to skin exposure, the presence of moisture or perspiration on the skin tends to increase the effect of exposure to agent.

2-4. Dosages. The eyes are more sensitive to mustard vapor than either the skin or the respiratory tract. Totally incapacitating eye damage of several days duration can be produced by dosages which are insufficient to produce "even partial" incapacitation by either the percutaneous or respiratory route. Personnel working in areas where mustard agent filled items are present without protection from the inhalation of agent vapors shall not be exposed to concentrations exceeding the following limits:

a. 0.4 mg/m^3 maximum exposure level.

b. 0.01 mg/m^3 for a single three hour period.

c. 0.005 mg/m^3 for a single eight hour period.

d. 0.003 mg/m^3 for any eight hour exposure period average over five or more consecutive workdays.

When known or suspected agent concentrations exceed the above values, appropriate toxicological agent protective clothing will be worn as outlined in chapter 4.

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