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REMEDIAL INVESTIGATION AND FEASIBILITY STUDY HEALTH AND SAFETY PLAN  
OPERABLE UNITS 3, 4, 5 AND 6 (OU3) (OU4) (OU5) (OU6) VOLUME III NAS CECIL FIELD  
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ABB ENVIRONMENTAL

**VOLUME III**

**REMEDIAL INVESTIGATION AND FEASIBILITY STUDY**

**HEALTH AND SAFETY PLAN**  
**OPERABLE UNITS 3, 4, 5, AND 6**

**NAVAL AIR STATION CECIL FIELD**  
**JACKSONVILLE, FLORIDA**

**Unit Identification Code (UIC) No. N60200**

**Contract No. N62467-89-D-0317**

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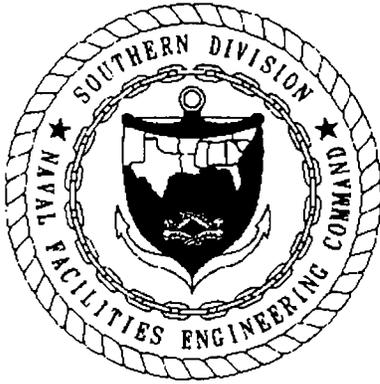
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## FOREWORD

The Department of the Navy developed the Installation Restoration (IR) program to locate, identify, and remediate environmental contamination from the past disposal of hazardous materials at Navy and Marine Corps installations. The Navy's IR program follows the Department of Defense's environmental restoration program mandated by the Superfund Amendments and Reauthorization Act of 1986 to address waste sites that may pose a threat to human health or the environment.

The Navy's IR program consists of Preliminary Assessment and Site Inspection, Remedial Investigation and Feasibility Study (RI/FS), and Remedial Design and Remedial Action at sites where hazardous materials were possibly disposed. The Preliminary Assessment and Site Inspection identify the presence of pollutants. The RI/FS analyzes the nature and extent of contamination and determines the optimum remedial solution. The Remedial Design and Remedial Action complete the implementation of the solution.

Previous investigations have determined that Naval Air Station (NAS) Cecil Field has 19 sites that may pose a threat to human health or the environment; therefore, an RI/FS will be performed at each site to address the extent and magnitude of contamination at these sites.

This document presents the workplan, sampling and analysis plan (SAP), and health and safety plan (HASP) for conducting the RI/FS for Operable Units 3, 4, 5, and 6, which include Sites 7, 8, 10, 11, 14, and 15. The workplan discusses the history and environmental setting of the sites, and presents the RI/FS rationale and scope of work. The SAP focuses on the field investigative procedures, analytical methods, and quality assurance and quality control (QA/QC) procedures. The HASP outlines the health and safety procedures for all field tasks.

Questions regarding this report should be addressed to the Commanding Officer, Code OOB, P.O. Box 111, NAS Cecil Field, Jacksonville, Florida 32215-0111.

## PREFACE

The planning documents prepared to support the Remedial Investigation and Feasibility Study (RI/FS) activities for Operable Units (OUs) 3, 4, 5, and 6 at Naval Air Station (NAS) Cecil Field consist of the following three volumes:

- Volume I, Workplan;
- Volume II, Sampling and Analysis Plan (incorporating both the Field Sampling Plan and the Quality Assurance Project Plan); and
- Volume III, Health and Safety Plan.

Together, the three volumes present the scope of the RI/FS activities. The workplan (Volume I) describes the features of each site, provides a record of facility and site history, describes the environmental factors, details previous investigative results, provides an initial evaluation of each site, presents the RI approach, details the RI/FS tasks, and outlines the project schedule.

The sampling and analysis plan (SAP) (Volume II) focuses on the field investigation procedures, analytical methods, and quality assurance and quality control (QA/QC) procedures. The SAP provides a project description, describes site management and field methods, details the technical approach and sampling plans, and describes the QA/QC requirements for sample collection, sample handling, sample analysis, data assessment, corrective action, and reporting.

The Health and Safety Plan (HASP) (Volume III) outlines the health and safety procedures for all field tasks. The HASP includes material safety data sheets for chemicals that may be encountered at each site and provides emergency information and telephone numbers.

Volumes I through III of the RI/FS planning documents for OUs 3, 4, 5, and 6 have been prepared by CDM Federal Programs Corporation (CDM Federal) and ABB Environmental Services, Inc. (ABB-ES), under the Comprehensive Long-Term Environmental Action, Navy (CLEAN) contract (contract number N62467-89-D-0317). The format and scope of these documents are in compliance with *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. Environmental Protection Agency [USEPA], 1988) and *Navy/Marine Corps Installation Restoration Manual* (Department of Navy [DON], 1992), as well as other applicable USEPA and DON guidance documents.

The RI technical approach developed for each site comprising OUs 3, 4, 5, and 6 are based on several considerations including: (1) the physical characteristics and geographic location of the site, (2) the history and previous use of the site, (3) the results and conclusions of previous investigations, and (4) site reconnaissance. The primary objectives of the RI are to collect sufficient data to: characterize and quantify the nature and extent of contamination, assess potential risks to human health and the environment posed by contaminants of concern, support an FS at sources of contamination where remedial action is warranted, and support a Record of Decision (ROD) for each operable unit addressed. The FS is designed to screen and evaluate potential remedial alternatives, and to conduct treatability studies to evaluate the suitability of remedial technologies to site conditions and problems.

Note that the Base Conversion and Redevelopment Commission is developing a reuse plan for NAS Cecil Field in anticipation of the DON releasing the property. Simultaneously, the Base Realignment and Closure (BRAC) Cleanup Team (BCT) is developing a strategy to address environmental issues at the facility. The BCT strategy integrates the activities under the Installation Restoration (IR) program (including this RI/FS) with the operating compliance program and the closure compliance program. The BCT strategy supports full restoration of NAS Cecil Field. The DON is the lead agency in implementing this strategy; however, decisions regarding the BCT strategy are being made jointly by the DON, USEPA, and the Florida Department of Environmental Protection (FDEP).

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## GLOSSARY

ABB-ES	ABB Environmental Services, Inc.
AMU	atomic mass unit
ANSI	American National Standards Institute
BCT	BRAC Cleanup Team
BHC	benzene hexachloride
BRAC	Base Realignment and Closure
CDM Federal	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CO	carbon monoxide
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
CS	confined space
DON	Department of the Navy
EED	Electroexplosive Device
EMM	earth moving machinery
EMR	electronmagnetic radiation
EMR	Environmental Medicine Resources
EOD	explosive ordnance disposal
EPC	Exposure Control Plan
eV	electron volts
FDEP	Florida Department of Environmental Protection
FID	flame ionization detector
FS	Feasibility Study
GSS	General Site Supervisor
HASP	Health and Safety Plan
HBV	hepatitis B virus
HEAT	High Explosive Anti-Tank
Hg	mercury
HIV	human immunodeficiency virus
HR	heart rate
HSM	Health and Safety Manager
HSO	Health and Safety Officer
HSS	Health and Safety Supervisor
IDHL	immediately dangerous to life or health
IR	Installation Restoration
LANTARPLX	Land Target Complex
LEL	lower explosive limit

## GLOSSARY (Continued)

mg/kg	milligrams per kilogram
mg/m <sup>3</sup>	milligrams per cubic meter
mm	millimeter
MPC-H	maximum permissible concentration hours
MSDS	material safety data sheet
µg/kg	micrograms per kilogram
µg/ℓ	micrograms per liter
µg/m <sup>3</sup>	micrograms per cubic meter
NA	not available
NAS	Naval Air Station
NCP	National Oil and Hazardous Substances Contingency Plan
NE	not established
NIOSH	National Institute for Occupational Safety and Health
NPL	National Priority List
OEW	Ordnance Explosive Waste Hazardous/Non-hazardous
OLF	Outlying Landing Field
OSHA	Occupational Safety and Health Administration
OT	oral temperature
OU	operable unit
OVA	organic vapor analyzer
PEL	permissible exposure limit
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
PSC	potential source of contamination
PZ	piezometric
QA/QC	quality assurance and quality control
RI	Remedial Investigation
RI/FS	Remedial Investigation and Feasibility Study
ROD	Record of Decision
SAP	Sampling and Analysis Plan
SCBA	self-contained breathing apparatus
SOP	standard operating procedure
SVOC	semivolatile organic compound
TLV	threshold limit value
TM	Technical Manual
TOM	Task Order Manager
TWA	tie-weighted average
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
UXO	unexploded ordnance

GLOSSARY (Continued)

VOC                   volatile organic compound  
VT                    variable time  
  
WP                    white phosphorus

## 1.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), began a formal program of site risk assessment and implementation of mitigation health and safety programs in March 1981. At that time, existing departmental policies and practices were collected and reviewed, additional needs identified, and a corporate personnel health and safety plan drafted.

Currently, ABB-ES' Health and Safety Manager (HSM) regularly reviews health and safety issues, updates practices as new information becomes available, oversees administration of the Health Monitoring Program, and provides guidance for personnel training as appropriate.

Prior to onsite activities, a site-specific health and safety plan (HASP) must be completed by the project engineer or scientist. This is accomplished by a review of available information on the site to assess the potential risks and provide an initial determination of personal protection requirements. The site-specific HASP is subsequently reviewed and must be approved by the Health and Safety Officer (HSO). The designated HSO monitors actual site conditions and may alter these requirements as needed. In all cases, personnel safety is the paramount factor in decision making.

1.1 SCOPE AND PURPOSE. This HASP was prepared in conformance with the ABB-ES health and safety program (see Attachment A) and is intended to meet the requirements found in 29 Code of Federal Regulations (CFR) 1910.120. As such, the HASP addresses all of the activities associated with the site investigation at Naval Air Station (NAS) Cecil Field, Jacksonville, Florida. Compliance with this HASP is required of all ABB-ES personnel, contractor personnel, or third parties entering the site.

This document describes the training, monitoring, and work procedures that will be employed to ensure that the health and safety program is implemented as designed. The objectives of this HASP are as follows:

- to provide a safe work environment,
- to minimize the risk of human and economic losses,
- to comply with all applicable safety and health laws and regulations, and
- to ensure that project work activities are conducted in a safe, efficient manner.

This HASP outlines project personnel and corporate health and safety policies; provides a brief site characterization and description of the scope of work; outlines potential hazards, protective measures, and monitoring for each site; and summarizes decontamination procedures. In addition, the HASP includes material safety data sheets (MSDS) for chemicals that may be encountered at the site and provides emergency information, such as a map to the hospital and emergency telephone numbers.

**1.2 PROJECT PERSONNEL.** This section presents a description of key positions involved with health and safety for this project. All personnel identified below will have completed the 40-hour Occupational Safety and Health Administration (OSHA) required training.

**1.2.1 Task Order Manager** The Task Order Manager (TOM) is the individual with overall project management responsibilities. Those responsibilities as they relate to health and safety include provision for the development of this project-specific HASP, the necessary resources to meet requirements of this HASP, the coordination of staff assignments to ensure that personnel assigned to the project meet medical and training requirements, and the means and materials necessary to resolve any health and safety issues that are identified or that develop on the project.

**1.2.2 General Site Supervisor** The General Site Supervisor (GSS) has vested authority from the TOM to carry out day-to-day site operations, including interfacing with the HSO.

**1.2.3 Health and Safety Officer** The HSO is designated by the TOM with concurrence of the Health and Safety Supervisor (HSS) or HSM. The HSO will have at least an indirect line of reporting to the HSM through the HSS for the duration of his/her assignment as project HSO. The HSO is responsible for developing and implementing this project-specific HASP in accordance with the ABB-ES health and safety program. The HSO will investigate all accidents, illnesses, and incidents occurring onsite. The HSO will also conduct safety briefings and project-specific training for onsite personnel. As necessary, the HSO will accompany all U.S. Environmental Protection Agency (USEPA), OSHA, or other governmental agency personnel visiting the site in response to health and safety issues. The HSO, in consultation with the HSS or HSM, is responsible for updating and modifying this HASP as site or environmental conditions change.

The HSO is vested with the authority to stop site operations by ABB-ES or subcontractor personnel (stop work authority) if he or she determines that an imminent health or safety hazard or other potentially dangerous situation exists. The HSO is to immediately notify the HSS of any stop work orders issued. The HSO may also recommend to the HSS or HSM that the downrange authorization of individual site personnel be revoked for health or safety reasons.

The HSO, through the HSS, ensures that all personnel entering the site are qualified for downrange employment, in accordance with the ABB-ES health and safety program requirements.

**1.2.4 Health and Safety Supervisor** The HSS will be responsible for: (1) approval of the individual chosen to serve as the site HSO for this field investigation; (2) review and approval of this site-specific HASP, as well as any significant changes made over time to this site-specific HASP; (3) oversight of the daily efforts of the HSO; (4) resolution of site disputes involving health and safety issues; and (5) implementation of the HASP by the HSO. The HSS will notify the HSM of any stop work orders issued by the HSO.

**1.2.5 Health and Safety Manager** The HSM has final authority over health and safety issues that are not resolved at the site or through the HSS, and has overall responsibility for ensuring that the policies and procedures of this HASP

are implemented by the HSO. In the various regions, the HSM may delegate additional functions to the regional HSS.

**1.3 TRAINING.** Training is defined under the ABB-ES health and safety program, and all personnel entering potentially contaminated areas at NAS Cecil Field (Operable Units [OUs] 3, 4, 5, and 6) must meet the requirements of 29 CFR 1910.120. Personnel without the required training will not be permitted in any area with potential for exposure to toxic substances or harmful physical agents (i.e., downrange). Refer to Attachment A, Appendix B, of the ABB-ES Generic Health and Safety Plan for further information.

**1.4 MEDICAL SURVEILLANCE.** All personnel entering potentially contaminated areas at NAS Cecil Field (OUs 3, 4, 5, and 6) will be medically qualified for site assignment through a medical surveillance program outlined in the ABB-ES Generic HASP. Personnel who have not received medical clearance will not be permitted in any area with potential for exposure to toxic substances or harmful physical agents (i.e., downrange). Refer to Attachment A, Appendix B of the ABB-ES Generic Health and Safety Plan for further information.

## 2.0 CORPORATE HEALTH MONITORING AND SAFETY PROGRAM

To protect the health and safety of employees assigned to work at sites, ABB-ES has developed and implemented a health and safety program. This program is administered by a committee consisting of representatives of ABB-ES technical department staffs with support from medical advisors. All personnel onsite must be enrolled in the health monitoring program and each must receive training appropriate for this assigned function.

In addition to ABB-ES employees, ABB-ES subcontractors and consultants working on Navy sites will be enrolled in an equivalent health monitoring program and receive health and safety indoctrination prior to commencing work on the site. Indoctrination, training, and periodic follow-up is conducted as appropriate. Indoctrination and training include:

- site history,
- inventory of site chemicals known or suspected (will be updated and reviewed at each stage of the field investigative program),
- project organization,
- workplan review,
- project documentation,
- review of this site-specific HASP (site-specific HASPs are updated as new information becomes available),
- review of decontamination procedures,
- proper use and care of personal protective equipment (PPE),
- proper calibration and use of monitoring equipment,
- emergency response procedures,
- accident reporting procedures, and
- contingency plans.

Project-specific information on the items listed above will be presented at the beginning of this document. This will provide critical information on health and safety matters that may be needed at a moment's notice at the site. The project-specific information will include:

- summary site-specific HASPs,
- chemical hazard data sheets,
- miscellaneous reports, and
- heat stress casualty prevention plans.

The ABB-ES health and safety program including medical surveillance, personal protective equipment, and emergency planning, is presented in Attachment A.



## 4.0 SITE CHARACTERIZATION AND ANALYSIS

4.1 SCOPE OF WORK. The field investigations at NAS Cecil Field (OUs 3, 4, 5, and 6) will include geophysical investigations; monitoring well installation; well development and purging; soil, groundwater, surface water, and sediment sample collection; and general field data collection. Sampling and exploration objectives, rationale, locations, methods, and techniques for these activities are detailed in Chapters 4.0 and 2.0 of the Workplan and Sampling and Analysis Plan (SAP), respectively.

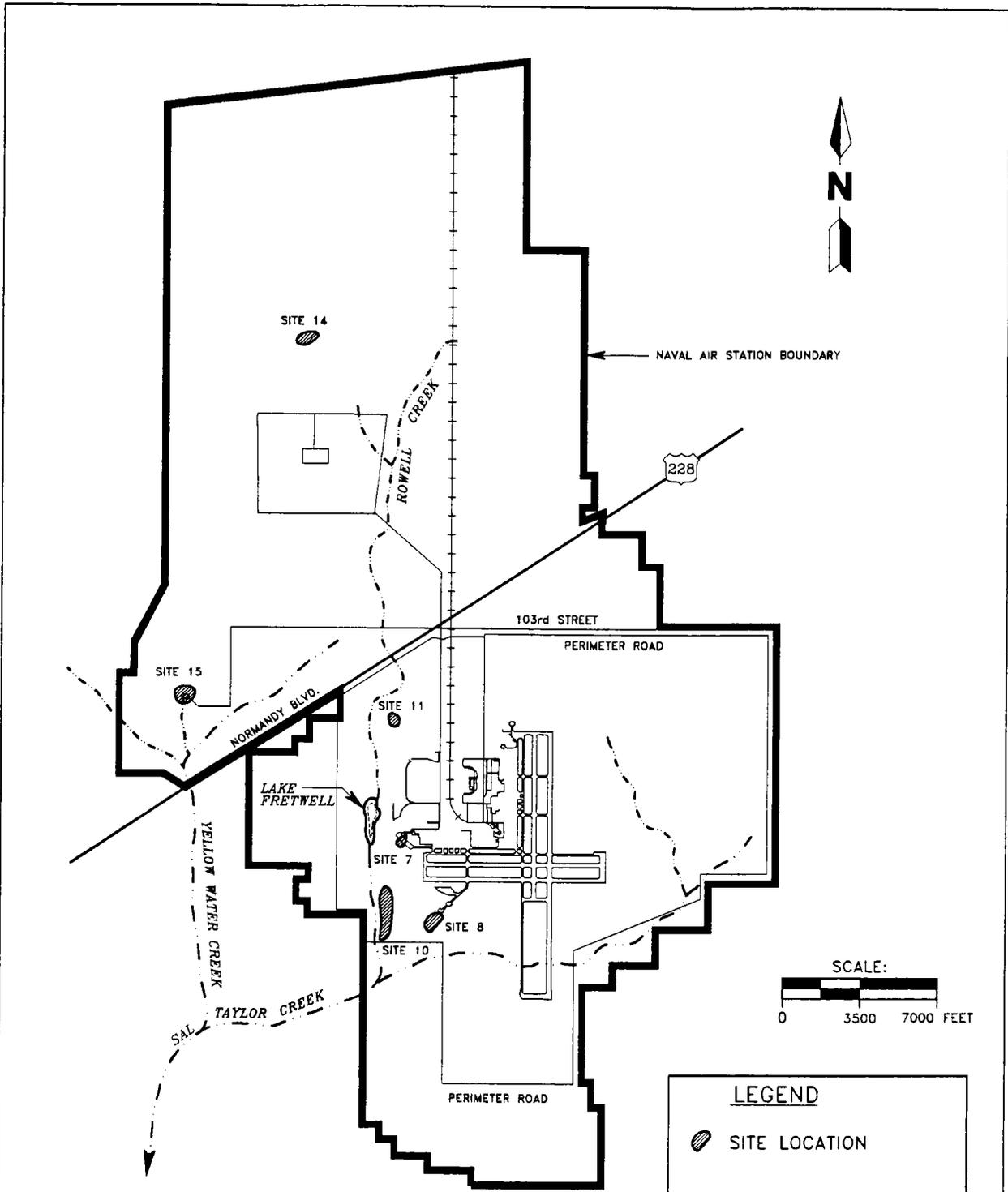
4.2 SITE NAME, LOCATION, AND SIZE. NAS Cecil Field is located in northeastern Florida, primarily within Duval County with the southernmost part in Clay County. Downtown Jacksonville lies approximately 14 miles northeast of the facility main entrance. The Georgia State line is located approximately 15 miles north. A site location map for the six sites comprising OUs 3, 4, 5, and 6 is provided in Figure 4-1.

NAS Cecil Field occupies more than 31,000 acres and can be divided into four distinct areas: the main station (NAS Cecil Field), which occupies 9,516 acres; the Yellow Water Weapons Area, which occupies 8,091 acres; Outlying Landing Field (OLF) Whitehouse, which occupies 2,587 acres; and the 11,072-acre Land Target Complex (LANTARPLX) Detachment Astor, which includes Pinecastle Electronic Warfare Range, Stevens Lake, Lake George, and Rodman ranges. The main station and the Yellow Water Weapons Area are bisected by State Road 228. OLF Whitehouse lies approximately 7 miles north of the main entrance. OUs 3, 4, 5, and 6 are located in NAS Cecil Field and the Yellow Water Weapons Area. OLF Whitehouse and LANTARPLX are not included in this Remedial Investigation and Feasibility Study (RI/FS) program and, therefore, are not discussed further in this HASP.

4.3 SITE HISTORY. Cecil Field was constructed in 1941, just prior to United States involvement in World War II, on 2,600 acres of forest and farm land in southwestern Duval County, Florida. The station now occupies more than 31,000 acres and employs more than 10,000 military and civilian personnel.

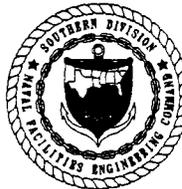
The official mission of NAS Cecil Field is to provide facilities, services, and material support for the operation and maintenance of naval weapons and aircraft and other units of the operating forces as designated by the Chief of Naval Operations. Some of the tasks required to accomplish this mission include (1) operation of fuel storage facilities, (2) provision of facilities and performance of organizational level aircraft maintenance, (3) provision of facilities and performance of intermediate level aircraft maintenance, (4) maintenance and operation of an engine repair facility and test cells for designated turbo-jet engines, and (5) provision of special weapons support.

Based on USEPA's evaluation of data collected during previous investigations, NAS Cecil Field has been listed on the National Priority List (NPL) for Uncontrolled Hazardous Waste Sites, according to Title 40, 40 CFR Part 300, August 30, 1990. The NPL was initially promulgated as Appendix C of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) on September 8, 1983.



SOURCE: ADAPTED FROM ENVIRODYNE ENGINEERS, 1985

**FIGURE 4-1**  
**SITE LOCATION MAP**



**REMEDIAL INVESTIGATION/  
FEASIBILITY STUDY  
HEALTH AND SAFETY PLAN  
OPERABLE UNITS 3,4,5, AND 6**

**NAS CECIL FIELD  
JACKSONVILLE, FLORIDA**

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Previous investigations have determined that NAS Cecil Field has approximately 19 potential sources of contamination (PSCs), which are sites that may pose a threat to human health or the environment. RI/FSs are being planned and conducted at NAS Cecil Field to assess the extent, magnitude, and impact of any confirmed contamination at these sites, and to develop appropriate remediation for sites that are determined to pose a threat to human health and/or the environment. Most of these sites have been initially grouped into OUs based on the types of potential contaminants used at each site, the common chemical characteristics of the suspected contaminants, and shared potential migratory pathways or potential receptors. This HASP addresses the RI/FS activities to be conducted for OUs 3, 4, 5, and 6, which consist of the following six sites:

- OU 3        Site 7, Old Firefighter Training Area;  
              Site 8, Firefighter Training Area, Boresite Test Range,  
              Hazardous Waste Storage Area;
- OU 4        Site 10, Rubble Disposal Area;
- OU 5        Site 14, Blue 5 Ordnance Disposal Area;  
              Site 15, Blue 10 Ordnance Disposal Area; and
- OU 6        Site 11, Pesticide Disposal Area.

The results of the previous investigations indicate that various media at these six sites may be contaminated above acceptable levels. The primary constituents identified during the previous investigations include metals (arsenic, cadmium, chromium, lead, and mercury), extractable organics (polynuclear aromatic hydrocarbons and bis(2-ethylhexyl)phthalate), volatile organics (1,1,1-trichloroethane, trichloroethene, trans-1,3-dichloropropene, toluene, benzene, and methylene chloride), and pesticides and herbicides (1,2-dibromo-3-chloropropane, parathion, alpha-benzene hexachloride [BHC], gamma-BHC, 2,4-dichlorophenoxyacetic acid, and toxaphene). A summary of the maximum concentrations measured for the chemicals previously identified at the six sites comprising OUs 3, 4, 5, and 6 is presented in Table 4-1. Due to the presence of 1,2-dibromo-3-chloropropane at Site 11 (OU 6), special safety precautions are required when working at this site. These precautions can be found in the Site 11 HASP Addendum (Attachment B).

**4.4 SITE RISKS.** Contaminants of concern known or suspected to be present at OUs 3, 4, 5, and 6 are presented and discussed in this section. Also included are the established exposure limits for those substance indicated as contaminants of concern. Health hazards and safety hazards that are expected to be encountered at each OU are also identified and discussed. Note that all areas potentially containing unexploded ordnance will be cleared by the Naval Ordnance Division prior to the performance of any work in those areas.

**4.4.1 Health Hazards** The potential for exposure to contaminants by field personnel working at NAS Cecil Field OUs 3, 4, 5, and 6 does exist. However, at this time it is thought that the concentrations of contaminants are low and that the contamination associated with the six sites is mainly limited to groundwater and soil. Therefore, the health hazards associated with all non-intrusive onsite activities is considered to be low. The potential for exposure to site contaminants does, however, increase during activities such as soil boring, soil

**Table 4-1**  
**Summary of Maximum Measured Concentrations**

Remedial Investigation and Feasibility Health and Safety Plan  
Operable Units 3, 4, 5, and 6  
NAS Cecil Field, Jacksonville, Florida

Site	Chemical	Concentration
Site 7, Old Firefighter Training Area	Benzene (groundwater)	6 µg/ℓ <sup>1</sup>
	Cadmium (groundwater)	6 µg/ℓ <sup>1</sup>
	Chromium (groundwater)	61 µg/ℓ <sup>1</sup>
	Lead (groundwater)	50 µg/ℓ <sup>1</sup>
	Methylene chloride (soil)	53 µg/kg
	Cadmium (soil)	17 mg/kg
	Lead (soil)	14 mg/kg
Site 8, Boresite Range/Firefighter Training Area	Chromium (groundwater)	28 µg/ℓ
	Lead (groundwater)	20 µg/ℓ <sup>1</sup>
	Methylene chloride (soil)	80 µg/kg
	1,1,1-Trichloroethane (soil)	82 µg/kg
	Chromium (soil)	16 mg/kg
	Lead (soil)	47 mg/kg
	Chromium (sediment)	6.2 mg/kg
	Lead (sediment)	4.7 mg/kg
Site 10, Rubble Disposal Area	1,1,1-Trichloroethane (sediment)	16 µg/kg
	bis(2-Ethylhexyl)phthalate (groundwater)	46 µg/ℓ
	Chromium (groundwater)	145 µg/ℓ <sup>1</sup>
	Lead (groundwater)	60 µg/ℓ <sup>1</sup>
	Mercury (groundwater)	0.8 µg/ℓ <sup>1</sup>
	Trichloroethene (groundwater)	1.6 µg/ℓ
Site 11, Golf Course Pesticide Disposal Area	Trans-1,3-Dichloropropene (groundwater)	0.1 µg/ℓ
	Chromium (groundwater)	332 µg/ℓ <sup>1</sup>
	Lead (groundwater)	573 µg/ℓ <sup>1</sup>
	1,2-dibromo-3-chloropropane (soil)	160 µg/kg
	Parathion (soil)	330 µg/kg
	Toluene (soil)	16 µg/kg
	Methylene chloride (soil)	24 µg/kg
	(25 µg/ℓ in QA/QC samples)	
	1,1,1-Trichloroethane (soil)	39 µg/kg
	(11 µg/ℓ in QA/QC samples)	
	Lead (soil)	8.3 mg/kg
	Aluminum (soil)	1690 mg/kg
	Arsenic (soil)	46.6 mg/kg
	Barium (soil)	3.4 mg/kg
	Chromium (soil)	4.6 mg/kg
	Copper (soil)	1.2 mg/kg
	Iron (soil)	623 mg/kg
Magnesium (soil)	5.0 mg/kg	
Zinc (soil)	6.0 mg/kg	
alpha-BHC (product)	85 µg/kg	
gamma-BHC (product)	60 µg/kg	
2,4-Dichlorophenoxyacetic acid (product)	47,000 µg/kg	
1,2-dibromo-3-chloropropane (product)	340,000 µg/ℓ	
toxaphene (product)	73 µg/ℓ	

See notes at end of table.

**Table 4-1 (Continued)**  
**Summary of Maximum Measured Concentrations**

Remedial Investigation and Feasibility Health and Safety Plan  
 Operable Units 3, 4, 5, and 6  
 NAS Cecil Field, Jacksonville, Florida

Site	Chemical	Concentration
Site 14, Blue 5 Ordnance Disposal Area	1,1,1-Trichloroethane (soil)	11 $\mu\text{g}/\text{kg}$
Site 15, Blue 10 Ordnance Disposal Area	(Soil sampling)	
	Acenaphthene	6,600 $\mu\text{g}/\text{kg}$
	Anthracene	25,800 $\mu\text{g}/\text{kg}$
	Benzo(a)anthracene	176,400 $\mu\text{g}/\text{kg}$
	Benzo(a)pyrene	192,000 $\mu\text{g}/\text{kg}$
	Benzo(b)fluoranthene	352,800 $\mu\text{g}/\text{kg}$
	Benzo(g,h,i)perylene	103,800 $\mu\text{g}/\text{kg}$
	Benzo(k)fluoranthene	176,400 $\mu\text{g}/\text{kg}$
	Chrysene	202,500 $\mu\text{g}/\text{kg}$
	Fluoranthene	238,800 $\mu\text{g}/\text{kg}$
	Fluorene	3,000 $\mu\text{g}/\text{kg}$
	Indeno (1,2,3-cd) pyrene	108,900 $\mu\text{g}/\text{kg}$
	Naphthalene	5,700 $\mu\text{g}/\text{kg}$
	Phenanthrene	108,900 $\mu\text{g}/\text{kg}$
	Pyrene	275,100 $\mu\text{g}/\text{kg}$
	Lead	599 $\text{mg}/\text{kg}$

<sup>1</sup> Exceeds groundwater standards for Chapter 62-550, Florida Administrative Code, maximum contaminant levels.

Notes:  $\mu\text{g}/\text{l}$  = microgram per liter.  
 $\mu\text{g}/\text{kg}$  = microgram per kilogram.  
 $\text{mg}/\text{kg}$  = milligram per kilogram.  
 QA/QC = quality assurance and quality control.  
 BHC = benzene hexachloride.

sampling, and groundwater sampling. Based on the types of materials that were used at the six sites comprising OUs 3, 4, 5, and 6, the types of contaminants that could be found in the various media at these sites can be divided into five categories: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, nitroaromatic chemicals, and metals. The basis of classifying these materials is solely on their chemical properties. At one end of the spectrum are VOCs that are very mobile, thereby increasing the risk of exposure. Metals, on the other hand, are fairly inert, resulting in a lesser chance of exposure based on current site conditions. Table 4-2 presents general physical characteristics, odor threshold, threshold limit values, and other remarks for the previously identified and/or suspected chemicals at the six sites comprising OUs 3, 4, 5, and 6.

All activities at this site will be conducted in unconfined areas. This will minimize the chances of onsite personnel coming into contact with either high vapor concentrations or strong liquid concentrations of any of the substances described above. If confined space entry is necessary, the guidelines presented in Attachment A, Appendix I, will be followed.

In the event that activities conducted during this investigation may expose workers to lead or its compounds, OSHA provides guidelines for protection of workers in the construction industry. During the investigation, personnel will be informed of the risks and potential for exposure to lead or materials containing lead in each area. 40 CFR Part 1926 was amended in 1992 to include the new section 1926.62, which contains employee protection requirements for construction workers exposed to lead. Tasks will be performed with consideration of the potential for exposure to lead and ambient air dust monitoring may become necessary if lead exposure is indicated. Personnel performing duties are currently involved in health and safety programs, which includes medical monitoring, training, and use of PPE.

**4.4.2 Safety Hazards** Safety hazards include those hazards that are unrelated to hazardous wastes. These include hazards such as heat stress, operation and presence around heavy equipment, lifting of objects, vehicle traffic, and snake bites. Extreme caution should be exhibited by all personnel while conducting work around drill rigs, backhoes, and other heavy equipment. During hot days, personnel should take time to drink fluids and cool off to avoid overheating and symptoms related to heat stress (see Attachment A, Appendix K). Likewise, if field activities take place during cold weather, the guidelines presented in Attachment A, Appendix K, should be followed.

Lifting of heavy objects should be done with caution. Personnel should assist one another with moving heavy objects or use the appropriate equipment to accomplish these tasks. During all site activities, personnel should be aware of the possibility of an encounter with poisonous snakes, particularly rattlesnakes.

All areas suspected of containing unexploded ordnance will be cleared by the Naval Ordnance Division prior to the performance of any work on any of the sites.

**Table 4-2  
Chemical Hazards of Previously Identified and/or Suspected Contaminants**

Remedial Investigation and Feasibility Study Health and Safety Plan  
Operable Units 3, 4, 5, and 6  
NAS Cecil Field, Jacksonville, Florida

Chemical	Permissible Exposure Limit	IDLH	Warning	Signs and Symptoms	Ionization Potential
Aluminum	5 mg/m <sup>3</sup>	NE	Dust	Coughing, spitting, and pulmonary fibrosis.	Dust
Arsenic	10 µg/m <sup>3</sup>	100 mg/m <sup>3</sup>	Dust	Nasal ulcers, fever, bronchitis, melanosis, and peripheral neuropathy.	Dust
Barium	5 mg/m <sup>3</sup>	NE	Dust	Few symptoms; chronic baritosis	Dust
Benzene	1 ppm	3,000 ppm	4.68 ppm	Eye and nose irritation, headache, giddiness, nausea, and fatigue.	9.25 eV
bis(2-Ethylhexyl)phthalate	5 mg/m <sup>3</sup>	NE	NA	Pain in arms and legs	NA
Cadmium	5 µg/m <sup>3</sup>	50 mg/m <sup>3</sup>	Dust	Pulmonary edema, tight chest, and chills.	Dust
Chromium	500 µg/m <sup>3</sup>	250 mg/m <sup>3</sup>	Dust	Lung damage and skin sensitization.	Dust
Chrysene	200 µg/m <sup>3</sup>	700 mg/m <sup>3</sup>	Dust	Eye irritation, dermatitis, and bronchitis.	7.75 eV
Copper	1 mg/m <sup>3</sup>	NE	Dust	Nasal perforation and metal taste	Dust
1,2-Dibromo-3-chloropropane	0.001 ppm	Carcinogen	NA	Drowsiness, nausea, vomiting, and pulmonary edema.	NA
Iron	5 mg/m <sup>3</sup>	NE	Dust	Benign pneumoconiosis and cough	Dust
Lead	50 µg/m <sup>3</sup>	700 mg/m <sup>3</sup>	Dust	Fatigue, pallor, colic, and insomnia	Dust
Magnesium	10 mg/m <sup>3</sup>	NE	Dust	Flu-like fever and cough	Dust
Mercury	50 µg/m <sup>3</sup>	28 mg/m <sup>3</sup>	NA	Severe abdominal pain, tremors, weakness, gastro intestinal irritation, and fatigue.	NA
Methylene chloride	50 ppm	5,000 ppm	214 ppm	Weakness, tingling and numbness, vertigo, and nausea.	11.35 eV
Parathion	100 µg/m <sup>3</sup>	20 mg/m <sup>3</sup>	480 µg/m <sup>3</sup>	Small pupils, runny nose, headache, salivation, and stomach cramps.	NA
Toluene	50 ppm	2,000 ppm	1.7 ppm	Fatigue, confusion, euphoria, dizziness, headache, and tears.	8.82 eV
1,1,1-Trichloroethane	350 ppm	1,000 ppm	400 ppm	Headache, central nervous system depression, loss of balance, and eye irritation.	11.0 eV
Trichloroethene	50 ppm	1,000 ppm	21.4 ppm	Vertigo, visual disturbance, headache, and drowsiness.	9.45 eV
Zinc	10 mg/m <sup>3</sup>	NE	Dust	Sweet metal taste, dry throat, cough, tight chest, and chills.	Dust

Notes: IDLH = immediately dangerous to life or health.  
mg/m<sup>3</sup> = milligram per cubic meter.  
NE = not established.  
µg/m<sup>3</sup> = microgram per cubic meter.  
ppm = parts per million.  
eV = electron volts.  
NA = not available.

4.5 INITIAL SITE ENTRY. Based on the available site information and current site conditions, the level of personal protection and required monitoring planned for initial site work at the OUs are identified and presented. This is the minimum level of protection required when entering into the various field tasks. Upgrades will depend on the conditions encountered as each field task is performed.

4.5.1 Initial Levels of Protection

<u>Task</u>	<u>Minimum Level</u>
Installation of monitoring wells	D
Site ll intrusive tasks (including clearing)	B
All other tasks	D

PPE to be used in all Level D Operations is described in Section 6.3.

4.5.2 Initial Monitoring Where the development of site information either shows the potential for or is unable to rule out the possibility of ionizing radiation or "immediately dangerous to life or health" (IDLH) conditions, initial monitoring will consist of, at a minimum, an ionizing radiation survey and/or air monitoring using such devices as a combustible gas indicator, oxygen meter, photoionization detectors (PID), and a flame ionization detector (FID). It is intended that real-time monitoring instrumentation will be used to assist in the determination of the appropriate level of protection for the initial site entry team. Based on the available historical site information and current site conditions, the level of protection planned for initial site work at the naval facility is Level D. It should be noted, however, that this HASP allows for the upgrading of protection levels to conservatively preclude any potential for contamination to onsite personnel while not sacrificing efficiency.

## 5.0 SITE CONTROL

5.1 ZONATION. The level of contamination is expected to be low; however, exclusion zonation procedures will be observed at the sites. All the sites are secured from general public access.

Care will be taken when drilling in contaminated areas to prevent spreading of the contamination to clean areas. All equipment will be decontaminated between each drilling or sampling point.

The sites will normally be divided into three zones: (1) the majority of the work area, considered the exclusion zone; (2) an area for decontamination called the contamination reduction zone (CRZ); and (3) limited areas serving as the support zone. The exclusion zone and the CRZ will be determined prior to initiation of the field program. These zones will vary depending on the sites being investigated.

5.1.1 Exclusion Zone The exclusion zone isolates the area of contaminant generation and restricts (to the extent possible) the spread of contamination from active areas of the site to support areas and offsite locations. The exclusion zone is demarcated by the hot line (i.e., a tape line or physical barrier). Personnel entering the exclusion zone must (1) enter through the CRZ, (2) wear the prescribed level of protection, and (3) be otherwise authorized to enter the exclusion zone. Any personnel, equipment, or materials exiting the exclusion zone will be considered contaminated. Personnel will be subject to decontamination. Equipment and materials will either be subject to decontamination or containerized in uncontaminated devices.

Within the exclusion zone, specific locations or restricted areas (clearly marked or identified) will be established (as necessary) for particular locations or around specific site operations. In the case of well drilling, a restricted area will be established that includes a minimum 30-foot radius from the drill rig. Other restricted areas may include drum areas, active site areas, sources of combustible gases or air contaminants, or other dangerous areas as they are identified. Access for emergency services to areas of specific site operations will be established.

5.1.2 Contaminant Reduction Zone Moving out from the exclusion zone, starting at the hot line and continuing to the contamination control line, is the CRZ. The CRZ is a transition zone between contaminated and uncontaminated areas of the site. When "hot" or contaminated personnel, equipment, or materials cross the hot line, they are assumed to be as hot or contaminated as they are going to be from site operations. Being subjected to the decontamination process, they become less contaminated; when they reach the contamination control line, they are clean and can exit the CRZ without spreading contamination.

Within the CRZ is the contamination reduction corridor, where materials necessary for full personnel and portable equipment decontamination are kept. A separate facility will be established for heavy equipment decontamination. In addition, certain safety equipment (e.g., emergency eye wash, fire extinguisher, and first aid kit) are staged in this zone.

**5.1.3 Support Zone** The support zone is the outermost zone of the site, separated from the CRZ by the contamination control line, and is considered a clean area. Movement of personnel and materials from the support zone into the CRZ is generally unrestricted, except as required through access points controlled for administrative purposes. However, only uncontaminated or decontaminated personnel or materials may enter the support zone from the CRZ.

The support zone contains the necessary support facilities (including personal hygiene facilities) for site operations. It also serves as the communications center and source of emergency assistance for operations in the exclusion zone and CRZ. A log of all persons entering the site will be maintained by the HSO, the field operations leader, or the site designee.

**5.2 COMMUNICATIONS.** In most cases, field personnel will carry portable radios for communications. If this is the case, a transmission that indicates it is of an emergency nature will take priority over all other transmissions. All other site radios will yield the frequency to the emergency transmissions.

Where radio communication is not available, the following air-horn signals will be used:

Help	three short blasts	(. . .)
Evacuation	three long blasts	( _ _ _ )
All clear	alternating long and short blasts	( _ . _ . )

**5.3 WORK PRACTICES.** General work practices to be used during ABB-ES projects are described in Attachment A, Appendix H. Work on this project will be conducted according to these established protocol and guidelines for the safety and health of all involved. Note that for this project, all work and sampling will be conducted in Level D clothing and equipment. If the site conditions change after the work has begun, then PPE upgrades will be made as necessary. Work practices are further discussed in Section 6.2.

## 6.0 PERSONAL PROTECTIVE EQUIPMENT

6.1 ENGINEERING CONTROLS. Whenever needed, engineering controls (i.e., fans to blow volatilized chemicals away from the work area) will be used.

6.2 WORK PRACTICES. Workers will be expected to adhere to the established safe work practices for their respective specialties (e.g., drilling, laboratory analysis, construction, etc.). The need to exercise caution in the performance of specific work tasks is made more acute due to weather conditions, restricted mobility, reduced peripheral vision caused by the protective gear itself, the need to maintain the integrity of the protective gear, and the increased difficulty in communication caused by respirators. Work at the site will be conducted according to established protocol and guidelines for the safety and health of all involved and will include the following.

- In any unknown situation, always assume the worst conditions and plan responses accordingly.
- Use the buddy system.
- Establish and maintain communication. Hand-held radios may be used. In addition to radio communications, it is advisable to develop a set of hand signals.
- Because no personal protective equipment is 100 percent effective, all personnel must minimize contact with excavated or contaminated materials. Do not place equipment on drums or the ground. Do not sit on drums or other materials. Do not sit or kneel on the ground in the area where field operations are taking place. Avoid standing in or walking through puddles or stained soil.
- Disposable items will be used, when possible, to minimize risks during decontamination and possible cross contamination during sample handling.
- Smoking, eating, or drinking in the work area and before decontamination will not be allowed.
- Avoid heat and other work stresses related to wearing protective gear. Work breaks should be planned to prevent stress-related accidents or fatigue.
- Monitoring systems will be maintained. Conditions can change quickly if subsurface areas of contamination are penetrated.
- To the extent feasible, handling of contaminated materials should be done remotely, particularly when drummed or other containerized hazardous waste materials are found onsite. Every effort should be made to identify the contents of containers found onsite before they are subject to material-handling applications.
- Personnel must be observant of not only one's own immediate surroundings, but also those of others. Everyone will be working under

constraints; therefore, a team effort is needed to notice and warn of impending dangerous situations.

- Contact lenses may not be worn when actively sampling on those sites at which known eye irritants may be present.
- All facial hair that interferes with the respirator face piece fit must be removed prior to conducting work at all sites requiring Level C or B protection.
- Rigorous contingency planning and dissemination of plans to all personnel must be performed to minimize the impact of rapidly changing safety protocols in response to changing site conditions.
- Personnel must be aware that chemical contaminants may mimic or enhance symptoms of other illnesses or intoxication. Avoid excess use of alcohol or working while ill during field investigative assignments.
- In the event that unexploded ordnance is encountered during any assigned tasks, all work is to be immediately suspended and the explosive ordnance disposal (EOD) from NAS Mayport will be contacted.

6.3 PERSONAL PROTECTIVE EQUIPMENT. Check all that are to be used.

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> Self-contained breathing apparatus (SCBA) or airline respirator (Site 11 work) | <input type="checkbox"/> Escape mask               |
| <input checked="" type="checkbox"/> Full face cartridge respirator   | <input checked="" type="checkbox"/> Hard hat       |
| <input checked="" type="checkbox"/> Disposable boot covers   | <input checked="" type="checkbox"/> Safety glasses |
| <input checked="" type="checkbox"/> Coated Tyveks™   | <input type="checkbox"/> Face shield               |
| <input checked="" type="checkbox"/> Chemical-resistant safety boots or shoes                                       | <input checked="" type="checkbox"/> Coveralls      |
| <input checked="" type="checkbox"/> Inner chemical-resistant gloves  | <input checked="" type="checkbox"/> Ear protection |
| <input checked="" type="checkbox"/> Outer chemical-resistant gloves  |  |

Steel-toe and steel shank rubber boots or work boots will also be used, and disposable boot covers will be used in conjunction with leather work boots.

## 7.0 MONITORING

7.1 AIR SAMPLING. Check all that are to be used.

- ISD dual detector (combustible gases and oxygen meter)
- ISD HS267 (hydrogen sulfide detector)
- PID (for example, a Microtip) and/or FID (organic vapor analyzer [OVA])
- Dustmeter (i.e., Miniram)
- Radiation survey meter
- Dosimeter badges
- Dräger tube (benzene, vinyl chloride, and others, if necessary)

7.2 OTHER MONITORING EQUIPMENT. None.

7.3 CONTAMINANT LEVELS FOR MODIFICATION OF PROTECTIVE EQUIPMENT. The initial level of personal protection is level D. Should workers' clothing potentially come in contact with soil or water, or if the FID reads contaminants above background within the sampling area, workers will upgrade to modified level D (Level C dermal). If breathing zone contaminant levels exceed background, workers will monitor with benzene 0.5/c Dräger tubes. If benzene levels reach or exceed 0.5 parts per million (ppm) or if FID levels reach or exceed 5 ppm in the breathing zone, PPE will be upgraded to Level C. All intrusive work at Site 11, including clearing, will be conducted in Level B PPE.

The above action limits are summarized below.

Level B is required if:

FID  $\geq$  25 ppm, or  
benzene Dräger tube  $\geq$  10 ppm.

Level C is required if:

FID  $\geq$  15 ppm but  $<$  25 ppm, and/or  
benzene Dräger tube  $\geq$  0.5 ppm but  $<$  10 ppm.

Modified Level D is required if:

FID  $>$  background but  $<$  15 ppm, and  
benzene Dräger tube  $<$  0.5 ppm.

Level D is acceptable if:

no contact with contaminated soil or water, and/or if PID or FID readings are at background.

Site 11:

All clearing and intrusive activities will be conducted in Level B PPE. Monitoring of contaminants will be conducted with a PID or FID. No downgrading will be allowed.

## 8.0 DECONTAMINATION AND DISPOSAL

All personnel and/or equipment leaving contaminated site areas are subject to decontamination.

In the event that any of the sites are upgraded from Level D, the following decontamination and disposal procedures will be followed.

**8.1 PERSONNEL DECONTAMINATION.** Decontamination procedures are followed by all personnel leaving hazardous waste sites. Under no circumstances (except emergency evacuation) will personnel be allowed to leave the site prior to decontamination.

Disposable items (i.e., Tyvek™ coveralls, inner gloves, and latex overboots) will be changed on a daily basis unless there is a reason to change sooner. Dual respirator canisters will be changed daily, unless more frequent changes are deemed appropriate.

Respirators will be decontaminated daily and taken from the drop area, the masks will be disassembled, the cartridges discarded, and all other parts placed in a cleansing solution. After an appropriate time in the solution, the parts will be removed and rinsed with tap water. Old cartridges will be discarded in the contaminated trash container for disposal. In the morning, respirators will be reassembled and new cartridges installed.

**8.2 SMALL EQUIPMENT DECONTAMINATION.** Small equipment will be protected from contamination as much as possible by draping, masking, or otherwise covering the instruments with plastic to the extent feasible without hindering operation of the unit.

The contaminated equipment will be taken from the drop area and the protective coverings removed and disposed in appropriate containers. Any dirt or obvious contamination will be brushed or wiped with a disposable paper wipe. The units can then be taken inside in a clean plastic tub, wiped off with damp disposable wipes, and dried. The units will be checked, standardized, and recharged as necessary for the next day's operation, and then prepared with new protective coverings.

**8.3 HEAVY EQUIPMENT DECONTAMINATION.** It is anticipated that drilling rigs and backhoes will be contaminated during borehole and test-pitting activities. They will be cleaned with high-pressure water or steam and rinsed. Loose material will be removed with a brush. The person performing this activity will usually be at least at the level of protection used during the personnel and monitoring equipment decontamination.

**8.4 DISPOSAL OF DECONTAMINATED MATERIALS.** All protective gear, decontamination fluids (for both personnel and equipment), and other disposable materials will be disposed at each site. Disposable materials (e.g., gloves and Tyvek™) will be bagged and disposed according to the investigative-derived waste plan.

Disposable materials (e.g., gloves and Tyvek™) that are not contaminated or have been decontaminated will be bagged and disposed in a dumpster.

PPE that cannot be decontaminated will be drummed and disposed along with NAS Cecil Field's hazardous material.

Decontamination fluids will be drummed, contaminant concentrations checked visually and by headspace sampling using an OVA, and then disposed at a controlled rate into the Navy wastewater treatment plant. Contaminated fluids and fluids deemed inappropriate for disposal in a wastewater treatment plant will be disposed along with other Navy hazardous waste.

A complete discussion of disposal (of investigative-derived wastes) is provided in the IDW management plan (ABB-ES, 1994).

## 9.0 EMERGENCY AND CONTINGENCY PLANNING

9.1 PERSONNEL ROLES, LINES OF AUTHORITY, AND COMMUNICATIONS. The site HSO or the Health and Safety designee is the primary authority for directing operations at the site under emergency conditions. All communications both onsite and offsite will be directed through the HSO or designee.

9.2 EVACUATION. In the event of an emergency situation at the site, the procedures for evacuation are presented in this section. This may consist of a withdrawal to an upwind area, a site evacuation, or an evacuation of the surrounding area.

9.2.1 Withdrawal Upwind When conditions warrant moving away from the work site, the crew will relocate upwind at a distance of approximately 100 feet or farther if need is indicated by site monitoring instruments. Donning a SCBA and a safety harness and line, the HSO and a member of the crew (the buddy system must be used) may return to the work site to determine if the condition noted was transient or persistent. If persistent, an alarm should be raised to notify onsite personnel of the situation and the need to leave the site or don an SCBA. An attempt to decrease emissions should be made only if greater respiratory protection is donned. ABB-ES' HSS and the Navy will be notified of conditions. When site access is restricted, thus hindering escape, the crew may be instructed to evacuate the site rather than move upwind, especially if withdrawal upwind moves the crew away from escape routes.

9.2.2 Site Evacuation When conditions warrant site evacuation, the work party will proceed upwind of the work site and notify the security force, HSO, and field office of site conditions. If the decontamination area is upwind and greater than 500 feet from the work site, the crew will pass quickly through decontamination to remove contaminated outer suits. If the hazard is toxic gas, respirators will be retained. The crew will proceed to the field office to assess the situation.

9.2.3 Evacuation of Surrounding Area When the HSO determines that conditions warrant evacuation of downwind residences and commercial operations, local agencies will be notified and assistance requested. Designated onsite personnel will initiate evacuation of the immediate offsite area without delay.

9.3 EMERGENCY MEDICAL TREATMENT AND FIRST AID. First aid will be rendered to any person injured onsite, as appropriate. The injured person will then be transported to medical personnel for further examination and/or treatment. The preferred transport method is a professional emergency transportation service; however, when this is not readily available or would result in excessive delay, other transport is authorized. Under no circumstances will injured persons transport themselves to a medical facility for emergency treatment.

When an injury occurs in a downrange position, provisions for decontamination of the victim will be made. However, life threatening conditions may preclude normal decontamination procedures. In such cases, arrangements will be made with the medical facility and transporter to provide for the situation.

## 10.0 ADMINISTRATIVE

10.1 PERSONNEL AUTHORIZED DOWNRANGE. Personnel authorized downrange to participate in downrange activities at this site have been reviewed and certified for site operations by the Site Manager and HSS. Certification involves the completion of appropriate training, a medical examination, and a review of this site-specific HASP. All persons entering the site must use the buddy system, and check in with the Site Manager and/or HSO before proceeding downrange.

Certified ABB-ES Team Personnel:

HSO: <u>          Maria Pijnenburg          </u>	<u>          Alan Workman          </u>
<u>          Al Stodghill          </u>	<u>          Eddie Dowdy          </u>
<u>          Eric Blomberg          </u>	<u>          Bob Lunardini          </u>
<u>          Charles Donahue          </u>	<u>          Jim Denier          </u>
<u>          Rao Angara          </u>	<u>          Jack Pittman          </u>
<u>          Courtney Brooks          </u>	
<u>          Drew Lonergan          </u>	

10.2 VOLUNTARY MEDICAL DATA SHEET. This medical data sheet will be completed by all onsite personnel and will be kept in the support zone during site operations. It is in no way a substitute for the Medical Surveillance Program requirements consistent with the ABB-ES Corporate Health and Safety Program for Hazardous Waste Sites. This data sheet will accompany any personnel when medical assistance or transport to hospital facilities is required. This information is being requested for the protection of personnel working on the sites in the event that emergency medical treatment becomes necessary. It will not be used for any other purpose. If more information is required, use the back of this sheet.

Project: \_\_\_\_\_  
Name: \_\_\_\_\_  
Home Address: \_\_\_\_\_  
Home Phone:   Area Code (    ) \_\_\_\_\_  
DOB: \_\_\_\_\_ Height: \_\_\_\_\_ Weight: \_\_\_\_\_  
In case of emergency, contact: \_\_\_\_\_ (spouse)  
Address: \_\_\_\_\_  
Telephone (home):   Area Code (    ) \_\_\_\_\_  
Do you wear contact lenses?            (    ) Yes            (    ) No  
Allergies: \_\_\_\_\_  
List medications taken regularly: \_\_\_\_\_  
Particular sensitivities: \_\_\_\_\_  
Previous/recent illnesses or exposures to hazardous chemicals: \_\_\_\_\_  
\_\_\_\_\_  
Name of Personal Physician: \_\_\_\_\_  
Telephone:   Area Code (    ) \_\_\_\_\_

**10.3 HEALTH AND SAFETY PLAN (HASP) APPROVALS.**

By their signatures, the undersigned certify that this HASP will be used for the protection of the health and safety of all persons entering the sites.

_____	_____
Health and Safety Officer	Date
<i>James A. Davis</i> 11-30-94	
Project Manager	Date
_____	_____
Health and Safety Manager/Supervisor	Date

**10.4 FIELD TEAM REVIEW.** I have read and reviewed the HASP, understand the information contained, and agree to comply.

Name: _____	Date: _____

**10.5 EMERGENCY TELEPHONE NUMBERS.** All emergency telephone numbers and contacts are listed here, including police, fire department, ABB-ES, and Navy site contacts.

**10.5.1 NAS Cecil Field Emergency Telephone Numbers**

(On base) Police Department	(904) 778-5381
(On base) Fire Department	(904) 778-5333
(On base) Rescue	(904) 778-5212
St. Vincent's Hospital	(904) 387-7395
Riverside Hospital	(904) 387-7070

### 10.5.2 Other Contacts

National Poison Control Center	(800) 492-2414	
National Response Center	(800) 424-8802	
Regional USEPA Emergency Response	(800) 414-8802	
Chemical Manufacturer's Association		
Chemical Referral Center	(800) 262-8200	
Site HSO:	(904) 779-7226	
Task Order Manager:	(904) 656-1293	
Regional HSS:	Jack Davis	(904) 656-1293
ABB Environmental HSM:	Cindy Sundquist	(800) 341-0460 extension 3309
Department of Health, Welfare and Bioenvironmental Services:	Gerald Young	(904) 630-3666

### 10.5.3 Emergency Contacts

EMR (Dr. David Barnes)	(800) 229-3674
Florida Poison Control Center	(800) 282-3171
ABB-ES (Maine)	(800) 341-0460
ABB-ES (Florida)	(904) 656-1293
USEPA Emergency Response	(800) 414-8802

10.6 ROUTES TO EMERGENCY MEDICAL FACILITIES. The primary source of medical assistance for the site is listed in this section, along with directions to get to the facility. In addition, an alternative source and directions are given.

#### 10.6.1 Primary Source of Medical Assistance

Facility Name: Saint Vincent's Hospital  
Address: 1800 Barrs, Jacksonville, Florida  
Telephone Number: (904) 387-7395

Directions to primary source of medical assistance (see Figure 10-1):

Travel 12.5 miles northeast from the base on Highway 228 to Barrs Road, turn right, travel 0.05 mile. The hospital will be on the right side of the road.

#### 10.6.2 Alternate Source of Medical Assistance

Facility Name: Riverside Hospital  
Address: 2033 Riverside Avenue, Jacksonville, Florida  
Telephone Number: (904) 387-7070

Directions to alternate source of medical assistance (see Figure 10-1):

Travel 13 miles northeast from the base on Highway 228 to Margaret Street, turn right on Margaret Street then travel 0.03 mile. The hospital will be on the right side of the road.



11.0 CHEMICAL HAZARD DATA



# J. T. Baker Chemical Co.

222 Red School Lane Phillipsburg, N.J. 08865  
24-Hour Emergency Telephone -- (201) 859-2151

Chemtrec # (800) 424-9300  
National Response Center # (800) 424-8802

**MATERIAL  
SAFETY DATA  
SHEET**

A0036 -01  
Effective: 12/06/85

Acenaphthene

Page: 1  
Issued: 12/11/85

## SECTION I - PRODUCT IDENTIFICATION

Product Name: Acenaphthene  
Formula:  $C_{10}H_6-1,8-CH_2CH_2$   
Formula Wt: 154.21  
CAS No.: 83-32-9  
Common Synonyms: 1,2-Dihydroacenaphthylene; 1,8-Ethylenenaphthalene  
Product Codes: 4871

## PRECAUTIONARY LABELLING

### Precautionary Label Statements

**WARNING!**  
HARMFUL IF SWALLOWED, INHALED, OR ABSORBED THROUGH SKIN  
CAUSES IRRITATION

There is insufficient data in the published literature to assign complete numerical SAF-T-DATA ratings and laboratory protective equipment for this product. Special precautions must be used in storage, use and handling.

Protective equipment for laboratory bench use should be chosen using professional judgment based on the size and type of reaction or test to be conducted and the available ventilation, with overriding consideration to minimize contact with the chemical.

Avoid contact with eyes, skin, clothing.

Keep in tightly closed container. Wash thoroughly after handling.

## SECTION II - HAZARDOUS COMPONENTS

<u>Component</u>	<u>%</u>	<u>CAS No.</u>
Acenaphthene	90-100	83-32-9

## SECTION III - PHYSICAL DATA

Boiling Point: 279°C ( 534°F)	Vapor Pressure(mmHg): N/A
Melting Point: 93°C ( 199°F)	Vapor Density(air=1): 5.3
Specific Gravity: 1.07 (H <sub>2</sub> O=1)	Evaporation Rate: N/A (Butyl Acetate=1)
Solubility(H <sub>2</sub> O): Negligible (less than 0.1 %)	% Volatiles by Volume: 0

Appearance & Odor: White to off-white crystals.

## SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point: N/A



# J. T. Baker Chemical Co.

222 Red School Lane Phillipsburg, N.J. 08865  
24-Hour Emergency Telephone - (201) 859-2151

Chemtrec # (800) 424-9300  
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**MATERIAL  
SAFETY  
SHEET**

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-----  
**SECTION IV - FIRE AND EXPLOSION HAZARD DATA (Continued)**  
-----

Fire Extinguishing Media

Use extinguishing media appropriate for surrounding fire.

-----  
**SECTION V - HEALTH HAZARD DATA**  
-----

Effects of Overexposure

Dust inhalation may cause tightness and pain in chest, coughing, and difficulty in breathing.  
Contact with skin or eyes may cause irritation.

Emergency and First Aid Procedures

CALL A PHYSICIAN.

If swallowed, if conscious, immediately induce vomiting.

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Flush skin with water.

-----  
**SECTION VI - REACTIVITY DATA**  
-----

Stability: Stable

Hazardous Polymerization: Will not occur

Conditions to Avoid: none documented

Incompatibles: strong oxidizing agents  
-----

**SECTION VII - SPILL AND DISPOSAL PROCEDURES**  
-----

Steps to be taken in the event of a spill or discharge

Wear self-contained breathing apparatus and full protective clothing.  
With clean shovel, carefully place material into clean, dry container and cover; remove from area. Flush spill area with water.

Disposal Procedure

Dispose in accordance with all applicable federal, state, and local environmental regulations.  
-----

**SECTION VIII - INDUSTRIAL PROTECTIVE EQUIPMENT**  
-----

Eye/Skin Protection:

Since some of the hazards of this product are unknown, an Industrial Hygienist should be consulted on ventilation and personal protective equipment. Cover the body as much as possible to avoid contact with the chemical. Wear safety goggles, gloves, and impervious clothing.

Continued on Page: 3



# J. T. Baker Chemical Co.

222 Red School Lane Phillipsburg, N.J. 08865  
24-Hour Emergency Telephone -- (201) 859-2151

Chemtrec # (800) 424-9300  
National Response Center # (800) 424-8802

## MATERIAL SAFETY DATA SHEET

A0036 -01

Acenaphthene

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-----  
**SECTION IX - STORAGE AND HANDLING PRECAUTIONS**  
-----

Special Precautions

Keep container tightly closed. Suitable for any general chemical storage area.

-----  
**SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION**  
-----

DOMESTIC (D.O.T.)

Proper Shipping Name      Chemicals, n.o.s.

INTERNATIONAL (I.M.O.)

Proper Shipping Name      Chemicals, n.o.s.

N/A - Not Applicable or Not Available  
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The information published in this Material Safety Data Sheet has been compiled from our experience and data presented in various technical publications. It is the user's responsibility to determine the suitability of this information for the adoption of necessary safety precautions. We reserve the right to revise Material Safety Data Sheets periodically as new information becomes available.

# BENZENE

BNZ

Common Symptoms	Water-insoluble	Colorless	Gasoline-like odor
Benzol Benzole	Floats on water. Flammable, irritating vapors produced. Freezing point is 42°F.		
Avoid contact with liquid and vapor. Keep people away. Wear goggles and self-contained breathing apparatus. Shut off ignition sources and call fire department. Stop discharge if possible. Stay upwind and use water spray to "knock down" vapor. Isolate and remove discharged material. Notify local health and pollution control agencies.			
<b>Fire</b>	<b>FLAMMABLE.</b> 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.		
<b>Exposure</b>	<b>CALL FOR MEDICAL AID.</b> <b>VAPOR</b> Irritating to eyes, nose, and throat. If inhaled, will cause headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. <b>LIQUID</b> Irritating to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected area with plenty of water. Flush affected area 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.		
<b>Water Pollution</b>	<b>HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.</b> May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.		
<b>1. RESPONSE TO DISCHARGE</b>		<b>2. LABEL</b>	
(See Response Methods Handbook) Issue warning-high flammability Restrict access		2.1 Category: Flammable liquid 2.2 Class: 3	
<b>3. CHEMICAL DESIGNATIONS</b>		<b>4. OBSERVABLE CHARACTERISTICS</b>	
3.1 CG Compatibility Class: Aromatic Hydrocarbon 3.2 Formula: C <sub>6</sub> H <sub>6</sub> 3.3 IMO/UN Designation: 3.2/1114 3.4 DOT ID No.: 1114 3.5 CAS Registry No.: 71-43-2		4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Aromatic; rather pleasant aromatic odor; characteristic odor	
<b>5. HEALTH HAZARDS</b>			
5.1 Personal Protective Equipment: Hydrocarbon vapor canister, supplied air or a hose mask; hydrocarbon-insoluble rubber or plastic gloves; chemical goggles or face splash shield; hydrocarbon-insoluble apron such as neoprene. 5.2 Symptoms Following Exposure: Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction. Coma and possible death. 5.3 Treatment of Exposure: SKIN: flush with water followed by soap and water; remove contaminated clothing and wash skin. EYES: flush with plenty of water until irritation subsides. INHALATION: remove from exposure immediately. Call a physician. If breathing is irregular or stopped, start resuscitation, administer oxygen. 5.4 Threshold Limit Value: 10 ppm 5.5 Short Term Inhalation Limits: 75 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 3; LD50 = 50 to 500 mg/kg 5.7 Late Toxicity: Leukemia 5.8 Vapor (Gas) Irritant Characteristics: If present in high concentrations, vapors may cause irritation of eyes or respiratory system. The effect is temporary. 5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin. 5.10 Odor Threshold: 4.68 ppm 5.11 IDLH Value: 2,000 ppm			

<b>6. FIRE HAZARDS</b>	
6.1	Flash Point: 12°F C.C.
6.2	Flammable Limits in Air: 1.3%-7.9%
6.3	Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
6.4	Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5	Special Hazards of Combustion Products: Not pertinent
6.6	Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back
6.7	Ignition Temperature: 1097°F
6.8	Electrical Hazard: Class I, Group D
6.9	Burning Rate: 6.0 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

<b>7. CHEMICAL REACTIVITY</b>	
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

<b>8. WATER POLLUTION</b>	
8.1	Aquatic Toxicity: 5 ppm/6 hr/minnow/lethal/distilled water 20 ppm/24 hr/sunfish/TL <sub>50</sub> /tap water
8.2	Waterfowl Toxicity: Data not available
8.3	Biological Oxygen Demand (BOD): 1.2 lb/lb, 10 days
8.4	Food Concentration Potential: None

<b>9. SHIPPING INFORMATION</b>	
9.1	Grade of Purity: Industrial pure ..... 99+ % Triphenyl-free ..... 99+ % Nitration ..... 99+ % Industrial 90% ..... 85+ % Reagent ..... 99+ %
9.2	Storage Temperature: Open
9.3	Inert Atmosphere: No requirement
9.4	Venting: Pressure-vacuum

<b>10. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Handbook)	
A-T-U-V-W	

<b>11. HAZARD CLASSIFICATIONS</b>																													
11.1	Code of Federal Regulations: Flammable liquid																												
11.2	NAS Hazard Rating for Bulk Water Transportation: <table border="0"> <tr> <td>Category</td> <td>Rating</td> </tr> <tr> <td>Fire</td> <td>3</td> </tr> <tr> <td>Health</td> <td>1</td> </tr> <tr> <td>Vapor Irritant</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>1</td> </tr> <tr> <td>Poison</td> <td>3</td> </tr> <tr> <td>Water Pollution</td> <td>3</td> </tr> <tr> <td>Human Toxicity</td> <td>1</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>1</td> </tr> <tr> <td>Asesthetic Effect</td> <td>3</td> </tr> <tr> <td>Reactivity</td> <td>2</td> </tr> <tr> <td>Other Chemicals</td> <td>1</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self Reaction</td> <td>0</td> </tr> </table>	Category	Rating	Fire	3	Health	1	Vapor Irritant	1	Liquid or Solid Irritant	1	Poison	3	Water Pollution	3	Human Toxicity	1	Aquatic Toxicity	1	Asesthetic Effect	3	Reactivity	2	Other Chemicals	1	Water	0	Self Reaction	0
Category	Rating																												
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Other Chemicals	1																												
Water	0																												
Self Reaction	0																												
11.3	NFPA Hazard Classification: <table border="0"> <tr> <td>Category</td> <td>Classification</td> </tr> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>3</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </table>	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	3	Reactivity (Yellow)	0																				
Category	Classification																												
Health Hazard (Blue)	2																												
Flammability (Red)	3																												
Reactivity (Yellow)	0																												

<b>12. PHYSICAL AND CHEMICAL PROPERTIES</b>	
12.1	Physical State at 15°C and 1 atm: Liquid
12.2	Molecular Weight: 78.11
12.3	Boiling Point at 1 atm: 176°F = 80.1°C = 353.3°K
12.4	Freezing Point: 42.0°F = 5.6°C = 278.7°K
12.5	Critical Temperature: 552.0°F = 288.9°C = 562.1°K
12.6	Critical Pressure: 710 psia = 48.3 atm = 4.89 MN/m <sup>2</sup>
12.7	Specific Gravity: 0.879 at 20°C (liquid)
12.8	Liquid Surface Tension: 28.9 dynes/cm = 0.289 N/m at 20°C
12.9	Liquid Water Interfacial Tension: 35 dynes/cm = 0.035 N/m at 20°C
12.10	Vapor (Gas) Specific Gravity: 2.7
12.11	Ratio of Specific Heats of Vapor (Gas): 1.061
12.12	Latent Heat of Vaporization: 169 Btu/lb = 84.1 cal/g = 3.94 X 10 <sup>5</sup> J/kg
12.13	Heat of Combustion: -17,460 Btu/lb = -9998 cal/g = -408.0 X 10 <sup>3</sup> J/kg
12.14	Heat of Decomposition: Not pertinent
12.15	Heat of Solution: Not pertinent
12.16	Heat of Polymerization: Not pertinent
12.26	Heat of Fusion: 30.45 cal/g
12.28	Limiting Value: Data not available
12.27	Raid Vapor Pressure: 3.22 psia

NOTES

<b>BNZ</b>	<b>BENZENE</b>
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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
55	55.330	45	.394	75	.988	55	.724
60	55.140	50	.396	80	.981	60	.693
65	54.960	55	.398	85	.975	65	.665
70	54.770	60	.400	90	.969	70	.638
75	54.580	65	.403	95	.962	75	.612
80	54.400	70	.405	100	.956	80	.588
85	54.210	75	.407	105	.950	85	.566
90	54.030	80	.409	110	.944	90	.544
95	53.840	85	.411	115	.937	95	.524
100	53.660	90	.414	120	.931	100	.505
105	53.470	95	.416	125	.925	105	.487
110	53.290	100	.418	130	.919	110	.470
115	53.100			135	.912	115	.453
120	52.920			140	.906	120	.438
125	52.730			145	.900		
130	52.540			150	.893		
135	52.360			155	.887		
140	52.170			160	.881		
145	51.990			165	.875		
150	51.800			170	.868		
155	51.620						
160	51.430						
165	51.250						
170	51.060						
175	50.870						

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	.180	50	.881	50	.01258	0	.204
		60	1.171	60	.01639	25	.219
		70	1.535	70	.02109	50	.234
		80	1.989	80	.02681	75	.248
		90	2.547	90	.03371	100	.261
		100	3.227	100	.04196	125	.275
		110	4.049	110	.05172	150	.288
		120	5.033	120	.06317	175	.301
		130	6.201	130	.07652	200	.313
		140	7.577	140	.09194	225	.325
		150	9.167	150	.10960	250	.337
		160	11.060	160	.12960	275	.349
		170	13.220	170	.15270	300	.360
		180	15.700	180	.17850	325	.371
		190	18.520	190	.20750	350	.381
		200	21.740	200	.23970	375	.392
		210	25.360	210	.27560	400	.402
						425	.412
						450	.421
						475	.431
						500	.440
						525	.449
						550	.457
						575	.465
						600	.474

# ANTHRACENE

ATH

<p><b>Common Synonyms</b> Anthracen Paranaphthalene Green oil</p>	<p><b>Solid</b> White to yellow Sinks in water.</p>	<p><b>Weak aromatic odor</b></p>
<p>Stop discharge if possible. Aired people away. Avoid contact with solid and dust. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>		
<b>Fire</b>	<p><b>Combustible.</b> Dust cloud may explode if ignited in an enclosed area. Extinguish with water, dry chemicals, foam, or carbon dioxide.</p>	
<b>Exposure</b>	<p><b>CALL FOR MEDICAL AID.</b></p> <p><b>DUST</b> Irritating to eyes, nose and throat. If inhaled, get out of dust or fumes immediately. If in eyes, hold eyes open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.</p> <p><b>SOLID</b> 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. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.</p>	
<b>Water Pollution</b>	<p>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.</p>	
<p><b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Handbook) Should be removed. Chemical and physical treatment.</p>		<p><b>2. LABEL</b> 2.1 Category: None 2.2 Class: Not pertinent</p>
<p><b>3. CHEMICAL DESIGNATIONS</b> 3.1 CG Compatibility Class: Not listed 3.2 Formula: C<sub>14</sub>H<sub>10</sub> 3.3 ISO/LIN Designation: Not listed 3.4 DOT ID No.: Data not available 3.5 CAS Registry No.: 120-12-7</p>		<p><b>4. OBSERVABLE CHARACTERISTICS</b> 4.1 Physical State (as shipped): Solid 4.2 Color: White to yellow 4.3 Odor: Weak aromatic</p>
<p><b>5. HEALTH HAZARDS</b> 5.1 Personal Protective Equipment: Dust mask; goggles or face shield; rubber gloves 5.2 Symptoms Following Exposure: Inhalation of dust irritates nose and throat. Contact with eyes causes irritation. 5.3 Treatment of Exposure: <b>INHALATION:</b> move to fresh air. <b>EYES:</b> flush with water for 15 min. 5.4 Threshold Limit Value: Data not available 5.5 Short Term Inhalation Limit: Data not available 5.6 Toxicity by Ingestion: Data not available 5.7 Lethal Toxicity: Data not available 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: Data not available</p>		

<p><b>6. FIRE HAZARDS</b> 6.1 Flash Point: 250°F 6.2 Flammable Limits in Air: 0.6% LEL 6.3 Fire Extinguishing Agents: Water, foam, dry chemical, carbon dioxide 6.4 Fire Extinguishing Agents Not to be Used: Data not available 6.5 Special Hazards of Combustion Products: Data not available 6.6 Behavior in Fire: Data not available 6.7 Ignition Temperature: 1004°F 6.8 Electrical Hazard: Not pertinent 6.9 Burning Rate: Not pertinent 6.10 Autotetic Flame Temperature: Data not available 6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>	<p><b>10. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Handbook) <b>II</b></p>
<p><b>7. CHEMICAL REACTIVITY</b> 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</p>	<p><b>11. HAZARD CLASSIFICATIONS</b> 11.1 Code of Federal Regulations: Not listed 11.2 NAB Hazard Rating for Bulk Water Transportation: Not listed 11.3 NFPA Hazard Classification: Category Classification Health Hazard (Blue) 0 Flammability (Red) 1 Reactivity (Yellow) 2</p>
<p><b>8. WATER POLLUTION</b> 8.1 Aquatic Toxicity: 5 ppm/24 hr/trout &amp; bluegill/no effect 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None</p>	<p><b>12. PHYSICAL AND CHEMICAL PROPERTIES</b> 12.1 Physical State at 15°C and 1 atm: Solid 12.2 Molecular Weight: 178.23 12.3 Boiling Point at 1 atm: 666.2°F = 341.2°C = 614.4°K 12.4 Freezing Point: 421.7°F = 216.5°C = 489.7°K 12.5 Critical Temperature: Not pertinent 12.6 Critical Pressure: Not pertinent 12.7 Specific Gravity: 1.24 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: -17,100 Btu/lb = -9,510 cal/g = -398 X 10<sup>3</sup> J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.26 Heat of Fusion: 36.70 cal/g 12.28 Limiting Value: Data not available 12.27 Reid Vapor Pressure: Data not available</p>
<p><b>9. SHIPPING INFORMATION</b> 9.1 Grades of Purity: Various fluorescence grades; Scintillation grade; Technical grade, 90-98% 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open</p>	
<p><b>NOTES</b></p>	

<b>ATH</b>	<b>ANTHRACENE</b>
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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
	N O T  P E R T I N E N T		N O T  P E R T I N E N T	435	.868		N O T  P E R T I N E N T
				440	.866		
				445	.865		
				450	.863		
				455	.862		
				460	.860		
				465	.859		
				470	.857		
				475	.855		
				480	.854		
				485	.852		
				490	.851		
				495	.849		
				500	.848		
				505	.846		
				510	.845		
				515	.843		
				520	.842		
				525	.840		
				530	.839		

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
	I N S O L U B L E		N O T  P E R T I N E N T		N O T  P E R T I N E N T		N O T  P E R T I N E N T

**CERTIFIED SPECIFICATIONS and  
MATERIAL SAFETY DATA SHEET**

07/18/89

Last Revised June 1989

**SECTION I PRODUCT SPECIFICATIONS**

Chemical No. 1773      3,4-Benzoyrene  
 CAS No. 50-32-8      Other name: Benzoylbenzene  
 Supplied by CHEM SERVICE, Inc. PO BOX 3108, WEST CHESTER, PA. 19381 (215)692-3023  
 EMERGENCY PHONE #: 215-626-2100

Lot No. 2643D Purity 98.0% Certified by ZP  
 It is to certify that analysis of this sample was made by various chromatographic, spectral and  
 normal methods. The procedures used are considered to be STATE OF THE ART. CHEM SERVICE, Inc.  
 guarantees purity of unopened bottles until expiration on the bottle.

**SECTION II TOXICITY DATA**

RAT OR MOUSE LD50	RTECSH	OSHA PEL	ACGIH TLV
4595mg/kg	DJ3675000	NA	NA

This compound is considered to be slightly toxic.

**SECTION III PHYSICAL DATA**

MELTING POINT	BOILING POINT	DENSITY	VAPOR PRESSURE	VAPOR DENSITY	EVAPORATION RATE (Butyl acetate=1)
76.5-177.5°C	488-495°C	NA	NA	NA	NA
ODOR	COLOR	PHASE	SOLUBILITY IN WATER		
NA	Yellowish	Crystalline solid	Insoluble (immiscible)		

**SECTION IV FIRE AND EXPLOSION HAZARD DATA**

FLASH POINT: Data not available  
 EXTINGUISHING MEDIA: Carbon dioxide, dry chemical powder or spray.  
 Explosion limits are available for this compound.

**SECTION V HEALTH HAZARD DATA**

Contact lenses should not be worn in the laboratory.  
 All chemicals should be considered hazardous - Avoid direct physical contact!  
 Suspected Carcinogen-may produce cancer. Can be harmful if absorbed through the skin.  
 Can be harmful if inhaled. Can be harmful if swallowed. Can cause eye irritation.  
 Can cause skin irritation. Dust and/or vapors can cause irritation to respiratory tract.  
 Can be irritating to mucous membranes.  
 Can be rapidly absorbed thru the skin with potential adverse health effects.

**SECTION VI FIRST AID**

Antidote is a substance intended to counteract the effect of a poison. It should be administered by a physician or a trained emergency personnel. Medical advice can be obtained from a POISON CONTROL CENTER.

Flush eyes continuously with water for 15-20 minutes. Flush skin with water for 15-20 minutes. If no burns have occurred-use soap and water to cleanse skin.

Remove patient to fresh air. Administer oxygen if patient is having difficulty breathing. If patient has stopped breathing administer artificial respirations.

If patient is in cardiac arrest administer CPR.

Continue life supporting measures until medical assistance has arrived.

Remove and wash contaminated clothing.

If patient is exhibiting signs of shock - keep warm and quiet.

Contact Poison Control Center immediately if necessary.

Do not administer liquids or induce vomiting to an unconscious or convulsing person.

If swallowed give syrup of ipecac.

If patient is vomiting-watch closely to make sure airway does not become obstructed by vomit.

Seek medical attention if necessary.

**SECTION VII REACTIVITY DATA**

Highly absorbent and retained on clothing and on shoes. Incompatible with strong oxidizing agents. Decomposition liberates toxic fumes.

**SECTION VIII SPILL OR LEAK PROCEDURES**

In case of spills or leaks: Evacuate area. Wear appropriate OSHA regulated equipment. Ventilate area. Clean up and place in an appropriate container. Hold for disposal.

Wash contaminated surfaces to remove any residues.

AL: Burn in a chemical incinerator equipped with an afterburner and scrubber.

**SECTION IX PRECAUTIONS TO BE TAKEN IN HANDLING**

This chemical should be handled only in a hood. Eye shields should be worn. Use appropriate OSHA/MSHA approved safety equipment. Avoid contact with skin, eyes and clothing. Keep tightly closed in a cool dry place. Store only with compatible chemicals.

**SECTION X SPECIAL PRECAUTIONS AND COMMENTS**

The above information is believed to be correct on the date it is published and must not be considered all inclusive. The information has been obtained only by a search of available literature and is only a guide for handling the chemicals. OSHA regulations require that if other hazards become evident, an upgraded MSDS must be made available to the employee within three months. Responsibility for updates lies with the employer and not with CHEM SERVICE, Inc. Persons not specifically and properly trained should not handle this chemical or its container. This MSDS is provided without any warranty expressed or implied, including merchantability or fitness for any particular purpose.

This product is furnished FOR LABORATORY USE ONLY! Our products may NOT BE USED as cosmetics, agricultural or pesticidal products, food additives or as household chemicals.

**CERTIFIED SPECIFICATIONS and  
MATERIAL SAFETY DATA SHEET**

07/19/89

Last Revised June 1989

**SECTION I PRODUCT SPECIFICATIONS**

1. 071  
1. 50-50-1  
1.2-Benzanthracene  
Other name: Benz(a)anthracene  
Filed by CHEM SERVICE, Inc. PO BOX 3100, WEST CHESTER, PA. 19381 (615)692-3026  
AGENCY PHONE #: 615-696-2100

W.33-176A Purity: 99.02 Certified by ZE

Test to certify the analysis of this sample was made by various chromatographic, spectral and wet methods. The procedures used are considered to be STATE OF THE ART. CHEM SERVICE, Inc. stores purity of unopened bottles until expiration on the bottle.

**SECTION II TOXICITY DATA**

RAT OR MOUSE LD50	RTECSII	OSHA PEL	ACGIH TLV
240mg/kg	CV9275800	NA	NA

Compound is considered to be toxic.

**SECTION III PHYSICAL DATA**

MELTING POINT	BOILING POINT	DENSITY	VAPOR PRESSURE	VAPOR DENSITY	EVAPORATION RATE (Butyl acetate=1)
102 C	435sub C	NA	NA	NA	NA
ODOR	COLOR	PHASE	SOLUBILITY IN WATER		
NA	Greenish yellow flou	Crystalline solid	Insoluble (immiscible)		

**SECTION IV FIRE AND EXPLOSION HAZARD DATA**

SM POINT: Data not available  
 EXTINGUISHING MEDIA: Carbon dioxide, dry chemical powder or spray.  
 Explosion limits are available for this compound.

**SECTION V HEALTH HAZARD DATA**

Eye lenses should not be worn in the laboratory.  
 Chemicals should be considered hazardous - Avoid direct physical contact!  
 Suspected Carcinogen-may produce cancer. Can be fatal if absorbed through the skin!  
 Can be fatal if inhaled! May be fatal if swallowed! Can cause eye irritation.  
 Can cause skin irritation. Dust and/or vapors can cause irritation to respiratory tract.  
 Can be irritating to mucous membranes.  
 Based on the toxicity of compounds of similar structure this material is probably highly hazardous.

## SECTION VI FIRST AID

Antidote is a substance intended to counteract the effect of a poison. It should be administered only by a physician or a trained emergency personnel. Medical advice can be obtained from a POISON CONTROL CENTER.

Case of contact: Flush eyes continuously with water for 15-20 minutes. Flush skin with water for 20 minutes. If no burns have occurred use soap and water to cleanse skin.

Inhaled remove patient to fresh air. Administer oxygen if patient is having difficulty breathing. If patient has stopped breathing administer artificial respirations.

If patient is in cardiac arrest administer CPR.

Continue life supporting measures until medical assistance has arrived.

Remove and wash contaminated clothing.

If patient is exhibiting signs of shock - Keep warm and quiet.

Contact Poison Control Center immediately if necessary.

Do not administer liquids or induce vomiting to an unconscious or convulsing person.

If patient is vomiting-watch closely to make sure airway does not become obstructed by vomit.

Seek medical attention if necessary.

## SECTION VII REACTIVITY DATA

Incompatible with strong oxidizing agents. Will be absorbed and retained on clothing and/or shoes. Composition observed during fires.

## SECTION VIII SPILL OR LEAK PROCEDURES

Spills or leaks: Evacuate area. Wear appropriate OSHA regulated equipment. Ventilate area.

Pick up and place in an appropriate container. Hold for disposal.

Wash contaminated surfaces to remove any residues.

DISPOSAL: Burn in a chemical incinerator equipped with an afterburner and scrubber.

## SECTION IX PRECAUTIONS TO BE TAKEN IN HANDLING

This chemical should be handled only in a hood. Eye shields should be worn. Use appropriate OSHA approved safety equipment. Avoid contact with skin, eyes and clothing. Keep tightly sealed in a cool dry place. STORE UNDER REFRIGERATION. Store only with compatible chemicals.

## SECTION X SPECIAL PRECAUTIONS AND COMMENTS

The above information is believed to be correct on the date it is published and must not be considered all inclusive. The information has been obtained only by a search of available literature and is only a guide for handling the chemicals. OSHA regulations require that if other hazards become evident, an upgraded MSDS must be made available to the employee within three months. Responsibility for updates lies with the employer and not with CHEM SERVICE, Inc. Persons not specifically and properly trained should not handle this chemical or its container. This MSDS is provided without any warranty expressed or implied, including merchantability or fitness for any particular purpose.

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**CERTIFIED SPECIFICATIONS and  
MATERIAL SAFETY DATA SHEET**

27/1978

Last Revised June 1988

**SECTION I PRODUCT SPECIFICATIONS**

No. FF4      Benzo(b)fluoranthene  
 No. 205-14-0      Other name: 7,12-Benzo(b)fluoranthene  
 Area of CHEM SERVICE, Inc. PO BOX 1188, WEST CHESTER, PA. 19381 (215)692-3026  
 AGENCY PHONE No: 215-384-3100

No. 3025      Purity 99.8      Certified by ZP

It is to certify that analysis of this sample was made by various chromatographic, spectral and analytical methods. The procedures used are considered to be STATE OF THE ART. CHEM SERVICE, Inc. guarantees purity of unopened bottles until expiration on the bottle.

**SECTION II TOXICITY DATA**

ORAL OR MOUSE LD50	RTECS#	OSHA PEL	ACGIH TLV
72mg/kg	CU140000	NA	NA

Compound is considered to be toxic.

**SECTION III PHYSICAL DATA**

MELTING POINT	BOILING POINT	DENSITY	VAPOR PRESSURE	VAPOR DENSITY	EVAPORATION RATE (Butyl acetate=1)
168 C	NA	NA	NA	NA	NA
ODOR	COLOR	PHASE		SOLUBILITY IN WATER	
NA		Crystalline solid			

**SECTION IV FIRE AND EXPLOSION HAZARD DATA**

FLASH POINT: Data not available  
 EXTINGUISHING MEDIA: Carbon dioxide, dry chemical powder or spray.  
 Explosion limits are available for this compound.

**SECTION V HEALTH HAZARD DATA**

Eye lenses should not be worn in the laboratory.  
 Chemicals should be considered hazardous - Avoid direct physical contact!  
 All toxic data unavailable.

## SECTION VI FIRST AID

Antidote is a substance intended to counteract the effect of a poison. It should be administered by a physician or a trained emergency personnel. Medical advice can be obtained from a POISON CONTROL CENTER.

In case of contact: Flush eyes continuously with water for 15-20 minutes. Flush skin with water for 10 minutes. If no burns have occurred-use soap and water to cleanse skin.  
 Inhaled remove patient to fresh air. Administer oxygen if patient is having difficulty breathing. If patient has stopped breathing administer artificial respirations.  
 If patient is in cardiac arrest administer CPR.  
 Continue life supporting measures until medical assistance has arrived.  
 Remove and wash contaminated clothing.  
 If patient is exhibiting signs of shock - Keep warm and quiet.  
 Contact Poison Control Center immediately if necessary.  
 Do not administer liquids or induce vomiting to an unconscious or convulsing person.  
 If patient is vomiting-watch closely to make sure airway does not become obstructed by vomit.  
 Seek medical attention if necessary.

## SECTION VII REACTIVITY DATA

Reactivity unavailable.

## SECTION VIII SPILL OR LEAK PROCEDURES

In case of spills or leaks: Evacuate area. Wear appropriate OSHA regulated equipment. Ventilate area. Pick up and place in an appropriate container. Hold for disposal.  
 Clean contaminated surfaces to remove any residues.  
 DISPOSAL: Burn in a chemical incinerator equipped with an afterburner and scrubber.

## SECTION IX PRECAUTIONS TO BE TAKEN IN HANDLING

This chemical should be handled only in a hood. Eye shields should be worn. Use appropriate OSHA approved safety equipment. Avoid contact with skin, eyes and clothing. Keep tightly sealed in a cool dry place. Store only with compatible chemicals.

## SECTION X SPECIAL PRECAUTIONS AND COMMENTS

The above information is believed to be correct on the date it is published and must not be considered all inclusive. The information has been obtained only by a search of available literature and is only a guide for handling the chemicals. OSHA regulations require that if other hazards are evident, an upgraded MSDS must be made available to the employee within three months. Responsibility for updates lies with the employer and not with CHEM SERVICE, Inc. Persons not specially and properly trained should not handle this chemical or its container. This MSDS is issued without any warranty expressed or implied, including merchantability or fitness for any particular purpose.

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**CERTIFIED SPECIFICATIONS and  
MATERIAL SAFETY DATA SHEET**

07/18/89

Last revised June 1989

**SECTION I PRODUCT SPECIFICATIONS**

Lot # F75  
 CAS No. 207-98-9 Other name: 8,9-Benzofluoranthene  
 Supplied by CHEM SERVICE, Inc. PO BOX 3138, WEST CHESTER, PA. 19381 (215)692-3826  
 AGENCY PHONE #: 215-386-2100

No. 30-493 Purity 92.5% Certified by ZR  
 This is to certify that analysis of this sample was made by various chromatographic, spectral and  
 normal methods. The procedures used are considered to be STATE OF THE ART. CHEM SERVICE, Inc.  
 guarantees purity of unopened bottles until expiration on the bottle.

**SECTION II TOXICITY DATA**

RAT OR MOUSE LD50	RTECSH	OSHA PEL	ACGIH TLV
2820mg/kg	DF6350000	NA	NA

This compound is considered to be slightly toxic.

**SECTION III PHYSICAL DATA**

MELTING POINT	BOILING POINT	DENSITY	VAPOR PRESSURE	VAPOR DENSITY	EVAPORATION RATE (Butyl acetate=1)
117 C	488 C	NA	NA	NA	NA
ODOR	COLOR	PHASE		SOLUBILITY IN WATER	
NA	Pale yellow	Crystalline solid			

**SECTION IV FIRE AND EXPLOSION HAZARD DATA**

FLASH POINT: Data not available  
 EXTINGUISHING MEDIA: Carbon dioxide, dry chemical powder or spray.  
 Explosion limits are available for this compound.

**SECTION V HEALTH HAZARD DATA**

Contact lenses should not be worn in the laboratory.  
 All chemicals should be considered hazardous - Avoid direct physical contact!  
 Acute toxic data unavailable.

## SECTION VI FIRST AID

antidote is a substance intended to counteract the effect of a poison. It should be administered by a physician or a trained emergency personnel. Medical advice can be obtained from a POISON CONTROL CENTER.

**In case of contact:** Flush eyes continuously with water for 15-20 minutes. Flush skin with water for 20 minutes. If no burns have occurred-use soap and water to cleanse skin. Inhaled remove patient to fresh air. Administer oxygen if patient is having difficulty breathing. If patient has stopped breathing administer artificial respirations. If patient is in cardiac arrest administer CPR. Continue life supporting measures until medical assistance has arrived. Remove and wash contaminated clothing. If patient is exhibiting signs of shock - Keep warm and quiet. Contact Poison Control Center immediately if necessary. Do not administer liquids or induce vomiting to an unconscious or convulsing person. If patient is vomiting-watch closely to make sure airway does not become obstructed by vomit. Seek medical attention if necessary.

## SECTION VII REACTIVITY DATA

Reactivity unavailable.

## SECTION VIII SPILL OR LEAK PROCEDURES

**Spills or leaks:** Evacuate area. Wear appropriate OSHA regulated equipment. Ventilate area. Clean up and place in an appropriate container. Hold for disposal. Decontaminate surfaces to remove any residues.

**DISPOSAL:** Burn in a chemical incinerator equipped with an afterburner and scrubber.

## SECTION IX PRECAUTIONS TO BE TAKEN IN HANDLING

This chemical should be handled only in a hood. Eye shields should be worn. Use appropriate A/MSHA approved safety equipment. Avoid contact with skin, eyes and clothing. Keep tightly sealed in a cool dry place. Store only with compatible chemicals.

## SECTION X SPECIAL PRECAUTIONS AND COMMENTS

The above information is believed to be correct on the date it is published and must not be considered all inclusive. The information has been obtained only by a search of available literature and is only a guide for handling the chemicals. OSHA regulations require that if other hazards become evident, an upgraded MSDS must be made available to the employee within three months. Responsibility for updates lies with the employer and not with CHEM SERVICE, Inc. Persons not specifically and properly trained should not handle this chemical or its container. This MSDS is provided without any warranty expressed or implied, including merchantability or fitness for any particular purpose.

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**CERTIFIED SPECIFICATIONS and  
MATERIAL SAFETY DATA SHEET**

07/18/89

Last revised June 1989

**SECTION I PRODUCT SPECIFICATIONS**

879 1.12-Benzoperylene

191-14-01 Other name: benz[ghi]perylene

1140 BY ARMA SERVICE, Inc. PO BOX 2108, WEST CHESTER, PA. 19381 (215)892-3826  
AGENCY PHONE #: 215-886-2108

As 3G-14-B Purity 99.02 Certified by ZP

is to certify that analysis of this sample was made by various chromatographic, spectral and  
analytical methods. The procedures used are considered to be STATE OF THE ART. ARMA SERVICE, Inc.  
warrants purity of unopened bottles until expiration on the bottle.

**SECTION II TOXICITY DATA**

AT OR MOUSE LD50	RTECSH	OSHA PEL	ACGIH TLV
NA	DT6288588	NA	NA

Toxicity data has been found. Assume this chemical to be hazardous.

**SECTION III PHYSICAL DATA**

MELTING POINT	BOILING POINT	DENSITY	VAPOR PRESSURE	VAPOR DENSITY	EVAPORATION RATE (Butyl acetate=1)
277-279 C	500 C	NA	NA	NA	NA
ODOR	COLOR	PHASE		SOLUBILITY IN WATER	
NA		Crystalline solid			

**SECTION IV FIRE AND EXPLOSION HAZARD DATA**

FLASH POINT: Data not available

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical powder or spray.

EXPLOSION LIMITS are available for this compound.

**SECTION V HEALTH HAZARD DATA**

Eye lenses should not be worn in the laboratory.

Chemicals should be considered hazardous - Avoid direct physical contact!

Can be fatal if absorbed through the skin! Can be fatal if inhaled! May be fatal if swallowed!

## SECTION VI FIRST AID

Indicates a substance intended to counteract the effect of a poison. It should be administered only by a physician or a trained emergency personnel. Medical advice can be obtained from a POISON CONTROL CENTER.

In case of contact: Flush eyes continuously with water for 15-20 minutes. Flush skin with water for 10 minutes. If no burns have occurred-use soap and water to cleanse skin. Unleashed remove patient to fresh air. Administer oxygen if patient is having difficulty breathing. If patient has stopped breathing administer artificial respirations. If patient is in cardiac arrest administer CPR. Continue life supporting measures until medical assistance has arrived. Remove and wash contaminated clothing. If patient is exhibiting signs of shock - keep warm and quiet. Contact Poison Control Center immediately if necessary. Do not administer liquids or induce vomiting to an unconscious or convulsing person. If patient is vomiting-watch closely to make sure airway does not become obstructed by vomit. Seek medical attention if necessary.

## SECTION VII REACTIVITY DATA

Reactivity unavailable.

## SECTION VIII SPILL OR LEAK PROCEDURES

Spills or Leaks: Evacuate area. Wear appropriate OSHA regulated equipment. Ventilate area. Pick up and place in an appropriate container. Hold for disposal. Clean contaminated surfaces to remove any residues.

DISPOSAL: Burn in a chemical incinerator equipped with an afterburner and scrubber.

## SECTION IX PRECAUTIONS TO BE TAKEN IN HANDLING

This chemical should be handled only in a hood. Eye shields should be worn. Use appropriate A/MSHA approved safety equipment. Avoid contact with skin, eyes and clothing. Keep tightly sealed in a cool dry place. Store only with compatible chemicals.

## SECTION X SPECIAL PRECAUTIONS AND COMMENTS

The above information is believed to be correct on the date it is published and must not be considered all inclusive. The information has been obtained only by a search of available literature and is only a guide for handling the chemicals. OSHA regulations require that if other hazards become evident, an upgraded MSDS must be made available to the employee within three months. Responsibility for updates lies with the employer and not with CHEM SERVICE, Inc. Persons not specifically and properly trained should not handle this chemical or its container. This MSDS is provided without any warranty expressed or implied, including merchantability or fitness for any particular purpose.

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# MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION  
1145 CATALYN STREET  
SCHENECTADY, NY 12303-1836 USA  
(518) 377-8855



NO. 414  
DI(2-ETHYLHEXYL)PHTHALATE  
Revision A  
DATE December 1984

## SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: DI(2-ETHYLHEXYL)PHTHALATE  
OTHER DESIGNATIONS: DEHP, "DOP", o-C<sub>6</sub>H<sub>4</sub>[COOCH<sub>2</sub>CH(C<sub>2</sub>H<sub>5</sub>)C<sub>4</sub>H<sub>9</sub>]<sub>2</sub>, bis(2-Ethylhexyl)Phthalate,  
GE Material D589, ASTM D1249 Type I, CAS #000 117 817, Dioctyl Phthalate  
TRADE NAME & KODAFLEX DOP  
MANUFACTURER: Eastman Chemical Products U.S. Steel Corp. W.R. Grace & Co.  
Coatings Chemicals Div. Chemicals Div. Hatco Chemicals Div.  
Kingsport, TN 37662 600 Grant Avenue Fords, NJ 08863  
Phone: (800)327-8626 Pittsburgh, PA 15230 (201)738-1000  
7412433-7711

## SECTION II. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Di(2-ethylhexyl)phthalate Listed as a "suspected carcinogen" by the National Toxicology Program (NTP). (Long term, high level animal feeding tests have produced neoplasms.) National Center for Toxicological Research is currently testing (FY1984) for reproductive development toxicity.  *Current (1984) OSHA PEL and ACGIH TLV. ACGIH STEL is 10 mg/m <sup>3</sup> for 15 minutes exposure	ca 99	8-hr TWA 5 mg/m <sup>3</sup> * Man, Oral TDLo 143 mg/kg GI tract effects Rat (5-15 days Preg.) interperitoneal TDLo 15 g/kg Teratogenic effects Rat, Oral LD <sub>50</sub> 31 g/kg

## SECTION III. PHYSICAL DATA

Boiling point, 760 mm, deg C ----- ca 385	Specific gravity, 20/20 C ----- 0.99
54 mm, deg C ----- 230	Pour point, deg C ----- ca -48
Vapor pressure at 200 C, mm Hg --- 1.3	Viscosity, 20 C, cps ----- 81.4
Vapor density (Air=1) ----- ~13.5	Freezing point, deg C -- below - 50
Water solubility ----- Nearly insoluble (<0.01% at 20 C)	Molecular weight ----- 390.5

Appearance & Odor: Colorless to pale yellow oily liquid. Odorless to faint, mild odor.

## SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Auto-ignition Temp.	Flammability Limits in Air	Lower	Upper
425 F (COC)	770 F	Volume % @ 474F (245C)	0.3	-

Extinguishing media: Use foam, water spray, carbon dioxide or dry chemical. Water or foam may cause frothing of hot oil. Use water spray to cool fire-exposed containers of this material and to flush spills away from sensitive area.  
This material is a slight fire hazard when exposed to heat or flame; it presents no unusual fire hazard.  
Firefighters should use self-contained breathing equipment and full protective clothing.

## SECTION V. REACTIVITY DATA

This is a stable material under normal storage and handling conditions. It does not undergo hazardous polymerization.  
It is a combustible liquid (OSHA Class III-B) and is incompatible with strong oxidizing agents.  
Thermal-oxidative degradation products include carbon dioxide and carbon monoxide.

## SECTION VI. HEALTH HAZARD INFORMATION

TLV 5 mg/m<sup>3</sup> (See Sect II)

The low vapor pressure of this material essentially eliminates acute inhalation hazard unless the liquid is heated or misted. The TLV has been established to prevent inhaling of excessive levels of airborne DEHP which can cause nausea and be irritating to mucous membranes and the respiratory tract. Eye contact with liquid or mist is irritating. Ingestion can cause abdominal cramps, nausea, and diarrhea. Excessive skin contact can be irritating. (Rabbit, skin, LD<sub>50</sub> 25g/kg)

## FIRST AID:

**Eye Contact:** Flush eyes with running water for 15 minutes, including under eyelids. Get medical help if irritation persists.

**Skin Contact:** Wash exposed areas well with soap and water. Get medical help if irritation persists or if large areas of the body are affected. Remove contaminated clothing promptly.

**Inhalation:** Remove to fresh air. Support breathing if necessary. Get medical help. Keep warm and at rest.

**Ingestion:** Contact physician. Stomach lavage may be needed.

## SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Contain spill and pick up with absorbent solid, rags, or paper for disposal by burning. Prevent losses into the environment whenever possible. Do not send to sewer. (DEHP degrades in fresh water sediments under aerobic conditions; half life about 14 days. It does not degrade under anaerobic conditions. It is readily concentrated by aquatic organisms.) Clean up trace residues with water and detergent.

**DISPOSAL:** Scrap material can be disposed of by controlled incineration. Mix liquid scrap with a more flammable solvent and spray into incinerator's firebox. Follow Federal, State, and Local regulations.

## SECTION VIII. SPECIAL PROTECTION INFORMATION

Use general ventilation, combined with local exhaust ventilation (especially when material is heated or misted) to meet the TLV requirements. For nonroutine and emergency conditions where the TLV is exceeded, use an approved air-supplied mask or organic canister respirator for protection against mist and vapors.

Use rubber gloves and apron to avoid repeated or prolonged contact with liquid and safety glasses or goggles to avoid eye contact by splashing. Depending on how the material is used and conditions of use, additional body protection may be desirable.

Eyewash fountain and safety showers should be available to areas of use and handling. DEHP contaminated clothing should be removed and laundered before reuse.

## SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in a ventilated area away from oxidizing agents and sources of heat or ignition. Follow good hygienic practice to avoid chronic effects. Wear clean work clothing.

Avoid prolonged or repeated contact with liquid and inhalation of mist or vapors. Do not eat or smoke in areas where this material is used or stored. Wash exposed skin areas after working with this material and before using restroom facilities, eating or smoking. Do not take internally.

DATA SOURCE(S) CODE: 1-12, 14, 23, 38, 47

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APPROVALS: MIS CRD

INDUST. HYGIENE SAFETY

MEDICAL REVIEW: December 1984

# CADMIUM OXIDE

COX

<p><b>Common Synonyms</b> Cadmium fume</p>	<p><b>Solid</b> Yellow-brown  Odorless</p> <p>Sinks in water.</p>
<p>AVOID CONTACT WITH SOLID AND DUST. KEEP PEOPLE AWAY. Wear a dust respirator. Stop discharge if possible. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>	
<b>Fire</b>	<p>Not flammable. <b>POISONOUS GASES MAY BE PRODUCED IN FIRE.</b> Wear goggles and self-contained breathing apparatus.</p>
<b>Exposure</b>	<p>CALL FOR MEDICAL AID</p> <p><b>DUST</b> <b>POISONOUS IF INHALED.</b> If inhaled will cause coughing. 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.</p> <p><b>SOLID</b> 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.</p>
<b>Water Pollution</b>	<p>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.</p>
<p><b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Handbook) Should be removed. Chemical and physical treatment.</p>	<p><b>2. LABEL</b></p> <p>2.1 Category: None 2.2 Class: Not pertinent</p>
<p><b>3. CHEMICAL DESIGNATIONS</b></p> <p>3.1 CG Compatibility Class: Not listed 3.2 Formula: CdO 3.3 IMO/IUN Designation: Not listed 3.4 DOT ID No.: 2570 3.5 CAS Registry No.: 1306-19-0</p>	<p><b>4. OBSERVABLE CHARACTERISTICS</b></p> <p>4.1 Physical State (as shipped): Solid 4.2 Color: Yellow-brown to brown 4.3 Odor: None</p>
<p><b>5. HEALTH HAZARDS</b></p>	
<p>5.1 Personal Protective Equipment: Bu. Mines approved respirator; goggles; rubber gloves 5.2 Symptoms Following Exposure: A single exposure to cadmium oxide fumes can cause severe or fatal lung irritation; chronic poisoning is characterized by lung injury (emphysema) and kidney dysfunction. Ingestion produces severe toxic effects; both kidney and liver injuries may occur. Contact with eyes causes irritation. 5.3 Treatment of Exposure: <b>INHALATION:</b> if there has been known exposure to dense cadmium oxide fume or if cough, chest tightness, or respiratory distress occur after possible exposure, place patient at bed rest and call a physician. <b>INGESTION:</b> induce vomiting; stop irritation by giving milk or egg whites at frequent intervals; perform gastric lavage; seek medical attention. <b>EYES:</b> flush with water for at least 15 min. 5.4 Threshold Limit Value: 0.05 mg/m<sup>3</sup> as Cd 5.5 Short Term Intention Limit: 0.1 mg/m<sup>3</sup>, 30 min. 5.6 Toxicity by Ingestion: Grade 3; oral rat LD<sub>50</sub> = 72 mg/kg 5.7 Late Toxicity: Delayed liver, lung, and kidney damage has followed respiratory exposures to cadmium salts in industry. 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: 40 mg/m<sup>3</sup> as Cd</p>	

<p><b>6. FIRE HAZARDS</b></p> <p>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 cadmium oxide fume 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: 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</p>	<p><b>10. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Handbook) II</p>
<p><b>7. CHEMICAL REACTIVITY</b></p> <p>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 Alkalies: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Water Ratio (Resistant to Product): Data not available 7.8 Reactivity Group: Data not available</p>	<p><b>11. HAZARD CLASSIFICATIONS</b></p> <p>11.1 Code of Federal Regulations: Not listed 11.2 NAB Hazard Rating for Bulk Water Transportation: Not listed 11.3 NFPA Hazard Classification: Not listed</p>
<p><b>8. WATER POLLUTION</b></p> <p>8.1 Aquatic Toxicity: Data not available 8.2 Waterway Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): None 8.4 Food Chain Concentration Potential: Concentrated by shellfish</p>	<p><b>12. PHYSICAL AND CHEMICAL PROPERTIES</b></p> <p>12.1 Physical State at 15°C and 1 atm: Solid 12.2 Molecular Weight: 128.4 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: 6.96 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 12.18 Heat of Fusion: Data not available 12.19 Limiting Value: Data not available 12.27 Reid Vapor Pressure: Data not available</p>
<p><b>9. SHIPPING INFORMATION</b></p> <p>9.1 Grade of Purity: Reagent; technical 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open</p>	<p style="text-align: center;"><b>NOTES</b></p>

<b>COX</b>	<b>CADMIUM OXIDE</b>
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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
	N O T  P E R T I N E N T		N O T  P E R T I N E N T		N O T  P E R T I N E N T		N O T  P E R T I N E N T

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
	I N S O L U B L E		N O T  P E R T I N E N T		N O T  P E R T I N E N T		N O T  P E R T I N E N T

DATE 6/06/89

MATERIAL SAFETY DATA SHEET

PAGE 1

SECTION I - GENERAL INFORMATION

(REORDER PRODUCT BY THIS NO.)

CATALOG NO N/A

PRODUCT NAME PYRENE 5G

DATA SHEET NO R430780

PYRENE

CHEMICAL NAME PYRENE

FORMULA C16H10

FORMULA WEIGHT 202

AS 129-00-0 NRTECS UR2450000

SYNONYM BENZO(DEF)PHENANTHRENE

MANUFACTURER SUPELCO INC.

PHONE 814-359-3441

ADDRESS SUPELCO PARK, BELLEFONTE, PA 16823-0048

SECTION II - HAZARDOUS INGREDIENTS OF MIXTURES

CHEMICAL NAME

COMMON NAME - PERCENTAGE - CAS #

(FORMULA) - TLV(UNITS)

LD50 VALUE - CONDITIONS

N/A

SECTION III - PHYSICAL DATA

BOILING POINT 404

C

MELTING POINT 149

C

VAPOR PRESSURE N/A

VAPOR DENSITY 7

C (AIR=1)

SPECIFIC GRAVITY 1.271

G/ML

C (WATER=1)

PERCENT VOLATILE BY VOLUME N/A

WATER SOLUBILITY N/A

EVAPORATION RATE N/A

COLOR APPEARANCE WHITE TO LIGHT YELLOW SOLID

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT N/A

FLAMMABLE LIMITS LFL

UEL

EXTINGUISHING MEDIA

WATER

CO2

DRY CHEMICAL

SPECIAL FIRE FIGHTING PROCEDURES

WEAR SELF CONTAINED BREATHING APPARATUS WHEN FIGHTING A CHEMICAL FIRE.

UNUSUAL FIRE AND EXPLOSION HAZARDS

N/A

SECTION V - HEALTH HAZARD DATA

LD50 N/A

TLV N/A

EMERGENCY AND FIRST AID PROCEDURES

EYES

FLUSH EYES WITH WATER FOR 15 MINUTES.

SKIN

FLUSH SKIN WITH LARGE VOLUMES OF WATER.

6/06/89

MATERIAL SAFETY DATA SHEET

PAGE 2

ATALOG NO N/A (REORDER PRODUCT BY THIS NO.)  
PRODUCT NAME PYRENE 5G  
DATA SHEET NO R430780  
PYRENE

SECTION V - HEALTH HAZARD DATA

\* CONTINUED \*

REMOVE CONTAMINATED CLOTHING.

INHALATION

IMMEDIATELY MOVE TO FRESH AIR.

INGESTION

CONTACT A PHYSICIAN.

EFFECTS OF OVEREXPOSURE

MAY IRRITATE EYES AND/OR SKIN  
IRRITATES RESPIRATORY TRACT  
IRRITATES SKIN  
BURNS SKIN  
REPORTED ANIMAL CARCINOGEN.

SECTION VI - REACTIVITY DATA

STABILITY STABLE.

1

CONDITIONS TO AVOID

N/A

INCOMPATIBILITY

OXIDIZING AGENTS

HAZARDOUS DECOMPOSITION PRODUCTS

N/A

HAZARDOUS POLYMERIZATION WILL NOT OCCUR.

CONDITIONS TO AVOID

N/A

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

SWEEP UP MATERIAL.  
FLUSH AREA WITH WATER.

6/06/89

MATERIAL SAFETY DATA SHEET

PAGE 3

CATALOG NO N/A (REORDER PRODUCT BY THIS NO.)  
PRODUCT NAME PYRENE 5G  
DATA SHEET NO R430780  
PYRENE

SECTION VII - SPILL OR LEAK PROCEDURES

\* CONTINUED \*

WASTE DISPOSAL METHOD

COMPLY WITH ALL APPLICABLE FEDERAL, STATE, OR LOCAL REGULATIONS

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFIC TYPE)

WEAR DUST MASK.

PROTECTIVE GLOVES

WEAR GLOVES.

EYE PROTECTION

WEAR PROTECTIVE GLASSES.

VENTILATION

USE ONLY IN WELL VENTILATED AREA.

SPECIAL

N/A

OTHER PROTECTIVE EQUIPMENT

N/A

SECTION IX - SPECIAL PRECAUTIONS

STORAGE AND HANDLING

STORE IN SEALED CONTAINER IN COOL, DRY LOCATION.  
KEEP AWAY FROM OXIDIZERS.  
AVOID GENERATING DUST.

OTHER PRECAUTIONS

AVOID EYE OR SKIN CONTACT.

THE INFORMATION AND RECOMMENDATIONS SET FORTH HEREIN ARE BELIEVED TO BE ACCURATE AS OF THE DATE HEREOF. SUPELCO, INC. MAKES NO WARRANTY WITH RESPECT HERETO AND DISCLAIMS ALL LIABILITY FROM RELIANCE THEREON.

LAST REVISED 10/26/88

# TOLUENE

TOL

<p><b>Common Synonyms</b></p> <p>Toluol Methylbenzene Methylbenzol</p>	<p><b>Watery liquid</b></p> <p>Colorless</p> <p>Pleasant odor</p>	<p>Floats on water. Flammable, irritating vapor is produced.</p>
<p>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.</p>		
<b>Fire</b>	<p><b>FLAMMABLE</b> 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.</p>	
<b>Exposure</b>	<p><b>CALL FOR MEDICAL AID</b></p> <p><b>VAPOR</b> 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.</p> <p><b>LIQUID</b> 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.</p>	
<b>Water Pollution</b>	<p>Dangerous to aquatic life in high concentrations. Floating to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.</p>	
<p><b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Handbook) Issue warning-high flammability. Evacuate area.</p>		<p><b>2. LABEL</b></p> <p>2.1 Category: Flammable liquid 2.2 Class: 3</p>
<p><b>3. CHEMICAL DESIGNATIONS</b></p> <p>3.1 CG Compatibility Class: Aromatic Hydrocarbon 3.2 Formula: C<sub>7</sub>H<sub>8</sub> 3.3 IMO/IHM Designation: 3.2/1294 3.4 DOT ID No.: 1294 3.5 CAS Registry No.: 108-88-3</p>		<p><b>4. OBSERVABLE CHARACTERISTICS</b></p> <p>4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Pungent, aromatic, benzene-like; distinct, pleasant</p>
<p><b>5. HEALTH HAZARDS</b></p> <p>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, grating, diarrhea, decreased respiration. 5.3 Treatment of Exposure: <b>INHALATION:</b> remove to fresh air, give artificial respiration and oxygen if needed; call a doctor. <b>INGESTION:</b> do NOT induce vomiting; call a doctor. <b>EYES:</b> flush with water for at least 15 min. <b>SKIN:</b> wipe off, wash with soap and water. 5.4 Threshold Limit Value: 100 ppm 5.5 Short Term Inhalation Limit: 600 ppm for 30 min. 5.6 Toxicity by Ingestion: Grade 2; LD<sub>50</sub> = 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</p>		

<p><b>6. FIRE HAZARDS</b></p> <p>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</p> <p style="text-align: right;"><i>(Continued)</i></p>	<p><b>10. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Handbook) A-T-U</p>																																				
<p><b>7. CHEMICAL REACTIVITY</b></p> <p>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 Water Ratio (Resistant to Product): Data not available 7.8 Reactivity Group: 32</p>	<p><b>11. HAZARD CLASSIFICATIONS</b></p> <p>11.1 Code of Federal Regulations: Flammable liquid 11.2 NFAS Hazard Rating for Bulk Water Transportation:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: left;">Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>3</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>  Vapor Irritant</td> <td>1</td> </tr> <tr> <td>  Liquid or Solid Irritant</td> <td>1</td> </tr> <tr> <td>  Poison</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>  Human Toxicity</td> <td>1</td> </tr> <tr> <td>  Aquatic Toxicity</td> <td>3</td> </tr> <tr> <td>  Aesthetic Effect</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>  Other Chemicals</td> <td>1</td> </tr> <tr> <td>  Water</td> <td>0</td> </tr> <tr> <td>  Self Reaction</td> <td>0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Category</th> <th style="text-align: left;">Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>3</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>	Category	Rating	Fire	3	Health		Vapor Irritant	1	Liquid or Solid Irritant	1	Poison	2	Water Pollution		Human Toxicity	1	Aquatic Toxicity	3	Aesthetic Effect	2	Reactivity		Other Chemicals	1	Water	0	Self Reaction	0	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	3	Reactivity (Yellow)	0
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Reactivity (Yellow)	0																																				
<p><b>8. WATER POLLUTION</b></p> <p>8.1 Aquatic Toxicity: 1180 mg/L/96 hr/sunfish/TL<sub>01</sub>/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</p>	<p><b>12. PHYSICAL AND CHEMICAL PROPERTIES</b></p> <p>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 = 383.6°K 12.4 Freezing Point: -138°F = -95.0°C = 178.2°K 12.5 Critical Temperature: 606.4°F = 318.6°C = 591.8°K 12.6 Critical Pressure: 586.1 psia = 40.55 atm = 4.108 MN/m<sup>2</sup> 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 = 66.1 cal/g = 3.81 X 10<sup>4</sup> J/kg 12.13 Heat of Combustion: -17,430 Btu/lb = -8086 cal/g = -406.5 X 10<sup>4</sup> J/kg 12.14 Heat of Decomposition: Not pertinent 12.16 Heat of Solution: Not pertinent 12.18 Heat of Polymerization: Not pertinent 12.26 Heat of Fusion: 17.17 cal/g 12.28 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 1.1 psia</p>																																				
<p><b>9. SHIPPING INFORMATION</b></p> <p>9.1 Grades of Purity: Research, reagent, nitration at 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</p>																																					
<p><b>6. FIRE HAZARDS (Continued)</b></p> <p>6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>																																					

TOL

## TOLUENE

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
-30	57.180	0	.396	0	1.026	0	1.024
-20	56.870	5	.397	10	1.015	5	.978
-10	56.550	10	.399	20	1.005	10	.935
0	56.240	15	.400	30	.994	15	.894
10	55.930	20	.402	40	.983	20	.857
20	55.620	25	.403	50	.972	25	.821
30	55.310	30	.404	60	.962	30	.788
40	54.990	35	.406	70	.951	35	.757
50	54.680	40	.407	80	.940	40	.727
60	54.370	45	.409	90	.929	45	.700
70	54.060	50	.410	100	.919	50	.673
80	53.750	55	.411	110	.908	55	.649
90	53.430	60	.413	120	.897	60	.625
100	53.120	65	.414	130	.886	65	.603
110	52.810	70	.415	140	.876	70	.582
120	52.500	75	.417	150	.865	75	.562
		80	.418	160	.854	80	.544
		85	.420	170	.843	85	.526
		90	.421	180	.833	90	.509
		95	.422	190	.822	95	.493
		100	.424	200	.811	100	.477
		105	.425	210	.800		
		110	.427				
		115	.428				
		120	.429				
		125	.431				

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	.050	0	.038	0	.00070	0	.228
		10	.057	10	.00103	25	.241
		20	.084	20	.00150	50	.255
		30	.121	30	.00212	75	.268
		40	.172	40	.00296	100	.281
		50	.241	50	.00405	125	.294
		60	.331	60	.00547	150	.306
		70	.449	70	.00727	175	.319
		80	.600	80	.00954	200	.331
		90	.792	90	.01237	225	.343
		100	1.033	100	.01584	250	.355
		110	1.332	110	.02007	275	.367
		120	1.700	120	.02518	300	.378
		130	2.148	130	.03127	325	.389
		140	2.690	140	.03850	350	.400
		150	3.338	150	.04700	375	.411
		160	4.109	160	.05691	400	.422
		170	5.018	170	.06840	425	.432
		180	6.083	180	.08162	450	.443
		190	7.323	190	.09675	475	.453
		200	8.758	200	.11400	500	.462
		210	10.410	210	.13340	525	.472
						550	.482
						575	.491
						600	.500

# TRICHLOROETHANE

TCE

<p><b>Common Synonyms</b> 1,1,1-Trichloroethane Methylchloroform Aeroflame Chloroethane</p>		<p><b>Water liquid</b>      <b>Colorless</b>      <b>Sweet odor</b></p> <p>Sinks in water. Irritating vapor is produced.</p>
<p>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.</p>		
<p><b>Fire</b></p>	<p><b>Combustible</b> <b>POISONOUS GASES ARE PRODUCED IN FIRE.</b> Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, carbon dioxide, or foam.</p>	
<p><b>Exposure</b></p>	<p><b>CALL FOR MEDICAL AID.</b></p> <p><b>VAPOR</b> 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.</p> <p><b>LIQUID</b> 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.</p>	
<p><b>Water Pollution</b></p>	<p>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.</p>	
<p><b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Handbook) Should be removed. Chemical and physical treatment.</p>		<p><b>2. LABEL</b> 2.1 Category: None 2.2 Class: Not pertinent</p>
<p><b>3. CHEMICAL DESIGNATIONS</b> 3.1 CG Compatibility Class: Halogenated hydrocarbon 3.2 Formula: CH<sub>2</sub>Cl<sub>3</sub> 3.3 IMO/IUM Designation: Not listed 3.4 DOT ID No.: 2631 3.5 CAS Registry No.: 71-55-6</p>		<p><b>4. OBSERVABLE CHARACTERISTICS</b> 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Chloroform-like; sweetish</p>
<p><b>5. HEALTH HAZARDS</b></p> <p>5.1 Personal Protective Equipment: Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or polyvinyl-alcohol-type gloves; chemical safety goggles and face shield; neoprene safety shoes (or leather safety shoes plus neoprene footwear); neoprene or polyvinyl alcohol suit or apron for splash protection.</p> <p>5.2 Symptoms Following Exposure: <b>INHALATION:</b> 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. <b>INGESTION:</b> produces effects similar to inhalation and may cause some feeling of nausea. <b>EYES:</b> slightly irritating and lachrymatory. <b>SKIN:</b> detaching action may cause dermatitis.</p> <p>5.3 Treatment of Exposure: Get medical attention for all eye exposures and any other serious over-exposures. Do NOT administer adrenalin or epinephrine; otherwise, treatment is symptomatic. <b>INHALATION:</b> remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. <b>INGESTION:</b> have victim drink water and induce vomiting. <b>EYES:</b> flush thoroughly with water. <b>SKIN:</b> remove contaminated clothing and wash exposed area thoroughly with soap and warm water.</p> <p>5.4 Threshold Limit Value: 350 ppm 5.5 Short Term Inhalation Limit: 1,000 ppm for 60 min. in man 5.6 Toxicity by Ingestion: Grade 1; LD<sub>50</sub> = 5 to 15 g/kg (rat, mouse, rabbit, guinea pig) 5.7 Lethal 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</p>		

<p><b>6. FIRE HAZARDS</b></p> <p>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.) 2.9 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</p>	<p><b>10. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Handbook) A-X-Y</p>																																				
<p><b>7. CHEMICAL REACTIVITY</b></p> <p>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 Bases: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Water Ratio (Resistant to Product): Data not available 7.8 Reactivity Group: 3B</p>	<p><b>11. HAZARD CLASSIFICATIONS</b></p> <p>11.1 Code of Federal Regulations: ORM-A 11.2 NAB Hazard Rating for Bulk Water Transportation:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>1</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>1</td> </tr> <tr> <td>Poisons</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td>1</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>3</td> </tr> <tr> <td>Aesthetic Effect</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td>1</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self Reaction</td> <td>0</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>1</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>	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	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	1	Reactivity (Yellow)	0
Category	Rating																																				
Fire	1																																				
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<p><b>8. WATER POLLUTION</b></p> <p>8.1 Aquatic Toxicity: 75-150 ppm*/pintish/TL<sub>50</sub>/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</p>	<p><b>12. PHYSICAL AND CHEMICAL PROPERTIES</b></p> <p>12.1 Physical State at 16°C and 1 atm: Liquid 12.2 Molecular Weight: 133.41 12.3 Boiling Point at 1 atm: 186°F = 74°C = 347°K 12.4 Freezing Point: &lt;-38°F = &lt;-39°C = &lt;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<sup>6</sup> J/kg 12.13 Heat of Combustion: (est.) 4700 Btu/lb = 2600 cal/g = 110 X 10<sup>6</sup> J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.20 Heat of Fusion: Data not available 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: 4.0 psia</p>																																				
<p><b>9. SHIPPING INFORMATION</b></p> <p>9.1 Grade 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</p>	<p><b>NOTES</b></p>																																				

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## TRICHLOROETHANE

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
0	85.419	55	.240		N O T  P E R T I N E N T	15	1.363
10	84.870	60	.242			20	1.295
20	84.309	65	.244			25	1.231
30	83.759	70	.246			30	1.172
40	83.200	75	.248			35	1.117
50	82.650	80	.250			40	1.065
60	82.089	85	.252			45	1.017
70	81.540	90	.254			50	.972
80	80.981	95	.256			55	.929
90	80.429	100	.258			60	.889
100	79.870	105	.260			65	.852
110	79.320	110	.262			70	.817
120	78.759	115	.264			75	.784
130	78.209	120	.266			80	.753
140	77.650	125	.268			85	.723
150	77.099	130	.270				
160	76.540	135	.272				
		140	.274				

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	.070	70	2.099	70	.04925	0	.146
		75	2.364	75	.05495	25	.150
		80	2.657	80	.06119	50	.155
		85	2.960	85	.06799	75	.159
		90	3.335	90	.07540	100	.163
		95	3.725	95	.08348	125	.167
		100	4.152	100	.09220	150	.171
		105	4.619	105	.10170	175	.175
		110	5.130	110	.11190	200	.179
		115	5.686	115	.12300	225	.183
		120	6.292	120	.13490	250	.186
		125	6.950	125	.14770	275	.190
		130	7.663	130	.16150	300	.193
		135	8.437	135	.17630	325	.196
		140	9.273	140	.19220	350	.199
		145	10.180	145	.20920	375	.202
		150	11.150	150	.22730	400	.205
		155	12.200	155	.24670	425	.208
		160	13.330	160	.26730	450	.210
		165	14.540	165	.28930	475	.213
		170	15.840	170	.31270	500	.215
		175	17.240	175	.33760	525	.217
		180	18.730	180	.36390	550	.219
		185	20.330	185	.39180	575	.222
		190	22.030	190	.42140	600	.223

# TRICHLOROETHYLENE

TCL

<p><b>Common Synonyms</b></p> <p>Trichloroethylene Trelene; Alkylen Chlorien Gemalgene Trichloron Trichloron; Triene</p>		<p><b>Water liquid</b></p> <p>Sinks in water. Irritating vapor is produced.</p>	<p><b>Colorless</b></p>	<p><b>Sweet odor</b></p>
<p>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.</p>				
<p><b>Fire</b></p>		<p>Combustible. <b>POISONOUS GASES ARE PRODUCED IN FIRE.</b> Wear goggles and self-contained breathing apparatus. Extinguish with dry chemical, carbon dioxide, or foam.</p>		
<p><b>Exposure</b></p>		<p>CALL FOR MEDICAL AID</p> <p><b>VAPOR</b> 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.</p> <p><b>LIQUID</b> 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.</p>		
<p><b>Water Pollution</b></p>		<p>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.</p>		
<p><b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Handbook) Should be removed Chemical and physical treatment</p>		<p><b>2. LABEL</b> 2.1 Category: None 2.2 Class: Not pertinent</p>		
<p><b>3. CHEMICAL DESIGNATIONS</b> 3.1 CG Compatibility Class: Halogenated hydrocarbon 3.2 Formula: <math>\text{CHCl}_2-\text{CCl}_2</math> 3.3 MSD/UN Designation: 9.0/1710 3.4 DOT ID No.: 1710 3.5 CAS Registry No.: 79-01-6</p>		<p><b>4. OBSERVABLE CHARACTERISTICS</b> 4.1 Physical State (as shipped): Liquid 4.2 Color: Colorless 4.3 Odor: Chloroform-like; ethereal</p>		
<p><b>5. HEALTH HAZARDS</b></p> <p>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.</p> <p>5.2 Symptoms Following Exposure: <b>INHALATION:</b> 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. <b>INGESTION:</b> symptoms similar to inhalation. <b>SKIN:</b> defatting action can cause dermatitis. <b>EYES:</b> slightly irritating sensation and lachrymation.</p> <p>5.3 Treatment of Exposure: Do NOT administer adrenalin or epinephrine; get medical attention for all cases of overexposure. <b>INHALATION:</b> remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. <b>INGESTION:</b> have victim drink water and induce vomiting; repeat three times; then give 1 tablespoon epsom salts in water. <b>EYES:</b> flush thoroughly with water. <b>SKIN:</b> wash thoroughly with soap and warm water.</p> <p>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; <math>\text{LD}_{50} = 50</math> 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</p>				

<p><b>6. FIRE HAZARDS</b></p> <p>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 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>		<p><b>10. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Handbook) A-X-Y</p>																																					
<p><b>7. CHEMICAL REACTIVITY</b></p> <p>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 Water Ratio (Reactant to Product): Data not available 7.8 Reactivity Group: 36</p>		<p><b>11. HAZARD CLASSIFICATIONS</b></p> <p>11.1 Code of Federal Regulations: OSHA 11.2 NAB Hazard Rating for Bulk Water Transportation:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Rating</th> </tr> </thead> <tbody> <tr> <td>Fire</td> <td>1</td> </tr> <tr> <td>Health</td> <td></td> </tr> <tr> <td>Vapor Irritant</td> <td>1</td> </tr> <tr> <td>Liquid or Solid Irritant</td> <td>1</td> </tr> <tr> <td>Poisons</td> <td>2</td> </tr> <tr> <td>Water Pollution</td> <td></td> </tr> <tr> <td>Human Toxicity</td> <td>1</td> </tr> <tr> <td>Aquatic Toxicity</td> <td>2</td> </tr> <tr> <td>Aesthetic Effect</td> <td>2</td> </tr> <tr> <td>Reactivity</td> <td></td> </tr> <tr> <td>Other Chemicals</td> <td>1</td> </tr> <tr> <td>Water</td> <td>0</td> </tr> <tr> <td>Self Reaction</td> <td>1</td> </tr> </tbody> </table> <p>11.3 NFPA Hazard Classification:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Classification</th> </tr> </thead> <tbody> <tr> <td>Health Hazard (Blue)</td> <td>2</td> </tr> <tr> <td>Flammability (Red)</td> <td>1</td> </tr> <tr> <td>Reactivity (Yellow)</td> <td>0</td> </tr> </tbody> </table>		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	Category	Classification	Health Hazard (Blue)	2	Flammability (Red)	1	Reactivity (Yellow)	0
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<p><b>8. WATER POLLUTION</b></p> <p>8.1 Aquatic Toxicity: 980 mg/l/40 hr/daphnia/MS/ fresh water 8.2 Water-level Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: None</p>		<p><b>12. PHYSICAL AND CHEMICAL PROPERTIES</b></p> <p>12.1 Physical State at 18°C and 1 atm: Liquid 12.2 Molecular Weight: 131.39 12.3 Boiling Point at 1 atm: 188°F = 87°C = 360°K 12.4 Freezing Point: -123.5°F = -88.4°C = 188.8°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: 109 Btu/lb = 57.2 cal/g = <math>2.4 \times 10^4</math> 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</p>																																					
<p><b>9. SHIPPING INFORMATION</b></p> <p>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</p>		<p><b>NOTES</b></p>																																					

TCL

## TRICHLOROETHYLENE

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
0	94.669	0	.220		N	15	.800
5	94.410	10	.221		O	20	.775
10	94.150	20	.223		T	25	.750
15	93.889	30	.225			30	.727
20	93.629	40	.226		P	35	.705
25	93.370	50	.228		E	40	.684
30	93.110	60	.230		R	45	.664
35	92.849	70	.231		T	50	.645
40	92.589	80	.233		I	55	.627
45	92.330	90	.235		N	60	.610
50	92.070	100	.236		E	65	.593
55	91.809	110	.238		N	70	.577
60	91.549	120	.240		T	75	.562
65	91.290	130	.241			80	.548
70	91.030	140	.243			85	.534
75	90.770	150	.245			90	.521
80	90.509	160	.246			95	.508
85	90.250	170	.248			100	.496
90	89.990					105	.485
95	89.730					110	.474
100	89.469					115	.463
105	89.209					120	.453
110	88.950						
115	88.690						
120	88.429						
125	88.169						

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	.110	40	.508	40	.01245	0	.136
		50	.678	50	.01628	25	.139
		60	.894	60	.02105	50	.143
		70	1.166	70	.02695	75	.146
		80	1.507	80	.03418	100	.149
		90	1.929	90	.04296	125	.152
		100	2.448	100	.05354	150	.155
		110	3.081	110	.06619	175	.157
		120	3.848	120	.08120	200	.160
		130	4.765	130	.09891	225	.162
		140	5.862	140	.11960	250	.165
		150	7.163	150	.14380	275	.167
		160	8.695	160	.17180	300	.169
		170	10.490	170	.20390	325	.172
		180	12.580	180	.24080	350	.174
		190	15.010	190	.28260	375	.176
		200	17.810	200	.33040	400	.177
		210	21.020	210	.38420	425	.179
						450	.181
						475	.182
						500	.184
						525	.185
						550	.186
						575	.187
						600	.188

DATE 2/20/90

MATERIAL SAFETY DATA SHEET

PAGE 1

SECTION I - GENERAL INFORMATION

(REORDER PRODUCT BY THIS NO.)

CATALOG NO 48565  
PRODUCT NAME CHRYSENE 0.1G  
DATA SHEET NO R430760

CHEMICAL NAME CHRYSENE

FORMULA C18H12

FORMULA WEIGHT 228

CAS 218-01-9 NRTECS GC0700000

SYNONYM CHRYSENE

MANUFACTURER SUPELCO INC. PHONE 814-359-3441

ADDRESS SUPELCO PARK, BELLEFONTE, PA 16823-0048

SECTION II - HAZARDOUS INGREDIENTS OF MIXTURES

CHEMICAL NAME

COMMON NAME - PERCENTAGE - CAS #  
(FORMULA) - PEL(UNITS) - TLV(UNITS)  
LD50 VALUE - CONDITIONS

N/A

SECTION III - PHYSICAL DATA

BOILING POINT 448

C MM MELTING POINT 254 C

VAPOR PRESSURE N/A

VAPOR DENSITY N/A

SPECIFIC GRAVITY N/A

PERCENT VOLATILE BY VOLUME N/A

WATER SOLUBILITY N/A

EVAPORATION RATE N/A

APPEARANCE WHITE SOLID

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT N/A

FLAMMABLE LIMITS LEL N/A UEL N

EXTINGUISHING MEDIA

WATER

CO2

DRY CHEMICAL

ALCOHOL FOAM.

SPECIAL FIRE FIGHTING PROCEDURES

WEAR SELF CONTAINED BREATHING APPARATUS WHEN FIGHTING A CHEMICAL FIRE.

UNUSUAL FIRE AND EXPLOSION HAZARDS

N/A

SECTION V - HEALTH HAZARD DATA

LD50 N/A

TLV N/A

PEL N/A

EMERGENCY AND FIRST AID PROCEDURES

EYES

RUSH EYES WITH WATER FOR 15 MINUTES.

2/20/90

MATERIAL SAFETY DATA SHEET

PAGE 2

CATALOG NO 48565 (REORDER PRODUCT BY THIS NO.)  
PRODUCT NAME CHRYSENE 0.1G  
DATA SHEET NO R430760  
CHRYSENE

SECTION V - HEALTH HAZARD DATA

\* CONTINUED \*

SKIN  
PROMPTLY WASH SKIN WITH MILD SOAP AND LARGE VOLUMES OF WATER.  
REMOVE CONTAMINATED CLOTHING.

INHALATION  
IMMEDIATELY MOVE TO FRESH AIR.

INGESTION  
N/A

EFFECTS OF OVEREXPOSURE

REPORTED ANIMAL CARCINOGEN.

SECTION VI - REACTIVITY DATA

STABILITY STABLE.

CONDITIONS TO AVOID

N/A

COMPATIBILITY

OXIDIZING AGENTS

DANGEROUS DECOMPOSITION PRODUCTS

N/A

DANGEROUS POLYMERIZATION WILL NOT OCCUR.

CONDITIONS TO AVOID

N/A

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

SWEEP UP MATERIAL.  
FLUSH AREA WITH WATER.

BEST DISPOSAL METHOD

COMPLY WITH ALL APPLICABLE FEDERAL, STATE, OR LOCAL REGULATIONS

2/20/90

MATERIAL SAFETY DATA SHEET

PAGE 3

CATALOG NO 48565

PRODUCT NAME CHRYSENE 0.1G

(REORDER PRODUCT BY THIS NO.)

DATA SHEET NO R430760

CHRYSENE

\* CONTINUED \*

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFIC TYPE)

N/A

PROTECTIVE GLOVES

WEAR RUBBER GLOVES.

EYE PROTECTION

WEAR PROTECTIVE GLASSES.

VENTILATION

USE ONLY IN EXHAUST HOOD.

SPECIAL

N/A

OTHER PROTECTIVE EQUIPMENT

N/A

SECTION IX - SPECIAL PRECAUTIONS

STORAGE AND HANDLING

STORE IN SEALED CONTAINER IN COOL, DRY LOCATION.

OTHER PRECAUTIONS

REPORTED CANCER HAZARD.

AVOID EYE OR SKIN CONTACT.

AVOID BREATHING VAPORS.

ALL THE INFORMATION AND RECOMMENDATIONS SET FORTH HEREIN ARE BELIEVED TO BE ACCURATE AS OF THE DATE HEREOF, SUPELCO, INC. MAKES NO WARRANTY WITH RESPECT THERETO AND DISCLAIMS ALL LIABILITY FROM RELIANCE THEREON.

LAST REVISED 12/28/89

# MERCURY

MCR

<b>Common Synonyms</b> Quicksilver		Liquid	Silver	Odorless
		Sinks in water.		
AVOID CONTACT WITH LIQUID. Keep people away. Stop discharge if possible. Soak and remove discharged material. Notify local health and pollution control agencies.				
<b>Fire</b>		Not flammable.		
<b>Exposure</b>		CALL FOR MEDICAL AID <b>LIQUID</b> Effects of exposure may be delayed.		
<b>Water Pollution</b>		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.		
<b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Handbook) Should be removed Chemical and physical treatment		<b>2. LABEL</b> 2.1 Category: None		
<b>3. CHEMICAL DESIGNATIONS</b> 3.1 CG Compatibility Class: Not listed 3.2 Formula: Hg 3.3 IMO/UN Designation: Not listed 3.4 DOT ID No.: 2808 3.5 CAS Registry No.: 7439-97-6		<b>4. OBSERVABLE CHARACTERISTICS</b> 4.1 Physical State (as shipped): Liquid 4.2 Color: Silvery 4.3 Odor: None		
<b>5. HEALTH HAZARDS</b> 5.1 Personal Protective Equipment: Avoid contact of liquid with skin. For vapor use chemical cartridge (Hopcalite) respirator. 5.2 Symptoms Following Exposure: No immediate symptoms. As poisoning becomes established, slight muscular tremor, loss of appetite, nausea, and diarrhea are observed. Psychic, kidney, and cardiovascular disturbances may occur. 5.3 Treatment of Exposure: Consult a doctor. 5.4 Threshold Limit Value: 0.05 mg/m <sup>3</sup> 5.5 Short Term Inhalation Limit: Data not available 5.6 Toxicity by Ingestion: No immediate toxicity 5.7 Late Toxicity: Development of mercury poisoning 5.8 Vapor (Gas) Irritant Characteristics: None 5.9 Liquid or Solid Irritant Characteristics: None 5.10 Odor Threshold: Not pertinent 5.11 IDLH Value: 26 mg/m <sup>3</sup>				

<b>6. FIRE HAZARDS</b> 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: Not flammable 6.7 Ignition Temperature: Not flammable 6.8 Electrical Hazards: 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		<b>10. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Handbook) A-X	
<b>7. CHEMICAL REACTIVITY</b> 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 (Resistant to Product): Data not available 7.8 Reactivity Group: Data not available		<b>11. HAZARD CLASSIFICATIONS</b> 11.1 Code of Federal Regulations: ORM-B 11.2 NAB Hazard Rating for Bulk Water Transportation: Not listed 11.3 NFPA Hazard Classification: Not listed	
<b>8. WATER POLLUTION</b> 8.1 Aquatic Toxicity: 0.5-1 ppm/48 hr/caragus ardm/TL <sub>50</sub> /fresh water 0.29 ppm/48 hr/marine fish/TL <sub>50</sub> /salt water 8.2 Waterfowl Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): None 8.4 Food Chain Concentration Potential: Mercury concentrates in liver and kidneys of ducts and gills to levels above FDA limit of 0.5 ppm. Muscle tissue usually well below the limit.		<b>12. PHYSICAL AND CHEMICAL PROPERTIES</b> 12.1 Physical State at 15°C and 1 atm: Liquid 12.2 Molecular Weight: 200.59 12.3 Boiling Point at 1 atm: 675°F = 357°C = 630°K 12.4 Freezing Point: -38.0°F = -38.9°C = 234.3°K 12.5 Critical Temperature: 2084°F = 1462°C = 1736°K 12.6 Critical Pressure: 23,300 psia = 1567 atm = 160.8 MN/m <sup>2</sup> 12.7 Specific Gravity: 13.55 at 20°C (liquid) 12.8 Liquid Surface Tension: 470 dynes/cm = 0.470 N/m at 20°C 12.9 Liquid Water Interfacial Tension: 375 dynes/cm = 0.375 N/m at 20°C 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Heat 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: 2.7 cal/g 12.26 Limiting Value: Data not available 12.27 Reid Vapor Pressure: Data not available	
<b>9. SHIPPING INFORMATION</b> 9.1 Grades of Purity: Pure 9.2 Storage Temperature: Ambient 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open		<b>NOTES</b>	

MCR

## MERCURY

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
0	851.399	35	.033		N O T  P E R T I N E N T	0	1.827
5	851.000	40	.033			5	1.801
10	850.500	45	.033			10	1.777
15	850.099	50	.033			15	1.754
20	849.699	55	.033			20	1.731
25	849.199	60	.033			25	1.709
30	848.799	65	.033			30	1.688
35	848.399	70	.033			35	1.668
40	847.899	75	.033			40	1.648
45	847.500	80	.033			45	1.629
50	847.099	85	.033		50	1.610	
55	846.599	90	.033		55	1.592	
60	846.199	95	.033		60	1.575	
65	845.799	100	.033		65	1.558	
70	845.299				70	1.541	
75	844.899				75	1.525	
80	844.500				80	1.510	
85	844.000				85	1.495	
90	843.599				90	1.480	
95	843.199				95	1.466	
100	842.699				100	1.452	

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
	I N S O L U B L E		N O T  P E R T I N E N T		N O T  P E R T I N E N T		N O T  P E R T I N E N T

**CERTIFIED SPECIFICATIONS and  
MATERIAL SAFETY DATA SHEET**

07/18/89

Last revised June 1989

**SECTION I      PRODUCT SPECIFICATIONS**

Chemical No. 0-785      Fluoranthene

Product No. 206-44-0

Supplied by CHEM SERVICE, Inc. PO BOX 5100, WEST CHESTER, PA. 19381 (215)692-3026  
TELEPHONE: (215)336-2100

Lot No. 1990C      Purity 99.8%      Certified by ZR  
This is to certify that analysis of this sample was made by various chromatographic, spectral and  
chemical methods. The procedures used are considered to be STATE OF THE ART. CHEM SERVICE, Inc.  
warrants purity of unopened bottles until expiration on the bottle.

**SECTION II      TOXICITY DATA**

RAT OR MOUSE LD50	RTECSII	OSHA PEL	ACGIH TLV
2000mg/kg	LL4625000	NA	NA

This compound is considered to be slightly toxic.

**SECTION III      PHYSICAL DATA**

MELTING POINT	BOILING POINT	DENSITY	VAPOR PRESSURE	VAPOR DENSITY	EVAPORATION RATE (Butyl acetate=1)
110 C	304 C	NA	NA	NA	NA
ODOR	COLOR	PHASE		SOLUBILITY IN WATER	
NA	Yellow-green	Crystalline solid		Insoluble (immiscible)	

**SECTION IV      FIRE AND EXPLOSION HAZARD DATA**

Flash Point: Data not available

Extinguishing Media: Carbon dioxide, dry chemical powder or spray.

Explosion limits are available for this compound.

**SECTION V      HEALTH HAZARD DATA**

Contact lenses should not be worn in the laboratory.

Chemicals should be considered hazardous - Avoid direct physical contact!

May cause skin irritation. Can cause eye irritation. Can be harmful if absorbed through the skin.

May be harmful if swallowed. Can be harmful if inhaled. Can be irritating to mucous membranes.

Expected Carcinogen-may produce cancer.

Prolonged exposure may cause nausea/headache/dizziness and/or eye damage.

## SECTION VI FIRST AID

Antidote is a substance intended to counteract the effect of a poison. It should be administered only by a physician or a trained emergency personnel. Medical advice can be obtained from a POISON CONTROL CENTER.

In case of contact: Flush eyes continuously with water for 15-20 minutes. Flush skin with water for 5 minutes. If no burns have occurred-use soap and water to cleanse skin. If inhaled remove patient to fresh air. Administer oxygen if patient is having difficulty breathing. If patient has stopped breathing administer artificial respirations. If patient is in cardiac arrest administer CPR. Continue life supporting measures until medical assistance has arrived.

## SECTION VII REACTIVITY DATA

Stable. Incompatible with strong oxidizing agents. Decomposition liberates toxic fumes. Decomposition products are corrosive.

## SECTION VIII SPILL OR LEAK PROCEDURES

In case of spill or leak: Evacuate area. Wear appropriate OSHA regulated equipment. Ventilate area. Pick up and place in an appropriate container. Hold for disposal. Decontaminate surfaces to remove any residues.

OSAL: Burn in a chemical incinerator equipped with an afterburner and scrubber.

## SECTION IX PRECAUTIONS TO BE TAKEN IN HANDLING

Chemical should be handled only in a hood. Eye shields should be worn. Use appropriate OSHA/MSHA approved safety equipment. Avoid contact with skin, eyes and clothing. Keep tightly sealed in a cool dry place. Store only with compatible chemicals.

## SECTION X SPECIAL PRECAUTIONS AND COMMENTS

The above information is believed to be correct on the date it is published and must not be considered all inclusive. The information has been obtained only by a search of available literature and is only a guide for handling the chemicals. OSHA regulations require that if other hazards are evident, an updated MSDS must be made available to the employee within three months. Responsibility for updates lies with the employer and not with CHEM SERVICE, Inc. Persons not specially and properly trained should not handle this chemical or its container. This MSDS is provided without any warranty expressed or implied, including merchantability or fitness for any particular purpose.

This product is furnished FOR LABORATORY USE ONLY! Our products may NOT BE USED as drugs, cosmetics, agricultural or pesticidal products, food additives or as household chemicals.

**CERTIFIED SPECIFICATIONS and  
MATERIAL SAFETY DATA SHEET**

97/18/89

1991 revised June 1989

**SECTION I PRODUCT SPECIFICATIONS**

Chemical No. **F83**  
CAS No. **193-39-5**  
Other name: **2,3-Phenylene pyrene**  
Supplied by **CHEM SERVICE, Inc. PO BOX 3100, WEST CHESTER, PA, 19381 (215)692-3026**  
Emergency Phone No: **215-386-2100**

No. 33-1314 Purity 99.5% Certified by   
This is to certify that analysis of this sample was made by various chromatographic, spectral and chemical methods. The procedures used are considered to be STATE OF THE ART. CHEM SERVICE, Inc. guarantees purity of unopened bottles until expiration on the bottle.

**SECTION II TOXICITY DATA**

RAT OR MOUSE LD50	RTECSH	OSHA PEL	ACGIH TLV
72mg/kg	NK9300000	NA	NA

This compound is considered to be toxic.

**SECTION III PHYSICAL DATA**

MELTING POINT	BOILING POINT	DENSITY	VAPOR PRESSURE	VAPOR DENSITY	EVAPORATION RATE (Butyl acetate=)
12-164 C	>300 C	NA	<0.1 mm@40 C	NA	NA
ODOR	COLOR	PHASE		SOLUBILITY IN WATER	
NA	Yellow	Crystalline solid		Insoluble (immiscible)	

**SECTION IV FIRE AND EXPLOSION HAZARD DATA**

Flash Point: **200+ C**  
Extinguishing Media: **Carbon dioxide, dry chemical powder or spray.**  
Explosion limits are available for this compound.

**SECTION V HEALTH HAZARD DATA**

Contact lenses should not be worn in the laboratory.  
All chemicals should be considered hazardous - Avoid direct physical contact!  
Suspected Carcinogen-may produce cancer. Overall toxic data unavailable.  
Based on the toxicity of compounds of similar structure this material is probably highly hazardous.

## SECTION VI FIRST AID

antidote is a substance intended to counteract the effect of a poison. It should be administered by a physician or a trained emergency personnel. Medical advice can be obtained from a POISON CONTROL CENTER.

In case of contact: Flush eyes continuously with water for 15-20 minutes. Flush skin with water for 20 minutes. If no burns have occurred—use soap and water to cleanse skin. If inhaled remove patient to fresh air. Administer oxygen if patient is having difficulty breathing. If patient has stopped breathing administer artificial respirations. If patient is in cardiac arrest administer CPR. Continue life supporting measures until medical assistance has arrived. Remove and wash contaminated clothing. If patient is exhibiting signs of shock - Keep warm and quiet. Contact Poison Control Center immediately if necessary. Do not administer liquids or induce vomiting to an unconscious or convulsing person. If patient is vomiting—watch closely to make sure airway does not become obstructed by vomit. Seek medical attention if necessary.

## SECTION VII REACTIVITY DATA

Reactivity. Incompatible with strong oxidizing agents. Flammable. Incompatible with active metals (e.g. Sodium).

## SECTION VIII SPILL OR LEAK PROCEDURES

In spills or leaks: Evacuate area. Wear appropriate OSHA regulated equipment. Ventilate area. Pick up and place in an appropriate container. Hold for disposal. Clean contaminated surfaces to remove any residues. DISPOSAL: Burn in a chemical incinerator equipped with an afterburner and scrubber.

## SECTION IX PRECAUTIONS TO BE TAKEN IN HANDLING

This chemical should be handled only in a hood. Eye shields should be worn. Use appropriate A/MSHA approved safety equipment. Avoid contact with skin, eyes and clothing. Keep tightly sealed in a cool dry place. Store only with compatible chemicals.

## SECTION X SPECIAL PRECAUTIONS AND COMMENTS

The above information is believed to be correct on the date it is published and must not be considered all inclusive. The information has been obtained only by a search of available literature. This is only a guide for handling the chemicals. OSHA regulations require that if other hazards become evident, an upgraded MSDS must be made available to the employee within three months. Responsibility for updates lies with the employer and not with CHEM SERVICE, Inc. Persons not specifically and properly trained should not handle this chemical or its container. This MSDS is provided without any warranty expressed or implied, including merchantability or fitness for any particular purpose.

This product is furnished FOR LABORATORY USE ONLY! Our products may NOT BE USED as drugs, cosmetics, agricultural or pesticidal products, food additives or as household chemicals.



# J. T. Baker Chemical Co.

222 Red School Lane Phillipsburg, N.J. 08865  
24-Hour Emergency Telephone - (201) 859-2151

Chemtrec # (800) 424-9300  
National Response Center # (800) 424-8802

**MATERIAL  
SAFETY DATA  
SHEET**

N0090 -01

Naphthalene

Page: 2

Effective: 10/28/85

Issued: 10/29/85

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**SECTION III. - PHYSICAL DATA (Continued)**  
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Specific Gravity: 1.14  
(H<sub>2</sub>O=1)

Evaporation Rate: N/A  
(Butyl Acetate=1)

Solubility(H<sub>2</sub>O): Negligible (less than 0.1 %) % Volatiles by Volume: N/A

Appearance & Odor: White crystalline volatile solid with the odor of moth balls  
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**SECTION IV - FIRE AND EXPLOSION HAZARD DATA**  
-----

Flash Point: 88°C ( 190°F) NFPA 704M Rating: 2-2-0

Flammable Limits: Upper - 5.9 % Lower - 0.9 %

Fire Extinguishing Media

Use water spray, carbon dioxide, dry chemical or ordinary foam.

Special Fire-Fighting Procedures

Firefighters should wear proper protective equipment and self-contained (positive pressure if available) breathing apparatus with full facepiece. Move exposed containers from fire area if it can be done without risk. Use water to keep fire-exposed containers cool.

Unusual Fire & Explosion Hazards

Closed containers exposed to heat may explode.  
Contact with strong oxidizers may cause fire or explosion.  
-----

-----  
**SECTION V - HEALTH HAZARD DATA**  
-----

Threshold Limit Value (TLV/TWA): 50 mg/m<sup>3</sup> (10 ppm)

Short-Term Exposure Limit (STEL): 75 mg/m<sup>3</sup> (15 ppm)

Toxicity: LD<sub>50</sub> (oral-rat)(mg/kg) - 1780

LD<sub>50</sub> (scu-mouse)(mg/kg) - 969

LD<sub>50</sub> (iv-mouse)(mg/kg) - 100

Effects of Overexposure

Contact with skin or eyes may cause irritation.  
Ingestion may cause nausea, vomiting, headaches, dizziness, gastrointestinal irritation.



# J. T. Baker Chemical Co.

222 Red School Lane Phillipsburg, N.J. 08865  
24-Hour Emergency Telephone - (201) 859-2151

Chemtrec # (800) 424-9300  
National Response Center # (800) 424-8802

## MATERIAL SAFETY DATA SHEET

N0090 -01

Naphthalene

Effective: 10/28/85

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Issued: 10/29/85

### SECTION VI - REACTIVITY DATA

Stability: Stable

Hazardous Polymerization: Will not occur

Conditions to Avoid: heat, flame, sources of ignition

Incompatibles: strong oxidizing agents

### SECTION VII - SPILL AND DISPOSAL PROCEDURES

#### Steps to be taken in the event of a spill or discharge

Wear suitable protective clothing. Shut off ignition sources; no flares, smoking, or flames in area. With clean shovel, carefully place material into clean, dry container and cover; remove from area. Flush spill area with water.

#### Disposal Procedure

Dispose in accordance with all applicable federal, state, and local environmental regulations.

EPA Hazardous Waste Number: U165 (Toxic Waste)

### SECTION VIII - INDUSTRIAL PROTECTIVE EQUIPMENT

Ventilation: Use general or local exhaust ventilation to meet TLV requirements.

Respiratory Protection: Respiratory protection required if airborne concentration exceeds TLV. At concentrations up to 500 ppm, a chemical cartridge respirator with organic vapor cartridge is recommended. Above this level, a self-contained breathing apparatus is recommended.

Eye/Skin Protection: Safety glasses with sideshields, rubber gloves are recommended.

### SECTION IX - STORAGE AND HANDLING PRECAUTIONS

SAF-T-DATA™ Storage Color Code: Red

#### Special Precautions

Keep container tightly closed. Store in cool, dry, well-ventilated area away from heat, sparks, or flame.

### SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

#### DOMESTIC (D.O.T.)

Proper Shipping Name Naphthalene (air and water only)



# J. T. Baker Chemical Co.

222 Red School Lane Phillipsburg, N.J. 08865  
24-Hour Emergency Telephone -- (201) 859-2151

Chemtrec # (800) 424-9300  
National Response Center # (800) 424-8802

**MATERIAL  
SAFETY DATA  
SHEET**

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Naphthalene

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SECTION X - TRANSPORTATION DATA AND ADDITIONAL INFORMATION (Continued)  
-----

Hazard Class           ORM-A  
N/NA                   UN1334  
Labels                 NONE  
Reportable Quantity   5000 LBS.

INTERNATIONAL (I.M.O.)

Proper Shipping Name   Naphthalene, crude or refined  
Hazard Class           4.1  
N/NA                   UN1334  
Labels                 FLAMMABLE SOLID

-----  
NA = Not Applicable or Not Available  
-----

The information published in this Material Safety Data Sheet has been compiled from our experience and data presented in various technical publications. It is the user's responsibility to determine the suitability of this information for the adoption of necessary safety precautions. We reserve the right to revise Material Safety Data Sheets periodically as new information becomes available.

**CERTIFIED SPECIFICATIONS and  
MATERIAL SAFETY DATA SHEET**

87/12/89

Last revised June 1989

**SECTION I      PRODUCT SPECIFICATIONS**

1. 0-795      Phenanthrene  
2. 85-91-9

Supplied by CHEM SERVICE, Inc. PO BOX 3100, WEST CHESTER, PA. 19381 (215)692-3026  
EMERGENCY PHONE #: 215-386-3100

Lot No. 33-117B Purity 99.5% Certified by SP  
This is to certify that analysis of this sample was made by various chromatographic, spectral and  
elemental methods. The procedures used are considered to be STATE OF THE ART. CHEM SERVICE, Inc.  
warrants purity of unopened bottles until expiration on the bottle.

**SECTION II      TOXICITY DATA**

RAT OR MOUSE LD50	RTECSH	OSHA PEL	ACGIH TLV
780mg/kg	9F7175000	NA	NA

This compound is considered to be slightly toxic.

**SECTION III      PHYSICAL DATA**

MELTING POINT	BOILING POINT	DENSITY	VAPOR PRESSURE	VAPOR DENSITY	EVAPORATION RATE (Butyl acetate)
101 C	148 C	NA	NA	NA	NA
ODOR	COLOR	PHASE		SOLUBILITY IN WATER	
NA g	White	Crystalline solid			

**SECTION IV      FIRE AND EXPLOSION HAZARD DATA**

FLASH POINT: Data not available  
EXTINGUISHING MEDIA: Carbon dioxide, dry chemical powder or spray.  
Explosion limits are available for this compound.

**SECTION V      HEALTH HAZARD DATA**

Contact lenses should not be worn in the laboratory.  
All chemicals should be considered hazardous - Avoid direct physical contact!  
Can cause skin irritation. Can be irritating to mucous membranes. Can cause eye irritation.  
Can be harmful if absorbed through the skin. Can be harmful if inhaled.  
Can be harmful if swallowed. Suspected Carcinogen-may produce cancer.  
Prolonged exposure may cause nausea/headache/dizziness and/or eye damage.

## SECTION VI FIRST AID

Antidote is a substance intended to counteract the effect of a poison. It should be administered by a physician or a trained emergency personnel. Medical advice can be obtained from a POISON CONTROL CENTER.

In case of contact: Flush eyes continuously with water for 15-20 minutes. Flush skin with water for 15-20 minutes. If no burns have occurred-use soap and water to cleanse skin. Inhalation: Immediately remove patient to fresh air. Administer oxygen if patient is having difficulty breathing. If patient has stopped breathing administer artificial respirations. If patient is in cardiac arrest administer CPR. Continue life supporting measures until medical assistance has arrived.

## SECTION VII REACTIVITY DATA

Flammable. Incompatible with strong oxidizing agents. Decomposition liberates toxic fumes. Decomposition products are corrosive.

## SECTION VIII SPILL OR LEAK PROCEDURES

Spills or leaks: Evacuate Area. Wear appropriate OSHA regulated equipment. Ventilate area. Pick up and place in an appropriate container. Hold for disposal. Contaminated surfaces to remove any residues.

DISPOSAL: Burn in a chemical incinerator equipped with an afterburner and scrubber.

## SECTION IX PRECAUTIONS TO BE TAKEN IN HANDLING

This chemical should be handled only in a hood. Eye shields should be worn. Use appropriate OSHA/MSHA approved safety equipment. Avoid contact with skin, eyes and clothing. Keep tightly sealed in a cool dry place. Store only with compatible chemicals.

## SECTION X SPECIAL PRECAUTIONS AND COMMENTS

The above information is believed to be correct on the date it is published and must not be considered all inclusive. The information has been obtained only by a search of available literature and is only a guide for handling the chemicals. OSHA regulations require that if other hazards become evident, an upgraded MSDS must be made available to the employee within three months. Responsibility for updates lies with the employer and not with CHEM SERVICE, Inc. Persons not specifically and properly trained should not handle this chemical or its container. This MSDS is provided without any warranty expressed or implied, including merchantability or fitness for any particular purpose.

This product is furnished FOR LABORATORY USE ONLY! Our products may NOT BE USED as drugs, cosmetics, agricultural or pesticidal products, food additives or as household chemicals.

DATE 6/06/89 MATERIAL SAFETY DATA SHEET PAGE 1

SECTION I - GENERAL INFORMATION  
(REORDER PRODUCT BY THIS NO.)

CATALOG NO N/A  
PRODUCT NAME FLUORENE 5G  
DATA SHEET NO R430800  
FLUORENE  
CHEMICAL NAME 9H-FLUORENE  
FORMULA C13H10 FORMULA WEIGHT 166  
CAS 86-73-7 NRTECS LL5670000  
SYNONYM FLUORENE  
MANUFACTURER SUPELCO INC. PHONE 814-359-3441  
ADDRESS SUPELCO PARK, BELLEFONTE, PA 16823-0048

SECTION II - HAZARDOUS INGREDIENTS OF MIXTURES

CHEMICAL NAME  
COMMON NAME - PERCENTAGE - CAS #  
(FORMULA) - TLV(UNITS)  
LD50 VALUE - CONDITIONS

N/A

SECTION III - PHYSICAL DATA

BOILING POINT 298 C MM MELTING POINT 112 C  
VAPOR PRESSURE N/A VAPOR DENSITY N/A  
SPECIFIC GRAVITY N/A PERCENT VOLATILE BY VOLUME N/A  
WATER SOLUBILITY N/A EVAPORATION RATE N/A  
APPEARANCE WHITE SOLID

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT N/A FLAMMABLE LIMITS LEL UEL

EXTINGUISHING MEDIA

WATER  
CO2  
DRY CHEMICAL  
ALCOHOL FOAM.

SPECIAL FIRE FIGHTING PROCEDURES

WEAR SELF CONTAINED BREATHING APPARATUS WHEN FIGHTING A CHEMICAL FIRE.

UNUSUAL FIRE AND EXPLOSION HAZARDS

N/A

SECTION V - HEALTH HAZARD DATA

LD50 N/A TLV N/A

EMERGENCY AND FIRST AID PROCEDURES

EYES  
FLUSH EYES WITH WATER FOR 15 MINUTES.

SKIN

PROMPTLY WASH SKIN WITH MILD SOAP AND LARGE VOLUMES OF WATER.

DATE 6/06/89

MATERIAL SAFETY DATA SHEET

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(REORDER PRODUCT BY THIS NO.)

CATALOG NO N/A  
PRODUCT NAME FLUORENE SG  
DATA SHEET NO R430800  
FLUORENE

SECTION VII - SPILL OR LEAK PROCEDURES

\* CONTINUED \*  
AVOID GENERATING DUST.  
FLUSH AREA WITH WATER.

WASTE DISPOSAL METHOD

COMPLY WITH ALL APPLICABLE FEDERAL, STATE, OR LOCAL REGULATIONS

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFIC TYPE)

WEAR NIOSH/OSHA APPROVED RESPIRATORY PROTECTION.

PROTECTIVE GLOVES

WEAR RUBBER GLOVES.

EYE PROTECTION

WEAR PROTECTIVE GLASSES.

VENTILATION

USE ONLY IN WELL VENTILATED AREA.

SPECIAL

N/A

OTHER PROTECTIVE EQUIPMENT

N/A

SECTION IX - SPECIAL PRECAUTIONS

STORAGE AND HANDLING

STORE IN SEALED CONTAINER IN COOL, DRY LOCATION.

OTHER PRECAUTIONS

POSSIBLE CANCER HAZARD.  
- AVOID EYE OR SKIN CONTACT.  
LUSI

MATERIAL SAFETY DATA SHEET

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FLUORENE 5G  
R430800  
FLUORENE

SECTION V - HEALTH HAZARD DATA

MOVE TO FRESH AIR.  
IF BREATHING IS LABORED  
STOP, GIVE ARTIFICIAL RESPIRATION  
BY PHYSICIAN

SHOULD BE  
RESPECTED

DO NOT BREATH VAPOR TO AN UNCONSCIOUS PERSON  
DO NOT MAKE AN UNCONSCIOUS PERSON VOMIT  
BY PHYSICIAN.

EXPOSURE

IF EYES AND/OR SKIN  
CONTACTED, WASH WITH WATER  
IF SWALLOWED  
TOXICITY - INDEFINITE IN ANIMALS.

SECTION VI - REACTIVITY DATA

UNSTABLE.

AVOID

BY

CONTAINMENTS

COMPOSITION PRODUCTS

POLYMERIZATION WILL NOT OCCUR.

AVOID

SECTION VII - SPILL OR LEAK PROCEDURES

TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED  
CONTAINMENT OF MATERIAL.

## CHROMIUM

### Summary

Chromium is a heavy metal that generally exists, in either a trivalent or hexavalent oxidation state. Hexavalent chromium (Cr VI) is rather soluble and is quite mobile in groundwater and surface water. However, in the presence of reducing agents it is rapidly converted to trivalent chromium (Cr III), which is strongly adsorbed to soil components and consequently is much less mobile. A number of salts of hexavalent chromium are carcinogenic in rats. In addition, an increased incidence of lung cancer was seen in workers occupationally exposed to chromium VI. Hexavalent chromium also causes kidney damage in animals and humans. Trivalent chromium is less toxic than hexavalent chromium; its main effect is contact dermatitis in sensitive individuals.

CAS Number: 7440-47-3

Chemical Formula: Cr

IUPAC Name: Chromium

### Chemical and Physical Properties (Metal)

Atomic Weight: 51.996

Boiling Point: 2672°C

Melting Point: 1857 ± 20°C

Specific Gravity: 7.20 at 28°C

Solubility in Water: Insoluble; some compounds are soluble

### Transport and Fate

Hexavalent Cr is quite soluble, existing in solution as a component of a complex anion. It is not sorbed to any significant degree by clays or hydrous metal oxides. The anionic form varies according to pH and may be a chromate, hydrochromate, or dichromate. Because all anionic forms are so soluble, they are quite mobile in the aquatic environment. Cr VI is efficiently

removed by activated carbon and thus may have some affinity for organic materials in natural water. Cr VI is a moderately strong oxidizing agent and reacts with reducing materials to form trivalent chromium. Most Cr III in the aquatic environment is hydrolyzed and precipitates as chromium hydroxide. Sorption to sediments and bioaccumulation will remove much of the remaining Cr III from solution. Cr III is adsorbed only weakly to inorganic materials. Cr III and Cr VI are readily interconvertible in nature depending on microenvironmental conditions such as pH, hardness, and the types of other compounds present. Soluble forms of chromium accumulate if ambient conditions favor Cr VI. Conditions favorable for conversion to Cr III lead to precipitation and adsorption of chromium in sediments.

In air, chromium is associated almost entirely with particulate matter. Sources of chromium in air include windblown soil and particulate emissions from industrial processes. Little information is available concerning the relative amounts of Cr III and Cr VI in various aerosols. Relatively small particles can form stable aerosols and can be transported many miles before settling out.

Cr III tends to be adsorbed strongly onto clay particles and organic particulate matter, but can be mobilized if it is complexed with organic molecules. Cr III present in minerals is mobilized to different extents depending on the weatherability and solubility of the mineral in which it is contained. Hexavalent compounds are not strongly adsorbed by soil components and Cr VI is mobile in groundwater. Cr VI is quickly reduced to Cr III in poorly drained soils having a high content of organic matter. Cr VI of natural origin is rarely found in soils.

### Health Effects

The hexavalent form of chromium is of major toxicological importance in higher organisms. A variety of chromate (Cr VI) salts are carcinogenic in rats and an excess of lung cancer has been observed among workers in the chromate-producing industry. Cr VI compounds can cause DNA and chromosome damage in animals and humans, and Cr (VI) trioxide is teratogenic in the hamster. Inhalation of hexavalent chromium salts causes irritation and inflammation of the nasal mucosa, and ulceration and perforation of the nasal septum. Cr VI also produces kidney damage in animals and humans. The liver is also sensitive to the toxic effects of hexavalent Cr, but apparently less so than the kidneys or respiratory system. Cr III is less toxic than Cr VI; its main effect in humans is a form of contact dermatitis in sensitive individuals.

## Toxicity to Wildlife and Domestic Animals

Chromium is an essential nutrient and is accumulated in a variety of aquatic and marine biota, especially benthic organisms, to levels much higher than in ambient water. Levels in biota, however, usually are lower than levels in the sediments. Passage of chromium through the food chain can be demonstrated. The food chain appears to be a more efficient pathway for chromium uptake than direct uptake from seawater.

Water hardness, temperature, dissolved oxygen, species, and age of the test organism all modify the toxic effects of chromium on aquatic life. Cr III appears to be more acutely toxic to fish than Cr VI; the reverse is true in long term chronic exposure studies.

None of the plants normally used as food or animal feed are chromium accumulators. Chromium absorbed by plants tends to remain primarily in the roots and is poorly translocated to the leaves. There is little tendency for chromium to accumulate along food chains in the trivalent inorganic form. Organic chromium compounds, about which little is known, can have significantly different bioaccumulation tendencies. Little information concerning the toxic effects of chromium on mammalian wildlife and domestic animal species is available.

## Regulations and Standards

### Ambient Water Quality Criteria (USEPA):

Cr VI:

#### Aquatic Life (Proposed Criteria)

##### Freshwater

Acute toxicity: 11 µg/liter  
Chronic toxicity: 7.2 µg/liter

##### Saltwater

Acute toxicity: 1,200 µg/liter  
Chronic toxicity: 54 µg/liter

#### Human Health

Criterion: 50 µg/liter

Cr III:

Aquatic Life (Proposed Criteria)

Freshwater

Acute toxicity:  $e^{(0.819[\ln(\text{hardness})]+3.568)}$   $\mu\text{g/liter}$

Chronic toxicity:  $e^{(0.819 [\ln(\text{hardness})]+0.537)}$   $\mu\text{g/liter}$

Saltwater

The available data are not adequate for establishing criteria.

Human Health

Criterion: 170 mg/liter

CAG Unit Risk for inhalation exposure to CR VI (USEPA):  
41 (mg/kg/day)<sup>-1</sup>

National Interim Primary Drinking Water Standard: 50  $\mu\text{g/liter}$

NIOSH Recommended Standards for CR VI: 1  $\mu\text{g/m}^3$  carcinogenic  
25  $\mu\text{g/m}^3$  noncarcinogenic TWA  
50  $\mu\text{g/m}^3$  noncarcinogenic  
(15-min sample)

OSHA Standards: OSHA air standards have been set for several chromium compounds. Most recognized or suspected carcinogenic chromium compounds have ceiling limits of 100  $\mu\text{g/m}^3$ .

ACGIH Threshold Limit Values: Several chromium compounds have TWAs ranging from 0.05 to 0.5  $\text{mg/m}^3$ . Chromite ore processing (chromate), certain water insoluble Cr VI compounds, and chromates of lead and zinc are recognized or suspected human carcinogens and have 0.05  $\text{mg/m}^3$  TWAs.

REFERENCES

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH). 1980. Documentation of the Threshold Limit Values. 4th ed. Cincinnati, Ohio. 488 pages

INTERNATIONAL AGENCY FOR RESEARCH ON CANCER (IARC). 1980. IARC Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Vol. 23: Some Metals and Metallic Compounds. World Health Organization, Lyon, France

# LEAD

## Summary

Lead is a heavy metal that exists in one of three oxidation states, 0, +2, and +4. There is suggestive evidence that some lead salts are carcinogenic, inducing kidney tumors in mice and rats. Lead is also a reproductive hazard, and it can adversely affect the brain and central nervous system by causing encephalopathy and peripheral neuropathy. Chronic exposure to low levels of lead can cause subtle learning disabilities in children. Exposure to lead can also cause kidney damage and anemia, and it may have adverse effects on the immune system.

CAS Number: 7439-92-1

Chemical Formula: Pb

IUPAC Name: Lead

## Chemical and Physical Properties

Atomic Weight: 207.19

Boiling Point: 1,740°C

Melting Point: 327.502°C

Specific Gravity: 11.35 at 20°C

Solubility in Water: Insoluble; some organic compounds are soluble

Solubility in Organics: Soluble in HNO<sub>3</sub> and hot, concentrated H<sub>2</sub>SO<sub>4</sub>

## Transport and Fate

Some industrially produced lead compounds are readily soluble in water (USEPA 1979). However, metallic lead and the common lead minerals are insoluble in water. Natural compounds of lead are not usually mobile in normal surface or groundwater because the lead leached from ores is adsorbed by ferric hydroxide or combines with carbonate or sulfate ions to form insoluble compounds.

Movement of lead and its inorganic and organolead compounds as particulates in the atmosphere is a major environmental transport process. Lead carried in the atmosphere can be removed by either wet or dry deposition. Although little evidence is available concerning the photolysis of lead compounds in natural waters, photolysis in the atmosphere occurs readily. These atmospheric processes are important in determining the form of lead entering aquatic and terrestrial systems.

The transport of lead in the aquatic environment is influenced by the speciation of the ion. Lead exists mainly as the divalent cation in most unpolluted waters and becomes adsorbed into particulate phases. However, in polluted waters organic complexation is most important. Volatilization of lead compounds probably is not important in most aquatic environments.

Sorption processes appear to exert a dominant effect on the distribution of lead in the environment. Adsorption to inorganic solids, organic materials, and hydrous iron and manganese oxides usually controls the mobility of lead and results in a strong partitioning of lead to the bed sediments in aquatic systems. The sorption mechanism most important in a particular system varies with geological setting, pH, Eh, availability of ligands, dissolved and particulate ion concentrations, salinity, and chemical composition. The equilibrium solubility of lead with carbonate, sulfate, and sulfide is low. Over most of the normal pH range, lead carbonate, and lead sulfate control solubility of lead in aerobic conditions, and lead sulfide and the metal control solubility in anaerobic conditions. Lead is strongly complexed to organic materials present in aquatic systems and soil. Lead in soil is not easily taken up by plants, and therefore its availability to terrestrial organisms is somewhat limited.

Bioaccumulation of lead has been demonstrated for a variety of organisms, and bioconcentration factors are within the range of 100-1,000. Microcosm studies indicate that lead is not biomagnified through the food chain. Biomethylation of lead by microorganisms can remobilize lead to the environment. The ultimate sink of lead is probably the deep oceans.

### Health Effects

There is evidence that several lead salts are carcinogenic in mice or rats, causing tumors of the kidneys after either oral or parenteral administration. Data concerning the carcinogenicity of lead in humans are inconclusive. The available data are not sufficient to evaluate the carcinogenicity of organic lead compounds or metallic lead. There is equivocal evidence that exposure to lead causes genotoxicity in humans and animals. The available evidence indicates that lead presents

a hazard to reproduction and exerts a toxic effect on conception, pregnancy, and the fetus in humans and experimental animals (USEPA 1977, 1980).

Many lead compounds are sufficiently soluble in body fluids to be toxic (USEPA 1977, 1980). Exposure of humans or experimental animals to lead can result in toxic effects in the brain and central nervous system, the peripheral nervous system, the kidneys, and the hematopoietic system. Chronic exposure to inorganic lead by ingestion or inhalation can cause lead encephalopathy, and severe cases can result in permanent brain damage. Lead poisoning may cause peripheral neuropathy in adults and children, and permanent learning disabilities that are clinically undetectable in children may be caused by exposure to relatively low levels. Short-term exposure to lead can cause reversible kidney damage, but prolonged exposure at high concentrations may result in progressive kidney damage and possibly kidney failure. Anemia, due to inhibition of hemoglobin synthesis and a reduction in the life span of circulating red blood cells, is an early manifestation of lead poisoning. Several studies with experimental animals suggest that lead may interfere with various aspects of the immune response.

#### Toxicity to Wildlife and Domestic Animals

Freshwater vertebrates and invertebrates are more sensitive to lead in soft water than in hard water (USEPA 1980, 1983). At a hardness of about 50 mg/liter  $\text{CaCO}_3$ , the median effect concentrations for nine families range from 140  $\mu\text{g/liter}$  to 236,600  $\mu\text{g/liter}$ . Chronic values for Daphnia magna and the rainbow trout are 12.26 and 83.08  $\mu\text{g/liter}$ , respectively, at a hardness of about 50 mg/liter. Acute-chronic ratios calculated for three freshwater species ranged from 18 to 62. Bioconcentration factors, ranging from 42 for young brook trout to 1,700 for a snail, were reported. Freshwater algae show an inhibition of growth at concentrations above 500  $\mu\text{g/liter}$ .

Acute values for twelve saltwater species range from 476  $\mu\text{g/liter}$  for the common mussel to 27,000  $\mu\text{g/liter}$  for the soft-shell clam. Chronic exposure to lead causes adverse effects in mysid shrimp at 37  $\mu\text{g/liter}$ , but not at 17  $\mu\text{g/liter}$ . The acute-chronic ratio for this species is 118. Reported bioconcentration factors range from 17.5 for the Quahog clam to 2,570 for the blue mussel. Saltwater algae are adversely affected at approximate lead concentrations as low as 15.8  $\mu\text{g/liter}$ .

Although lead is known to occur in the tissue of many free-living wild animals, including birds, mammals, fishes, and invertebrates, reports of poisoning usually involve waterfowl. There is evidence that lead, at concentrations occasionally found near roadsides and smelters, can eliminate or reduce

populations of bacteria and fungi on leaf surfaces and in soil. Many of these microorganisms play key roles in the decomposer food chain.

Cases of lead poisoning have been reported for a variety of domestic animals, including cattle, horses, dogs, and cats. Several types of anthropogenic sources are cited as the source of lead in these reports. Because of their curiosity and their indiscriminate eating habits, cattle experience the greatest incidence of lead toxicity among domestic animals.

## Regulations and Standards

### Ambient Water Quality Criteria (USEPA):

#### Aquatic Life (Proposed Criteria)

The concentrations below are for active lead, which is defined as the lead that passes through a 0.45- $\mu$ m membrane filter after the sample is acidified to pH 4 with nitric acid.

#### Freshwater

Acute toxicity:  $e^{(1.34 [\ln(\text{hardness})] - 2.014)}$   $\mu$ g/liter

Chronic toxicity:  $e^{(1.34 [\ln(\text{hardness})] - 5.245)}$   $\mu$ g/liter

#### Saltwater

Acute toxicity: 220  $\mu$ g/liter

Chronic toxicity: 8.6  $\mu$ g/liter

#### Human Health

Criterion: 50  $\mu$ g/liter

Primary Drinking Water Standard: 50  $\mu$ g/liter

NIOSH Recommended Standard: 0.10 mg/m<sup>3</sup> TWA (inorganic lead)

OSHA Standard: 50  $\mu$ g/m<sup>3</sup> TWA

ACGIH Threshold Limit Values:

0.15 mg/m<sup>3</sup> TWA (inorganic dusts and fumes)

0.45 mg/m<sup>3</sup> STEL (inorganic dusts and fumes)

Lead

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## METHYLENE CHLORIDE

### Summary

Methylene chloride increased the incidence of lung and liver tumors and sarcomas in rats and mice. It was found to be mutagenic in bacterial test systems. In humans, methylene chloride irritates the eyes, mucous membranes, and skin. Exposure to high levels adversely affects the central and peripheral nervous systems and the heart. In experimental animals, methylene chloride is reported to cause kidney and liver damage, convulsions and paresis.

CAS Number: 75-09-2

Chemical Formula:  $\text{CH}_2\text{Cl}_2$

IUPAC Name: Dichloromethane

Important Synonyms and Trade Names: Methylene dichloride, methane dichloride

### Chemical and Physical Properties

Molecular Weight: 84.93

Boiling Point: 40°C

Melting Point: -95.1°C

Specific Gravity: 1.3266 at 20°C

Solubility in Water: 13,200-20,000 mg/liter at 25°C

Solubility in Organics: Miscible with alcohol and ether

Log Octanol/Water Partition Coefficient: 1.25

Vapor Pressure: 362.4 mm Hg at 20°C

Vapor Density: 2.93

### Transport and Fate

Volatilization to the atmosphere appears to be the major mechanism for removal of methylene chloride from aquatic systems

Methylene chloride  
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and its primary environmental transport process (USEPA 1979). Photooxidation in the troposphere appears to be the dominant environmental fate of methylene chloride. Once in the troposphere, the compound is attacked by hydroxyl radicals, resulting in the formation of carbon dioxide, and to a lesser extent, carbon monoxide and phosgene. Phosgene is readily hydrolyzed to HCl and CO<sub>2</sub>. About one percent of tropospheric methylene chloride would be expected to reach the stratosphere where it would probably undergo photodissociation resulting from interaction with high energy ultraviolet radiation. Aerial transport of methylene chloride is partly responsible for its relatively wide environmental distribution. Atmospheric methylene chloride may be returned to the earth in precipitation.

Photolysis, oxidation, and hydrolysis do not appear to be significant environmental fate processes for methylene chloride, and there is no evidence to suggest that either adsorption or bioaccumulation are important fate processes for this chemical. Although methylene chloride is potentially biodegradable, especially by acclimatized microorganisms, biodegradation probably only occurs at a very slow rate.

### Health Effects

Methylene chloride is currently under review by the National Toxicology Program (NTP 1984, USEPA 1985). Preliminary results indicate that it produced an increased incidence of lung and liver tumors in mice and mammary tumors in female and male rats. In a chronic inhalation study, male rats exhibited an increased incidence of sarcomas in the ventral neck region (Burek et al. 1984). However, the authors suggested that the relevance and toxicological significance of this finding were uncertain in light of available toxicity data. Methylene chloride is reported to be mutagenic in bacterial test systems. It also has produced positive results in the Fischer rat embryo cell transformation test. However, it has been suggested that the observed cell-transforming capability may have been due to impurities in the test material. There is no conclusive evidence that methylene chloride can produce teratogenic effects.

In humans, direct contact with methylene chloride produces eye, respiratory passage, and skin irritation (USEPA 1985). Mild poisonings due to inhalation exposure produce somnolence, lassitude, numbness and tingling of the limbs, anorexia, and lightheadedness, followed by rapid and complete recovery. More severe poisonings generally involve correspondingly greater disturbances of the central and peripheral nervous systems. Methylene chloride also has acute toxic effects on the heart, including the induction of arrhythmia. Fatalities reportedly

due to methylene chloride exposure have been attributed to cardiac injury and heart failure. Methylene chloride is metabolized to carbon monoxide in vivo, and levels of carboxyhemoglobin in the blood are elevated after acute exposures. In experimental animals, methylene chloride is reported to cause kidney and liver damage, convulsions, and distal paresis. An oral LD<sub>50</sub> value of 2,136 mg/kg, and an inhalation LC<sub>50</sub> value of 88,000 mg/m<sup>3</sup>/30 min are reported for the rat.

#### Toxicity to Wildlife and Domestic Animals

Very little information concerning the toxicity of methylene chloride to domestic animals and wildlife exists (USEPA 1980). Acute values for the freshwater species Daphnia magna, the fathead minnow, and the bluegill are 224,000, 193,000, and 224,000 µg/liter, respectively. Acute values for the saltwater species, mysid shrimp and sheepshead minnow, are 256,000 and 331,000 µg/liter, respectively. No data concerning chronic toxicity are available. The 96-hour EC<sub>50</sub> values for both freshwater and saltwater algae are greater than the highest test concentration, 662,000 µg/liter.

#### Regulations and Standards

Ambient Water Quality Criteria (USEPA):

##### Aquatic Life

The available data are not adequate for establishing criteria.

##### Human Health

Criterion: 12.4 mg/liter (for protection against the noncarcinogenic effects of methylene chloride)

CAG Unit Risk (USEPA):  $1.4 \times 10^{-2} (\text{mg/kg/day})^{-1}$

NIOSH Recommended Standards:

261 mg/m<sup>3</sup> TWA in the presence of no more than 9.9 mg/m<sup>3</sup> of CO  
1,737 mg/m<sup>3</sup> /15 min Peak Concentration

OSHA Standards: 1,737 mg/m<sup>3</sup> TWA  
3,474 mg/m<sup>3</sup> Ceiling Level  
6,948 mg/m<sup>3</sup> Peak Concentration (5 min in any 3 hr)

ACGIH Threshold Limit Values: 350 mg/m<sup>3</sup> TWA  
1,740 mg/m<sup>3</sup> STEL

Methylene chloride  
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# 1,3-DICHLOROPROPENE

DPU

Common Synonyms Dichloropropene Telone	Liquid Colorless Sweet odor
Sinks in water. Flammable, irritating vapor is produced.	

Avoid contact with liquid and vapor. Keep people away. Wear rubber overclothing (including gloves). Stop discharge if possible. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.

Fire	<b>FLAMMABLE</b> POISONOUS GASES ARE PRODUCED IN FIRE. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. WEAR GOGGLES AND SELF-CONTAINED BREATHING APPARATUS. Extinguish with water, dry chemical, foam, or carbon dioxide. Cool exposed containers with water.
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Exposure	CALL FOR MEDICAL AID. <b>VAPOR</b> Irritating to eyes, nose and throat. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. <b>LIQUID</b> 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 and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing, except keep victim warm.
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Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes. Notify local health and welfare 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 Oil Compatibility Class: Substituted ethyl 3.2 Formula: C <sub>3</sub> H <sub>4</sub> Cl <sub>2</sub> = CHCl 3.3 BQ/LN Designation: 3.3/3047 3.4 DOT ID No.: 2047 3.5 CAS Registry No.: 543-75-4	4. OBSERVABLE CHARACTERISTICS 4.1 Physical State (see shipping): Liquid 4.2 Color: Colorless 4.3 Odor: Sweet
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5. HEALTH HAZARDS	
5.1 Personal Protective Equipment: An approved full face mask equipped with a fresh black canister meeting specifications of the U.S. Bureau of Mines for organic vapors, a full face self-contained breathing apparatus, or full face air-supplied respirator.	
5.2 Symptoms Following Exposure: Swarming of skin and eyes. Prolonged contact of liquid with skin may cause second-degree burns.	
5.3 Treatment of Exposure: <b>INHALATION:</b> remove patient to fresh air, keep warm and quiet; call physician immediately; give artificial respiration if breathing has stopped. <b>INGESTION:</b> call physician immediately; induce vomiting by giving an emetic, e.g., 2 tablespoons table salt in glass of warm water. <b>CONTACT WITH SKIN OR EYES:</b> immediately remove contaminated clothing and shoes. Wash skin with soap and plenty of water. For eyes, flush immediately with plenty of water for at least 15 min. Call physician.	
5.4 Threshold Limit Value: 1 ppm	
5.5 Short Term Inhalation Limit: Data not available	
5.6 Toxicity by Ingestion: Grade 3; LD <sub>50</sub> = 50 to 800 mg/kg	
5.7 Lethal 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 swarming of the skin and first-degree burns on short exposure and 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: 95°F C.C.	
6.2 Flammable Limits in Air: Data not available	
6.3 Fire Extinguishing Agents: Water, dry chemical, foam, 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: Not pertinent	
6.7 Ignition Temperature: Data not available	
6.8 Electrical Hazard: Data not available	
6.9 Burning Rate: (est.) 3.4 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 Bases: Not pertinent	
7.5 Polymerization: Not pertinent	
7.6 Inhibitor of Polymerization: Not pertinent	
7.7 Water Ratio (Resistant to Product): Data not available	
7.8 Reactivity Group: 15	

8. WATER POLLUTION	
8.1 Aquatic Toxicity: 100 ppm*/daphnia/toxic/fresh water *Time period not specified.	
8.2 Water/Water 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: Telone soil fungicide: 100%; Telone C soil fungicide: 85%.	
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	
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11. HAZARD CLASSIFICATIONS	
11.1 Code of Federal Regulations: Flammable liquid	
11.2 NAB Hazard Rating for Bulk Water Transportation:	
Category	Rating
Fire	3
Health	
Vapor Irritant	2
Liquid or Solid Irritant	2
Poisons	3
Water Pollution	
Human Toxicity	3
Aquatic Toxicity	3
Anesthetic Effect	3
Reactivity	
Other Chemicals	2
Water	1
Self Reaction	0
11.3 NPPA 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: 110.96	
12.3 Boiling Point at 1 atm: 170°F = 77°C = 350°K	
12.4 Freezing Point: Not pertinent	
12.5 Critical Temperature: Not pertinent	
12.6 Critical Pressure: Not pertinent	
12.7 Specific Gravity: 1.2 at 20°C (liquid)	
12.8 Liquid Surface Tension: 31.2 dynes/cm = 0.0312 N/m at 24°C	
12.9 Liquid Water Interfacial Tension: 23.6 dynes/cm = 0.0236 N/m at 24°C	
12.10 Vapor (Gas) Specific Gravity: Not pertinent	
12.11 Ratio of Specific Heats of Vapor (Gas): (est.) 1.116	
12.12 Latent Heat of Vaporization: (est.) 113 Btu/lb = 62.6 cal/g = 2.63 X 10 <sup>5</sup> J/kg	
12.13 Heat of Combustion: (est.) 6900 Btu/lb = 3800 cal/g = 160 X 10 <sup>3</sup> J/kg	
12.14 Heat of Decomposition: Not pertinent	
12.15 Heat of Solution: Not pertinent	
12.16 Heat of Polymerization: Not pertinent	
12.17 Heat of Fusion: Data not available	
12.18 Limiting Value: Data not available	
12.19 Reid Vapor Pressure: 4.0 psia	

NOTES

DPU

## 1,3-DICHLOROPROPENE

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 (estimate)	Temperature (degrees F)	British thermal unit-inch per hour- square foot-F	Temperature (degrees F)	Centipoise
34	76.089	32	.478		D	46	.938
36	76.020	34	.478		A	48	.924
38	75.950	36	.478		T	50	.911
40	75.879	38	.478		A	52	.898
42	75.809	40	.478			54	.885
44	75.740	42	.478		N	56	.872
46	75.669	44	.478		O	58	.860
48	75.599	46	.478		T	60	.848
50	75.530	48	.478			62	.836
52	75.459	50	.478		A	64	.824
54	75.389	52	.478		V	66	.813
56	75.320	54	.478		A	68	.802
58	75.250	56	.478		I	70	.791
60	75.179	58	.478		L	72	.780
62	75.120	60	.478		A	74	.770
64	75.049	62	.478		B	76	.760
66	74.980	64	.478		L	78	.750
68	74.910	66	.478		E	80	.740
70	74.839					82	.730
72	74.770					84	.721
74	74.700					86	.712
76	74.629					88	.703
78	74.559					90	.694
80	74.490					92	.685
82	74.419					94	.677
84	74.349					96	.668

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 (estimate)	Temperature (degrees F)	British thermal unit per pound-F (estimate)
	D	35	.834	35	.01743	30	.163
	A	40	.963	40	.01872	40	.165
	T	45	1.067	45	.02226	50	.167
	A	50	1.236	50	.02507	60	.170
		55	1.401	55	.02815	70	.172
	N	60	1.566	60	.03155	80	.174
	O	65	1.790	65	.03527	90	.176
	T	70	2.016	70	.03935	100	.178
		75	2.265	75	.04380	110	.180
	A	80	2.540	80	.04866	120	.183
	V	85	2.842	85	.05395	130	.185
	A	90	3.174	90	.05969	140	.187
	I	95	3.537	95	.06593	150	.189
	L	100	3.934	100	.07267	160	.191
	A	105	4.368	105	.07997	170	.193
	B	110	4.840	110	.08784	180	.195
	L	115	5.354	115	.09632	190	.197
	E	120	5.912	120	.10540	200	.199
						210	.201
						220	.203
						230	.205
						240	.207
						250	.208
						260	.210

## DIBROMOCHLOROPROPANE

### Summary

Dibromochloropropane (DBCP) was formerly used as a soil fumigant and nematocide. It has been found to be carcinogenic in mice and rats. It causes mammary tumors (in female rats only) and forestomach tumors when administered orally, and nasal, tongue, and lung tumors when given by inhalation. Men occupationally exposed to DBCP had abnormally low sperm counts. Animals studies have shown that dibromochloropropane has adverse effects on the liver, kidneys, and blood cells.

CAS Number: 96-12-8

Chemical Formula:  $C_3H_5Br_2Cl$

IUPAC Name: 1,2-Dibromo-3-chloropropane

Important Synonyms and Trade Names: DBCP, Fumazone, Nemagon

### Chemical and Physical Properties

Molecular Weight: 236.36

Boiling Point: 196°C

Melting Point: 6°C

Specific Gravity: 2.093 at 14°C

Solubility in Water: Slightly soluble (probably 5-10 g/liter)

Solubility in Organics: Miscible with oils, dichloropropane, and isopropyl alcohol

Vapor Pressure: 0.8 mm Hg at 21°C

### Transport and Fate

There was no information available on the transport and fate of 1,2-dibromo-3-chloropropane (DBCP) at the time of this review. However, there is some information on the transport and fate of structurally similar compounds that may be relevant to the environmental fate of DBCP.

1,2,3-Trichloropropane was found to have a half-life of 51 minutes in stirred water, suggesting volatilization of DBCP

Dibromochloropropane

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from water could be significant. However, DBCP is considerably heavier than 1,2,3-trichloropropane and thus somewhat less likely to volatilize. The log octanol/water partition coefficient, 2.23, of 1,2-dichloropropane suggests that it will readily adsorb to organic components of soils and sediments and, therefore, be transported in dust and suspended solids. The tendency of brominated aliphatics to have higher log octanol/water partition coefficients than chlorinated aliphatics suggest DBCP will adsorb to a greater degree than 1,2-dichloropropane. Because of its water solubility, density, and low vapor pressure, DBCP is a likely groundwater contaminant. Its high density suggests that it would settle to the bottom of a contaminant plume and ultimately to the bottom of the aquifer.

Based on information of one and two carbon aliphatics, DBCP may be oxidized in the troposphere by hydroxyl radicals and hydrolyzed in an aqueous environment. Biodegradation of 1,2-dichloropropane does occur by soil microorganisms. However, the amount and speed of biodegradation and chemical degradation of DBCP is unknown.

### Health Effects

DBCP has been found to be carcinogenic in two animal bioassays and mutagenic in the Ames assay system. In a gavage study, DBCP was found to produce significantly increased incidences of squamous-cell carcinomas of the forestomach of mice and rats and of mammary adenocarcinomas in female rats. In an inhalation study, rats had increased incidences of nasal cavity tumors and tumors of the tongue, while mice had increased incidences of nasal cavity tumors and lung tumors.

Men occupationally exposed to DBCP during its manufacture were found to have abnormally low sperm counts. Male rats exposed to DBCP during subchronic toxicity studies were also found to have abnormally low sperm cells as well as degenerative changes in the seminiferous tubules, decreased weight of the testes, and an increased proportion of abnormal sperm cells. Liver and kidney effects have also been noted in animal studies. Effects range from dilatation of the sinusoids and centrilobular congestion to cirrhosis and necrosis in the liver. Cloudy swelling of the epithelium of the proximal convoluted tubules and increased amounts of interstitial tissue have been found in the kidneys. Effects on blood cells were also noted in several studies. These effects include severe leukopenias and anemias in exposed monkeys and decreased activity of phagocytic cells in exposed rats.

## Toxicity to Wildlife and Domestic Animals

The oral LD<sub>50</sub> value of DBCP to young mallards is 66.5 mg/kg, which is lower than the oral LD<sub>50</sub> value for the rat and mouse--173 and 257 mg/kg, respectively. Exposure to a water concentration of 1 mg/liter DBCP for 24 hours produced a 90% mortality in clam larvae. At a use concentration of 20 gallons DBCP per acre, 100% of exposed earthworms died in 1 day. At a use rate of 5 pounds per acre, DBCP killed 87% of the Lumbricus and 28% of the Helodrilus sp. in 32 days.

## Standards and Regulations

NIOSH Recommended Standard: 10 ppb (0.1 mg/m<sup>3</sup>)

OSHA Standard (air): 1 ppb (9.6 µg/m<sup>3</sup>) TWA

# ARSENIC

## Summary

Arsenic is a metal that is present in the environment as a constituent of organic and inorganic compounds; it also occurs in a number of valence states. Arsenic is generally rather mobile in the natural environment, with the degree of mobility dependent on its chemical form and the properties of the surrounding medium. Arsenic is a human carcinogen; it causes skin tumors when it is ingested and lung tumors when it is inhaled. Arsenic compounds are teratogenic and have adverse reproductive effects in animals. Chronic exposure to arsenic is associated with polyneuropathy and skin lesions. It is acutely toxic to some early life stages of aquatic organisms at levels as low as 40 µg/liter.

## Background Information

Arsenic can be found in the environment in any of four valence states (-3, 0, +3, and +5) depending on the pH, Eh, and other factors. It can exist as either inorganic or organic compounds and often will change forms as it moves through the various media. The chemical and physical properties depend on the state of the metalloid. Only the properties of metallic arsenic have been listed; properties of other arsenic compounds are often quite different.

CAS Number: 7440-38-2

Chemical Formula: As

IUPAC Name: Arsenic

## Chemical and Physical Properties

Atomic Weight: 74.91

Boiling Point: 613°C

Melting Point: 817°C

Specific Gravity: 5.72 at 20°C

Arsenic  
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Solubility in Water: Insoluble; some salts are soluble

### Transport and Fate

In the natural environment, arsenic has four different oxidation states, and chemical speciation is important in determining arsenic's distribution and mobility. Interconversions of the +3 and +5 states as well as organic complexation, are the most important. Arsenic is generally quite mobile in the environment. In the aquatic environment, volatilization is important when biological activity or highly reducing conditions produce arsine or methylarsenics. Sorption by the sediment is an important fate for the chemical. Arsenic is metabolized to organic arsenicals by a number of organisms; this increases arsenic's mobility in the environment. Because of its general mobility, arsenic tends to cycle through the environment. Its ultimate fate is probably the deep ocean, but it may pass through numerous stages before finally reaching the sea.

### Health Effects

Arsenic has been implicated in the production of skin cancer in humans. There is also extensive evidence that inhalation of arsenic compounds causes lung cancer in workers. Arsenic compounds cause chromosome damage in animals, and humans exposed to arsenic compounds have been reported to have an elevated incidence of chromosome aberrations. Arsenic compounds have been reported to be teratogenic, fetotoxic, and embryotoxic in several animal species, and an increased incidence of multiple malformations among children born to women occupationally exposed to arsenic has been reported. Arsenic compounds also cause noncancerous, possibly precancerous, skin changes in exposed individuals. Several cases of progressive polyneuropathy involving motor and sensory nerves and particularly affecting the extremities and myelinated long-axon neurons have been reported in individuals occupationally exposed to inorganic arsenic. Polyneuropathies have also been reported after the ingestion of arsenic-contaminated foods.

### Toxicity to Wildlife and Domestic Animals

Various inorganic forms of arsenic appear to have similar levels of toxicity; they all seem to be much more toxic than organic forms. Acute toxicity to adult freshwater animals occurs at levels of arsenic trioxide as low as 812 µg/liter and at levels as low as 40 µg/liter in early life stages of aquatic organisms. Acute toxicity to saltwater fish occurs at levels around 15 mg/liter, while some invertebrates are affected at much lower levels (508 µg/liter). Arsenic toxicity

does not appear to increase greatly with chronic exposure, and it does not seem that arsenic is bioconcentrated to a great degree.

Arsenic poisoning is a rare but not uncommon toxic syndrome among domestic animals. Arsenic causes hyperemia and edema of the gastrointestinal tract, hemorrhage of the cardiac serosal surfaces and peritoneum, and pulmonary congestion and edema; and it may cause liver necrosis. Information on arsenic toxicity to terrestrial wildlife was not reported in the literature reviewed.

### Regulations and Standards

#### Ambient Water Quality Criteria (USEPA):

##### Aquatic Life

###### Freshwater

Acute toxicity: 440 µg/liter  
Chronic toxicity: No available data

###### Saltwater

Acute toxicity: 508 µg/liter  
Chronic toxicity: No available data

##### Human Health

Estimates of the carcinogenic risks associated with lifetime exposure to various concentrations of arsenic in water are:

<u>Risk</u>	<u>Concentration</u>
10 <sup>-5</sup>	22 ng/liter
10 <sup>-6</sup>	2.2 ng/liter
10 <sup>-7</sup>	0.22 ng/liter

CAG Unit Risk (USEPA): 15 (mg/kg/day)<sup>-1</sup>

National Interim Primary Drinking Water Standard (USEPA):  
50 µg/liter

NIOSH Recommended Standard (air): 2 µg/m<sup>3</sup> Ceiling Level

OSHA Standard (air): 500 µg/m<sup>3</sup> TWA

ACGIH Threshold Limit Value: 200 µg/m<sup>3</sup> (soluble compounds, as As)

## BARIUM

### Summary

In its pure form, barium is an extremely reactive metal that decomposes in water. In natural waters it forms insoluble carbonate or sulfate salts and is usually present at concentrations of less than 1 mg/liter. Insoluble forms of barium are not very toxic; but soluble barium salts are highly toxic after acute exposure, and they have a prolonged stimulant effect on muscles. A benign pneumoconiosis, baritosis, can result from inhaling barium dusts. The EPA Interim Primary Drinking Water Standard is 1 mg/liter.

CAS Number: 7440-39-3

Chemical Formula: Ba

IUPAC Name: Barium

### Chemical and Physical Properties

Atomic Weight: 137.3

Boiling Point: 1,640°C

Melting Point: 725°C

Specific Gravity: 3.5

Solubility in Water: Decomposes; combines with sulfate present in natural waters to form BaSO<sub>4</sub>, which has a solubility of 1.6 mg/liter at 20°C

Solubility in Organics: Soluble in alcohol; insoluble in benzene

### Transport and Fate

Barium is extremely reactive, decomposes in water, and readily forms insoluble carbonate and sulfate salts. Barium is generally present in solution in surface or groundwater only in trace amounts. Large amounts will not dissolve because natural waters usually contain sulfate, and the solubility of barium sulfate is generally low. Barium is not soluble at more than a few parts per million in water that contains sulfate at more than a few parts per million. However, barium sulfate may become considerably more soluble in the presence

of chloride and other anions. Monitoring programs show that it is rare to find barium in drinking water at concentrations greater than 1 mg/liter. Atmospheric transport of barium, in the form of particulates, can occur. Bioaccumulation is not an important process for barium.

### Health Effects

There are no reports of carcinogenicity, mutagenicity, or teratogenicity associated with exposure to barium or its compounds. Effects on gametogenesis and on the reproductive organs are reported in male and female rats after inhalation of barium carbonate; intratesticular injection of barium chloride affects the male reproductive organs.

Insoluble forms of barium, particularly barium sulfate, are not toxic by ingestion or inhalation because only minimal amounts are absorbed. However, soluble barium compounds are highly toxic in humans after exposure by either route. The most important effect of acute barium poisoning is a strong, prolonged stimulant action on muscle. Smooth, cardiac, and skeletal muscles are all affected, and a transient increase in blood pressure due to vasoconstriction can occur. Effects on the hematopoietic system and cerebral cortex have also been reported in humans. Accidental ingestion of soluble barium salts has resulted in gastroenteritis, muscular paralysis, and ventricular fibrillation and extra systoles. Potassium deficiency can occur in cases of acute poisoning. Doses of barium carbonate and barium chloride of 57 mg/kg and 11.4 mg/kg, respectively, have been reported to be fatal in humans. Digitalis-like toxicity, muscle stimulation, and effects on the hematopoietic and central nervous systems have been confirmed in experimental animals. There are no adequate animal data available for determining the chronic effects of low level exposure to barium by ingestion.

Baritosis, a benign pneumoconiosis, is an occupational disease arising from the inhalation of barium sulfate dust, barium oxide dust, and barium carbonate. The radiologic changes produced in the lungs are reversible with cessation of exposure. Other reports of industrial exposure to barium compounds describe pulmonary nodulation with or without a decrease in lung function. Dusts of barium oxide are considered potential agents of dermal and nasal irritation. The biological half-life for barium is less than 24 hours.

### Toxicity to Wildlife and Domestic Animals

Adequate data for characterization of toxicity to wildlife and domestic animals are not available.

Regulations and Standards

Interim Primary Drinking Water Standard: 1 mg/liter

OSHA Standard: 0.5 mg/m<sup>3</sup> (soluble compounds, as Ba)

ACGIH Threshold Limit Value: 0.5 mg/m<sup>3</sup> (soluble compounds, as Ba)

## COPPER

### Summary

Copper is among the more mobile metals in the environment. It is toxic to humans at high levels; it causes irritation following acute exposure and anemia following chronic exposure. Sheep are very susceptible to copper toxicosis, as are many aquatic organisms.

### Background Information

Copper exists in a valence state of +1 or +2. It is a lustrous, reddish metal. The physical properties of copper include ductility and conductivity of heat and electricity. Copper is found in nature as sulfide, oxide, or carbonate ore.

CAS Number: 7440-50-8

Chemical Formula: Cu

IUPAC Name: Copper

### Chemical and Physical Properties

Atomic Weight: 63.546

Boiling Point: 2,567°C

Melting Point: 1,083°C

Specific Gravity: 8.92

Solubility in Water: Most copper salts are insoluble, with the exception of  $\text{CuSO}_4$ ,  $\text{Cu}(\text{NO}_3)_2$ , and  $\text{CuCl}_2$  (the more common copper salts). The metal is insoluble in water.

Vapor Pressure: 1 mm Hg at 1,628°C

### Transport and Fate

Copper has two oxidation states, +1 (cuprous) and +2 (cupric). Cuprous copper is unstable in aerated water over the pH range of most natural waters (6 to 8) and oxidizes to the cupric state. Several processes determine the fate of copper in the aquatic environment: formation of complexes, especially with humic substances; sorption to hydrous metal oxides, clays, and organic materials; and bioaccumulation. In waters polluted

with soluble organic material, complexation with organic ligands can occur, thus favoring the prolonged dispersion of copper in solution. The presence of organic acids also can lead to the mobilization of copper from the sediments to solution. Copper has a strong affinity for hydrous iron and manganese oxides, clays, carbonate minerals, and organic matter. Sorption to these materials, both suspended in the water column and in the sediment, results in relative enrichment of the solid phase and reduction in dissolved levels. Sorption processes are quite efficient in scavenging dissolved copper and in controlling its mobility in natural unpolluted streams. The amounts of the various copper compounds and complexes that actually exist in solution depend on the pH, temperature, alkalinity, and concentrations of other chemical species. The levels of copper able to remain in solution are directly dependent on water chemistry. Generally, ionic copper is more soluble in low pH waters and less soluble in high pH waters.

As an essential nutrient, copper is accumulated by plants and animals, although apparently it is not generally biomagnified. Because copper is strongly bioaccumulated and because biogenic ligands play an important role in complexing copper, biological activity is a major factor in determining the distribution and occurrence of copper in the ecosystem. For example, bioaccumulation patterns may exhibit seasonal variations related to biological activity.

Because many copper compounds and complexes are readily soluble, copper is among the more mobile heavy metals in soil and other surface environments. The major process that limits the environmental mobility of copper is adsorption to organic matter, clays, and other materials. Atmospheric transport of copper compounds can also occur.

### Health Effects

Copper appears to increase the mutagenic activity of triose reductone and ascorbic acid in bacterial test systems. However, copper itself does not appear to have mutagenic, teratogenic, or carcinogenic effects in animals or humans. Dietary levels of trace elements such as molybdenum, sulfur, zinc, and iron can affect the level of copper that produces certain deficiency or toxicity symptoms. In general, more attention is given to the problems associated with copper deficiency than to problems of excess copper in the environment. However, high levels of copper can be toxic to humans.

Exposure to metallic copper dust can cause a short-term illness similar to metal fume fever that is characterized by chills, fever, aching muscles, dryness of mouth and throat, and headache. Exposure to copper fumes can produce upper

respiratory tract irritation, a metallic or sweet taste, nausea, metal fume fever, and sometimes discoloration of skin and hair. Individuals exposed to dusts and mists of copper salts may exhibit congestion of nasal mucous membranes, sometimes of the pharynx, and occasionally ulceration with perforation of the nasal septum.

If sufficient concentrations of copper salts reach the gastrointestinal tract, they act as irritants and can produce salivation, nausea, vomiting, gastritis, and diarrhea. Elimination of ingested ionic copper by vomiting and diarrhea generally protects the patient from more serious systemic toxic effects, which can include hemolysis, hepatic necrosis, gastrointestinal bleeding, oliguria, azotemia, hemoglobinuria, hematuria, proteinuria, hypotension, tachycardia, convulsions, and death. Chronic exposure may result in anemia.

Copper salts act as skin irritants producing an itching eczema. Conjunctivitis or even ulceration and turbidity of the cornea may result from direct contact of ionic copper with the eye.

#### Toxicity to Wildlife and Domestic Animals

Mean acute toxicity values for a large number of freshwater animals range from 7.2  $\mu\text{g/liter}$  for Daphnia pulex to 10,200  $\mu\text{g/liter}$  for the bluegill. Toxicity tends to decrease as hardness, alkalinity, and total organic carbon increase. Chronic values for a variety of freshwater species range from 3.9  $\mu\text{g/liter}$  for brook trout to 60.4  $\mu\text{g/liter}$  for northern pike. Hardness does not appear to affect chronic toxicity. The acute-chronic ratios for different species range from 3 to 156. The more sensitive species tend to have lower ratios than the less sensitive species. In addition, the ratio seems to increase with hardness. Acute toxicity values for saltwater organisms range from 17  $\mu\text{g/liter}$  for a calanoid copepod to 600  $\mu\text{g/liter}$  for the shore crab. A chronic value of 54  $\mu\text{g/liter}$  and an acute-chronic ratio of 3.4 is reported for the mysid shrimp. Long-term exposure to 5  $\mu\text{g/liter}$  is fatal to the bay scallop.

Bioconcentration factors in freshwater species range from zero for the bluegill to 2,000 for the alga Chlorella regularis. Among saltwater species, the highest bioaccumulation factors are those for the bivalve molluscs. Oysters can bioaccumulate copper up to 28,200 times without any significant mortality.

Sheep are very susceptible to copper toxicosis, and poisoning may be acute or chronic. Acute poisoning is caused by direct action of copper salts on the gastrointestinal tract, resulting in gastroenteritis, shock, and death. The toxic dose is about 200 mg/kg and is usually obtained through an

accidental overdose of an antihelminthic. Ingestion of excess copper over a long period of time results in absorption and accumulation of copper by the liver. This type of chronic cumulative poisoning may suddenly develop into an acute hemolytic crisis. Copper intake of 1.5 g/day for 30 days is known to be fatal for many breeds of sheep. Excessive copper may be stored in the liver as a result of excess copper ingestion, as a consequence of impaired liver function, or in connection with a deficiency or excess of other trace elements. Sheep eliminate accumulated copper very slowly after cessation of exposure.

Swine develop copper poisoning at levels of 250 mg/kg in the diet unless zinc and iron levels are increased. Toxicosis develops with hypochromic microcytic anemia, jaundice, and marked increases in liver and serum copper levels as well as serum aspartate amino transferase. High copper levels may be found in swine because of the practice of feeding them high copper diets in order to increase daily weight gain. However, swine rapidly eliminate copper once it is removed from the diet. Cattle are much more resistant to copper in the diet than sheep or swine. Copper toxicity in ruminants can be counteracted by including molybdenum and sulfate in the diet.

### Regulations and Standards

#### Ambient Water Quality Criteria (USEPA):

##### Aquatic Life (Proposed)

###### Freshwater

Acute toxicity:  $e^{(0.905 [\ln(\text{hardness})] - 1.413)}$   $\mu\text{g/liter}$

Chronic toxicity:  $e^{(0.905 [\ln(\text{hardness})] - 1.785)}$   $\mu\text{g/liter}$

###### Saltwater

Acute toxicity: 3.2  $\mu\text{g/liter}$

Chronic toxicity: 2.0  $\mu\text{g/liter}$

##### Human Health

Organoleptic criterion: 1 mg/liter

National Secondary Drinking Water Standards (USEPA): 1 mg/liter

OSHA Standards: 1.0  $\text{mg/m}^3$  TWA (dust and mist)  
0.1  $\text{mg/m}^3$  TWA (fume)

# IRON

## Summary

There is some evidence that high concentrations of certain soluble iron salts may be teratogenic. The ingestion of excess amounts of iron can irritate the gastrointestinal tract. Inhaling some iron-containing dusts and fumes can cause siderosis, a type of benign pneumoconiosis.

## Background Information

Iron is the fourth most abundant element in the earth's crust. The pure metal is very reactive chemically. It corrodes readily in the presence of oxygen and moisture, forming iron (III) hydroxide  $[\text{Fe}(\text{OH})_3]$ .

CAS Number: 7439-89-6

Chemical Formula: Fe

## Chemical and Physical Properties

Atomic Weight: 55.847

Boiling Point: 2,750°C

Melting Point: 1,535°C

Specific Gravity: 7.86

Solubility in Water: Insoluble

Solubility in Organics: Soluble in alcohol and ether

## Transport and Fate

Elemental iron and many iron compounds, including  $\text{Fe}(\text{OH})_3$  and the iron oxides, are insoluble in water. Iron also tends to chelate with organic and inorganic matter. Consequently, much of the iron present in aquatic systems tends to partition into the bottom sediments. Iron has relatively low mobility in soil. Atmospheric transport of iron can occur.

## Health Effects

Some studies have indicated that inhalation exposure to high concentrations of iron oxide is associated with increased risk of lung and laryngeal cancers in hematite miners and foundry workers. However, the significance of these findings is not established since exposures were to a mixture of substances, including radon gas and decomposition products of synthetic resins. Iron dextran solutions are reported to cause injection site sarcomas in experimental animals. Some iron compounds, notably ferrous sulfate, are reported to have high mutagenic activity in test systems. Intravenous injection of high concentrations of soluble iron salts is reported to cause teratogenic effects, including hydrocephalus and anophthalmia, in various species of experimental animals.

Iron is an essential element in plants and animals. However, the ingestion of excess amounts of iron produces toxic effects, primarily associated with gastrointestinal irritation. Severe poisoning may cause gastrointestinal bleeding, pneumonitis, convulsions, and hepatic toxicity. A dose of about 30 g of a soluble ferric salt is likely to be fatal in humans. Persons ingesting more than 30 mg/kg should be observed for clinical symptoms and possibly hospitalized. Chronic ingestion of excess iron may lead to hemosiderosis or hemochromatosis. Long-term inhalation exposure to iron-containing dusts and fumes, especially iron oxide, can produce siderosis. This condition is considered to be a type of benign pneumoconiosis that does not progress to fibrosis. Exposure to aerosols and mists of soluble iron salts may produce respiratory and skin irritation. The toxic effects of iron in experimental animals are similar to those observed in humans.

## Toxicity to Wildlife and Domestic Animals

The available data are not adequate to characterize the toxicity of iron to wildlife or domestic animals. Iron is unlikely to cause ecological toxicity.

## Regulations and Standards

OSHA Standard: 10 mg/m<sup>3</sup> TWA (iron oxide fume)

ACGIH Threshold Limit Values:

5 mg/m<sup>3</sup> TWA (iron oxide fume, as Fe)  
10 mg/m<sup>3</sup> STEL (iron oxide fume, as Fe)  
1 mg/m<sup>3</sup> TWA (soluble iron salts, as Fe)  
2 mg/m<sup>3</sup> STEL (soluble iron salts, as Fe)

# 2,4-DINITROTOLUENE

DTT

<p><b>Common Synonyms</b> DNT 2, 4-Dinitrotoluid 1-Methyl-2, 4-Dinitrobenzene</p>	<p>Solid or heated liquid Yellow to red solid or yellow liquid</p> <p>Liquid solidifies. Solid and liquid sink in water.</p>
<p><b>AVOID CONTACT WITH LIQUID AND SOLID. KEEP PEOPLE AWAY.</b></p> <p>Wear rubber overclothing (including gloves). Stop discharge if possible. Call fire department. Isolate and remove discharged material. Notify local health and pollution control agencies.</p>	
<p><b>Fire</b></p>	<p>Combustible. <b>POISONOUS GASES MAY BE PRODUCED IN FIRE.</b> Containers may explode in fire. Wear goggles and self-contained breathing apparatus. Extinguish with water, dry chemicals, foam, or carbon dioxide. Cool exposed containers with water.</p>
<p><b>Exposure</b></p>	<p>CALL FOR MEDICAL AID</p> <p><b>LIQUID OR SOLID POISONOUS IF SWALLOWED OR IF SKIN IS EXPOSED.</b> Will burn 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 and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.</p>
<p><b>Water Pollution</b></p>	<p>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.</p>
<p><b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Handbook) Issue warning-poison, water contaminant. Restrict access. Should be removed. Chemical and physical treatment.</p>	<p><b>2. LABEL</b> 2.1 Category: None 2.2 Class: Not pertinent</p>
<p><b>3. CHEMICAL DESIGNATIONS</b> 3.1 CB Compatibility Class: Not listed 3.2 Formula: 2, 4-(NO<sub>2</sub>)<sub>2</sub>C<sub>6</sub>H<sub>3</sub>CH<sub>3</sub> 3.3 IMO/IUM Designation: Solid: 6.1/2038; Liquid: 6.1/1800 3.4 DOT ID No.: 1800 (Liquid); 2038 (Solid) 3.5 CAS Registry No.: 121-14-2</p>	<p><b>4. OBSERVABLE CHARACTERISTICS</b> 4.1 Physical State (as shipped): Solid or liquid 4.2 Color: Yellow (liquid); yellow to red (solid) 4.3 Odor: Weak</p>
<p><b>5. HEALTH HAZARDS</b></p>	
<p>5.1 Personal Protective Equipment: Air-line mask or self-contained breathing apparatus; safety goggles and face shield; rubber gloves and boots; protective clothing. 5.2 Symptoms Following Exposure: Ingestion or overexposure to vapors from hot liquid can cause loss of color, nausea, headache, dizziness, drowsiness, collapse. Hot liquid can burn eyes and skin. Prolonged skin contact with solid can give same symptoms as after inhalation or ingestion. 5.3 Treatment of Exposure: <b>INHALATION:</b> remove victim from exposure; get medical attention for methemoglobinemia. <b>EYES:</b> flush with copious amounts of water and get medical attention. <b>SKIN:</b> wash well with soap and water. <b>INGESTION:</b> induce vomiting, if victim is conscious; give gastric lavage and saline cathartic; get medical attention. 5.4 Threshold Limit Value: 1.5 mg/m<sup>3</sup> 5.5 Short Term Inhalation Limit: Data not available 5.6 Toxicity by Ingestion: Grade 4; oral LD<sub>50</sub> = 30 mg/kg (rat) 5.7 Late Toxicity: May cause liver damage, anemia, neuritis. 5.8 Vapor (Gas) Irritant Characteristics: Not pertinent 5.9 Liquid or Solid Irritant Characteristics: Data not available 5.10 Odor Threshold: Data not available 5.11 IDLH Value: 200 mg/m<sup>3</sup></p>	

<p><b>6. FIRE HAZARDS</b></p> <p>6.1 Flash Point: 404°F C.C. 6.2 Flammable Limits in Air: Not pertinent 6.3 Fire Extinguishing Agents: Water, dry chemical, carbon dioxide from protected location 6.4 Fire Extinguishing Agents Not to be Used: Data not available 6.5 Special Hazards of Combustion: Products: Nitrogen oxides and dense black smoke are produced in a fire. 6.6 Behavior in Fire: Decomposition is self-sustaining at 260°C. Containers may explode in a fire. 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</p> <p style="text-align: right;"><i>(Continued)</i></p>	<p><b>10. HAZARD ASSESSMENT CODE</b> (See Hazard Assessment Handbook) A-X-Y-II</p> <p><b>11. HAZARD CLASSIFICATIONS</b></p> <p>11.1 Code of Federal Regulations: ORM-E 11.2 NAB Hazard Rating for Bulk Water Transportation: Not listed 11.3 NFPA Hazard Classification: Category Classification Health Hazard (Blue)..... 2 Flammability (Red)..... 1 Reactivity (Yellow)..... 3</p>
<p><b>7. CHEMICAL REACTIVITY</b></p> <p>7.1 Reactivity With Water: No reaction 7.2 Reactivity with Common Materials: No reaction 7.3 Stability During Transport: Stable below 482°F (250°C) 7.4 Neutralizing Agents for Acids and Caustics: Not pertinent 7.5 Polymerization: Not pertinent 7.6 Inhibitor of Polymerization: Not pertinent 7.7 Water Ratio (Resistant to Product): Data not available 7.8 Reactivity Group: Data not available</p>	<p><b>12. PHYSICAL AND CHEMICAL PROPERTIES</b></p> <p>12.1 Physical State at 15°C and 1 atm: Solid 12.2 Molecular Weight: 182.1 12.3 Boiling Point at 1 atm: Decompose 12.4 Freezing Point: 158°F = 70°C = 343°K 12.5 Critical Temperature: Not pertinent 12.6 Critical Pressure: Not pertinent 12.7 Specific Gravity: 1.379 at 20°C (liquid) 12.8 Liquid Surface Tension: Data not available 12.9 Liquid Water Interfacial Tension: Data not available 12.10 Vapor (Gas) Specific Gravity: Not pertinent 12.11 Ratio of Specific Heats of Vapor (Gas): Not pertinent 12.12 Latent Heat of Vaporization: 170 Btu/lb = 93 cal/g = 3.8 X 10<sup>4</sup> J/kg 12.13 Heat of Combustion: -8,306 Btu/lb = -4,614 cal/g = -180.0 X 10<sup>4</sup> J/kg 12.14 Heat of Decomposition: Not pertinent 12.15 Heat of Solution: Not pertinent 12.16 Heat of Polymerization: Not pertinent 12.17 Heat of Fusion: 26.40 cal/g 12.18 Limiting Value: Data not available 12.19 Reid Vapor Pressure: Data not available</p>
<p><b>8. WATER POLLUTION</b></p> <p>8.1 Aquatic Toxicity: Data not available 8.2 Waterway Toxicity: Data not available 8.3 Biological Oxygen Demand (BOD): Data not available 8.4 Food Chain Concentration Potential: Data not available</p>	<p><b>9. SHIPPING INFORMATION</b></p> <p>9.1 Grades of Purity: Technical. Mixtures such as an 80:20 mixture of 2, 4- and 2, 6-isomers are also available. The hazard properties are similar. 9.2 Storage Temperature: Ambient (solid); &gt; 60°C (liquid) 9.3 Inert Atmosphere: No requirement 9.4 Venting: Open (fume arrester)</p>
<p><b>6. FIRE HAZARDS (Continued)</b></p>	
<p>6.11 Stoichiometric Air to Fuel Ratio: Data not available 6.12 Flame Temperature: Data not available</p>	

DTT	<b>2,4-DINITROTOLUENE</b>
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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
	N O T  P E R T I N E N T	211.73	.349		N O T  P E R T I N E N T		N O T  P E R T I N E N T

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
34	.021		N O T  P E R T I N E N T		N O T  P E R T I N E N T		N O T  P E R T I N E N T
36	.022						
38	.022						
40	.022						
42	.022						
44	.023						
46	.023						
48	.023						
50	.024						
52	.024						
54	.024						
56	.024						
58	.025						
60	.025						
62	.025						
64	.026						
66	.026						
68	.026						
70	.026						
72	.027						
74	.027						
76	.027						
78	.028						
80	.028						
82	.028						
84	.029						

# PHOSPHORUS, WHITE

PPW

<b>Common Synonyms</b> Yellow phosphorus		Waxy solid Light yellow Garlic odor
Fumes and burns in air, sinks in water.		
AVOID CONTACT WITH SOLID. Keep people away. Wear rubber overclothing (including gloves). Call fire department. isolate and remove discharged material. Notify local health and pollution control agencies.		
<b>Fire</b>	<b>FLAMMABLE.</b> May ignite on contact with air. <b>POISONOUS, IRRITATING GASES ARE PRODUCED IN FIRE.</b> Wear rubber overclothing (including gloves). Flood discharge area with water. Cool exposed containers with water. Continue cooling after fire has been extinguished.	
<b>Exposure</b>	CALL FOR MEDICAL AID. <b>SOLID</b> Will burn skin and eyes. If swallowed, will cause nausea, vomiting or loss of consciousness. 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 WITH NO CONVULSIONS, have victim drink water or milk. DO NOT INDUCE VOMITING.	
<b>Water Pollution</b>	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.	
<b>1. RESPONSE TO DISCHARGE</b> (See Response Methods Handbook) Issue warning-high flammability, poison. Restrict access. Evacuate area. Should be removed. Chemical and physical treatment.		<b>2. LABEL</b> 2.1 Category: Flammable solid 2.2 Class: 4
<b>3. CHEMICAL DESIGNATIONS</b> 3.1 CG Compatibility Class: Special Class 3.2 Formula: P 3.3 IMO/UN Designation: 4.2/1381 3.4 DOT ID No.: 1381 3.5 CAS Registry No.: 10025-87-3		<b>4. OBSERVABLE CHARACTERISTICS</b> 4.1 Physical State (as shipped): Liquid or waxy solid 4.2 Color: Pale yellow to deep straw 4.3 Odor: Distinctive, disagreeable; pungent, sharp; like garlic
<b>5. HEALTH HAZARDS</b> 5.1 Personal Protective Equipment: Heavy rubber gloves and goggles or face shield. 5.2 Symptoms Following Exposure: Solid or liquid causes severe burns of skin. If ingested, causes nausea, vomiting, jaundice, low blood pressure, depression, delirium, coma, death. Symptoms after ingestion may be delayed for from a few hours to 3 days. 5.3 Treatment of Exposure: INGESTION: if ingested, do NOT induce vomiting; call a doctor at once. SKIN OR EYE CONTACT: immediately flush with plenty of water for at least 15 min.; keep skin area wet until medical attention is obtained. 5.4 Threshold Limit Value: 0.1 mg/m <sup>3</sup> 5.5 Short Term Inhalation Limits: Not pertinent 5.6 Toxicity by Ingestion: Grade 4; LD <sub>50</sub> below 50 mg/kg 5.7 Late Toxicity: Severe attack of liver and bones. 5.8 Vapor (Gas) Irritant Characteristics: Nonvolatile 5.9 Liquid or Solid Irritant Characteristics: Severe skin irritant. Causes second- and third-degree burns on short contact, and is very injurious to the eyes. 5.10 Odor Threshold: Not pertinent 5.11 IDLH Value: Data not available		

**6. FIRE HAZARDS**

6.1 Flash Point: Ignites spontaneously in air  
 6.2 Flammable Limits in Air: Not pertinent  
 6.3 Fire Extinguishing Agents: Water  
 6.4 Fire Extinguishing Agents Not to be Used: Not pertinent  
 6.5 Special Hazards of Combustion Products: Fumes from burning phosphorus are highly irritating.  
 6.6 Behavior in Fire: Intense white smoke is formed.  
 6.7 Ignition Temperature: 86°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: Ignites when exposed to air.  
 7.3 Stability During Transport: Stable  
 7.4 Neutralizing Agents for Acids and Bases: 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: See Combustibility Guide

**8. WATER POLLUTION**

8.1 Aquatic Toxicity: 0.106 ppm/48 hr/blugill/TL<sub>50</sub>/fresh water  
 8.2 Waterflow 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: 99.9-99.9%  
 9.2 Storage Temperature: Elevated  
 9.3 Inert Atmosphere: Padded  
 9.4 Venting: Pressure-vacuum

**10. HAZARD ASSESSMENT CODE**  
 (See Hazard Assessment Handbook)  
 H-RR

**11. HAZARD CLASSIFICATIONS**

11.1 Code of Federal Regulations: Flammable solid  
 11.2 NFPA Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	
Liquid or Solid Irritant	4
Poisons	4
Water Pollution	
Human Toxicity	3
Acute Toxicity	4
Aesthetic Effect	1
Reactivity	
Other Chemicals	4
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

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

**12. PHYSICAL AND CHEMICAL PROPERTIES**

12.1 Physical State at 15°C and 1 atm: Solid  
 12.2 Molecular Weight: 123.88  
 12.3 Boiling Point at 1 atm: 535.5°F = 279.7°C = 552.9°K  
 12.4 Freezing Point: 111.4°F = 44.1°C = 317.3°K  
 12.5 Critical Temperature: Not pertinent  
 12.6 Critical Pressure: Not pertinent  
 12.7 Specific Gravity: 1.82 at 20°C (solid)  
 12.8 Liquid Surface Tension: Not pertinent  
 12.9 Liquid Water Intercritical 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  
 12.18 Heat of Fusion: 4.8 cal/g  
 12.19 Limiting Value: Data not available  
 12.27 Reid Vapor Pressure: Very low

NOTES

PPW

## PHOSPHORUS, WHITE

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
	N O T  P E R T I N E N T		N O T  P E R T I N E N T		N O T  P E R T I N E N T		N O T  P E R T I N E N T

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
	I N S O L U B L E		N O T  P E R T I N E N T		N O T  P E R T I N E N T		N O T  P E R T I N E N T

## 1,3,5 Trinitrobenzene

### Summary

1,3,5 Trinitrobenzene is a high explosive, similar to trinitrotoluene. However, it is less sensitive to impact than the later. Its brisance and power are higher than those of TNT. It detonates when heated rapidly. The dry material is highly sensitive to shock and heat. Trinitrobenzene is a flammable solid. It emits highly toxic oxides of nitrogen on decomposition.

CAS Number: 99-35-4

RCRA Waste Number: U234

Chemical Formula:  $C_6H_3N_3O_6$

Important Synonyms: trinitrobenzol; trinitrobenzene; benzite

### Chemical and Physical Properties

Molecular Weight: 213.12

Boiling Point: sublimed by careful heating

Melting Point: 122.5°C

Solubility in Water: very slightly soluble (0.035g/100mL at 20°C)

Solubility in Organics: slightly soluble in carbon disulfide and petroleum ether, moderately soluble in benzene and methanol, freely soluble in sodium sulfite solution.

### Transport and Fate

Storage and shipping are similar to those used for TNT and other high explosives. Trinitrobenzene is stored in a permanent magazine well separated from initiator explosive, combustible and oxidizing materials, and heat sources. It is shipped in metal containers enclosed in wooden boxes or strong siftproof cloth or paper bags in amounts not exceeding 60 lb net weight.

### Health Effects

The toxic effects from ingestion of the solid or inhalation of its dusts include irritation of the respiratory tract, headache, dyspnea, and cyanosis. Other effects noted in animals were degenerative changes in the brain. The oral LD<sub>50</sub> values in rats and mice are 450 and 570 mg/kg, respectively.

## 2,4,6 Trinitrotoluene

### Summary

2,4,6 Trinitrotoluene (TNT) is used as a high explosive in mining and in the military. It is produced by nitration of toluene with a mixture of nitric and sulfuric acids. In comparison to many other high explosives, it is insensitive to heat, shock, or friction. However, when heated rapidly or subjected to strong shock, it detonates. In combination with other explosives, TNT is widely used as a military and industrial explosive. Amatol, cyclonite, and tetrytol are some of the examples of such combinations. TNT itself has a very high brisance.

CAS Number: 118-96-7

Chemical Formula:  $C_7H_5N_3O_6$

Important Synonyms: 2-methyl-1,3,5-trinitrobenzene; 1-methyl-2,4,6-trinitrobenzene; 2,4,6-trinitrotoluol; trotyl; TNT

### Chemical and Physical Properties

Molecular Weight: 227.15

Boiling Point: sublimed by careful heating

Melting Point: 80°C

Solubility in Water: very slightly soluble (0.01% at 25°C)

Solubility in Organics: soluble in acetone and benzene.

### Transport and Fate

Trinitrotoluene is stored in a permanent magazine well separated from combustible and oxidizable materials, initiators, and heat sources. It is shipped in metal containers enclosed in wooden boxes or strong siftproof cloth or paper bags in amounts not exceeding 60 lb net weight.

### Health Effects

The toxic effects of TNT are dermatitis, cyanosis, gastritis, yellow atrophy of the liver, somnolence, tremor, convulsions, and apastic anemia. Sneezing, sore throat, and muscular pain have also been noted in people exposed to this compound. It is an irritant to skin, respiratory tract, and urinary tract. Prolonged exposure may produce liver damage. The oral  $LD_{50}$  value in rats is in the range 800 mg/kg.

12.0 MISCELLANEOUS REPORTS

12.1 SITE SAFETY FOLLOW-UP REPORT. To be completed for each field change in the HASP.

Was the HASP followed as presented?  Yes  No

Describe in detail any changes to the HASP: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Reason for changes: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Approved By

Site Manager: \_\_\_\_\_

Date: \_\_\_\_\_

Site Safety Officer: \_\_\_\_\_

Date: \_\_\_\_\_

Evaluation of Health and Safety Plan

Was the HASP adequate?  Yes  No

What changes would you recommend?: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

12.2 ACCIDENT REPORT.

Site: \_\_\_\_\_ Project No.: \_\_\_\_\_

Location: \_\_\_\_\_

Location of accident (if different from above): \_\_\_\_\_

Name and address of injured: \_\_\_\_\_

SSN: \_\_\_\_\_ DOB: \_\_\_\_\_ Sex: \_\_\_\_\_

Years of service: \_\_\_\_\_ Time on present job: \_\_\_\_\_ Department No.: \_\_\_\_\_

Title/Classification: \_\_\_\_\_

Date of accident: \_\_\_\_\_ Time of accident: \_\_\_\_\_

Name of witness: \_\_\_\_\_ Telephone No.: \_\_\_\_\_

Accident Category:  Motor Vehicle  Property Damage  Fire

Chemical Exposure  Near Miss  Other

Severity of Injury or Illness:  Non-disabling  Property Damage

Medical Treatment  Fatality

Amount of Damage: \$ \_\_\_\_\_ Property Damaged: \_\_\_\_\_

**Classification of Injury**

- |  |  |  |
|--|--|--|
| <input type="checkbox"/> Fractures             | <input type="checkbox"/> Heat Burns        | <input type="checkbox"/> Cold Exposure   |
| <input type="checkbox"/> Dislocations          | <input type="checkbox"/> Chemical Burns    | <input type="checkbox"/> Heat Stroke     |
| <input type="checkbox"/> Sprains               | <input type="checkbox"/> Radiation Burns   | <input type="checkbox"/> Faint/Dizziness |
| <input type="checkbox"/> Abrasions             | <input type="checkbox"/> Concussion        | <input type="checkbox"/> Blisters        |
| <input type="checkbox"/> Lacerations           | <input type="checkbox"/> Toxic-Respiratory | <input type="checkbox"/> Bruises         |
| <input type="checkbox"/> Punctures             | <input type="checkbox"/> Toxic-Ingestion   | <input type="checkbox"/> Poison Ivy      |
| <input type="checkbox"/> Bites                 | <input type="checkbox"/> Toxic Dermal      | <input type="checkbox"/> Headache        |
| <input type="checkbox"/> Respiratory Allergy   |  |  |
| <input type="checkbox"/> Other (explain) _____ |  |  |

Parts of Body Affected: \_\_\_\_\_

Degree of Disability: \_\_\_\_\_

Date Medical Care was Received: \_\_\_\_\_ Emergency Service? \_\_\_\_\_

Name and Address of Medical Facility: \_\_\_\_\_

Follow-up Exam Required? \_\_\_\_\_ Estimated No. of Days Away From Job: \_\_\_\_\_

Accident Location (use the back of sheet as required): \_\_\_\_\_

Causative agent most directly related to accident (object, substance, material, machinery, equipment, conditions): \_\_\_\_\_

Was weather a factor? How? \_\_\_\_\_

Unsafe mechanical/physical/environmental condition at time of accident (be specific): \_\_\_\_\_

Unsafe act by injured and/or others contributing to the accident (be specific, must be answered): \_\_\_\_\_

Personal factors (improper attitude, lack of knowledge or skill, slow reaction, fatigue, inattention, horseplay): \_\_\_\_\_

**Modifications**

Level of personal protective equipment required in site-specific HASP: \_\_\_\_\_

Was injured using required equipment? \_\_\_\_\_ If not, how did actual equipment use differ from the HASP? \_\_\_\_\_

Was personal protective equipment required in the site safety plan adequate for site conditions? \_\_\_\_\_

If no, what additional equipment was needed: \_\_\_\_\_

What can be done to prevent a reoccurrence of this type of accident? (modification of machine, mechanical guards, modification of work practices, training): \_\_\_\_\_

Detailed Narrative Description (how did accident occur, why; objects, equipment, tools used, circumstance, assigned duties. Be specific.): \_\_\_\_\_

Signature of Preparer: \_\_\_\_\_ Date: \_\_\_\_\_

Signature of Site Manager: \_\_\_\_\_ Date: \_\_\_\_\_

SEND COPIES OF COMPLETED FORM TO HUMAN RESOURCES  
AND THE HEALTH AND SAFETY SUPERVISOR.

REFERENCE

ABB Environmental Services, Inc. (ABB-ES), 1994, Investigation-Derived Waste Management Plan: prepared for Southern Division, Naval Facilities Engineering Command, North Charleston, South Carolina.

**ATTACHMENT A**

**GENERIC HEALTH AND SAFETY PLAN, APPENDICES A THROUGH V**

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NAS Cecil Field, Jacksonville, Florida

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APPENDIX A  
AUTHORITY AND RESPONSIBILITY OF HEALTH AND SAFETY PERSONNEL

## APPENDIX A AUTHORITY AND RESPONSIBILITY OF HEALTH AND SAFETY PERSONNEL

This section describes the health and safety designations and general responsibilities that will be employed for the project.

### A.1 HEALTH AND SAFETY MANAGER

The Health and Safety Manager (HSM), ABB Environmental Services, Inc. (ABB-ES), can be reached by telephone at (207) 775-5401 in Portland, Maine. The HSM has final authority over health and safety issues that are not resolved at the site or through the Health and Safety Supervisor (HSS), and has overall responsibility for ensuring that the policies and procedures of this Health and Safety Plan (HASP) are implemented by the Health and Safety Officer (HSO). In the various regions, the HSM may delegate additional functions to the Regional HSS.

### A.2 HEALTH AND SAFETY SUPERVISOR

The HSS is the health and safety professional serving as the ABB-ES HSM's designee for this project. As such, the HSS will be responsible for (1) approval of the individual chosen to serve as the site HSO for this field operation; (2) review and approval of site-specific HASPs developed by the HSO, as well as any significant changes made over time to the site HASP; (3) oversight of the daily efforts of the HSO; (4) resolution of site disputes involving health and safety issues; and (5) implementation of the HASP by the HSO. The HSS will notify the HSM of any Stop Work Orders issued by an HSO.

**APPENDIX B TRAINING PROGRAM**

## APPENDIX B TRAINING PROGRAM

All personnel working on an ABB-ES site who potentially may be exposed to toxic substances or hazardous materials will participate in an initial and an annual refresher and/or supervisory training (as appropriate), as well as site-specific training before commencement of the onsite assignment. The initial Health and Safety Training Program consists of the 40-hour training program required and designated by the Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.120. In addition to the initial training, ABB-ES uses 8-hour annual refresher and supervisory training elements, which are augmented by site-specific training regarding site hazards and specialized problems and protocols.

### B.1 INITIAL TRAINING

All site-assigned personnel who are potentially exposed to toxic substances or hazardous materials will be required to participate in a training course on hazardous waste site operations. This training is required under provisions of the OSHA standard, and must consist of 40 hours covering the following areas:

- familiarity with the regulations and implications of OSHA regulations in 29 CFR 1910.120
- familiarity with the organizational structure responsible for site health and safety
- explanation of the medical surveillance requirements, including recognition of health hazards
- instruction in the use and maintenance of personal protective equipment
- identification and analysis of site chemical and physical hazards
- instruction regarding monitoring equipment, including personnel and environmental sampling instruments
- site control and decontamination procedures
- contingency planning
- confined-space entry procedures

### B.2 ANNUAL REFRESHER AND/OR SUPERVISORY TRAINING

Annually, all personnel required to participate in the initial training will take an 8-hour refresher training course. Those personnel with either site supervisory or health and safety responsibilities will also have an additional 8 hours of training beyond the initial 40 hours. The 8-hour supervisory training meets requirements of the annual refresher.

### **B.3 SITE-SPECIFIC TRAINING**

All personnel assigned to an ABB-ES site must participate in the site-specific training presentation, which will cover major elements of the site HASP, as well as health and safety procedures regarding an individual's specific job responsibilities and tasks. The site HSO or health and safety designee will provide this training before an individual is permitted to work in a downrange position.

### **B.4 OTHER TRAINING**

Additional training will be provided as determined by the HSM or the HSS, and may include additional refreshers on personal protective equipment, instrumentation, CPR, first aid, or any other pertinent health- or safety-related subject.

APPENDIX C MEDICAL SURVEILLANCE PROGRAM

## APPENDIX C MEDICAL SURVEILLANCE PROGRAM

### C.1 HEALTH MONITORING PROGRAM

All onsite ABB-ES personnel and laboratory staff must be enrolled in the Health Monitoring Program, which is implemented through Environmental Medicine Resources, Inc., a company consisting of a team of physicians and support personnel who specialize in occupational medicine. The health monitoring program consists of an initial medical examination to establish the employee's general health profile, which provides important baseline laboratory data for later comparative study and annual examinations. The contents of the initial comprehensive physical examination and laboratory testing routine are listed in Table C-1. Follow-up examinations are completed annually for all personnel enrolled in the health monitoring program, or more frequently if project assignments warrant testing following specific field activities.

### C.2 REVIEW OF EXPOSURE SYMPTOMS

Symptoms of exposure to hazardous materials will be reviewed for each site to indicate to personnel the recognized signs of possible exposure to those materials. This information will be supplemented with a discussion of the need for objectivity in the personal health assessment to account for normal reaction to stressful situations. The HSO will watch for outward evidence of changes in worker health. Symptoms may include skin irritations, skin discoloration, eye irritation, muscular soreness, fatigue, nervousness or irritability, intolerance to heat or cold, or loss of appetite. Employees will routinely be asked to assess their general state of health during the project. Special medical monitoring may be identified for certain sites.

**TABLE C-1  
BASELINE HEALTH MONITORING PROGRAM**

**PHYSICAL EXAMINATION**

medical history  
medical examination  
vision: - ~near/distant  
- ~color  
audiometry  
radiology: PA/LAT  
spirometry  
electrocardiogram

**LABORATORY ANALYSIS**

**Complete Blood Counts and Chemistries**

white blood count  
differential cell counts  
methemoglobin  
uric acid  
lactic dehydrogenase  
alkaline phosphatase  
calcium  
phosphorus  
cholesterol  
urea nitrogen  
glucose  
albumin  
globulin  
total protein  
total bilirubin  
serum glutamic oxalacetic transaminase  
hemoglobin and/or hematocrit

**Urine Analysis**

color and character  
specific gravity  
pH  
protein  
acetone  
glucose  
microscopic examination

**Biotox Panel**

**APPENDIX D ENGINEERING CONTROLS**

## APPENDIX D ENGINEERING CONTROLS

Whenever feasible, engineering controls will be used at the site to reduce employee exposure to hazardous substances. Feasible engineering controls include the following:

- the use of pressurized cabs or control booths
- the use of remotely operated materials-handling equipment
- the use of industrial-sized fans to blow hazardous vapors from the breathing zone when exposure is from a point source and a power source is available

APPENDIX E PERSONAL PROTECTIVE EQUIPMENT

## APPENDIX E PERSONAL PROTECTIVE EQUIPMENT

### E.1 PERSONAL PROTECTION LEVEL DETERMINATION

The level of personal protective equipment required will be determined by the type and levels of waste or spill material present at the site where project personnel may be exposed. In situations where the types of waste or spill material onsite are unknown, the hazards are not clearly established, or the situation changes during onsite activities, the HSO must make a reasonable determination of the level of protection that will ensure the safety of investigators and response personnel until potential hazards have been determined through monitoring, sampling, informational assessment, laboratory analyses, or other reliable methods. Once the hazards have been determined, protective levels commensurate with the hazards will be used. Protection requirements will be evaluated on a continuous basis to reflect new information as it is acquired.

### E.2 LEVELS OF PROTECTION

The following subsections describe the basic composition of the generally recognized protective ensembles to be used for site operations. Specific components for any level of protection will be selected based on hazard assessment; additional elements will be added as necessary. Disposable protective clothing, gloves, and other equipment, exclusive of respirators, should be used when feasible to minimize risks during decontamination and possible cross-contamination during sample handling.

#### E.2.1 Level A

Level A protection provides the highest level of protection for skin, eyes, and the respiratory system. It is appropriate for conditions where there are potential or actual high concentrations of atmospheric vapors, gases, or particulates. Level A should be used if site operations or work functions involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to the skin or capable of being absorbed through the intact skin. Level A is used primarily for emergency situations or when the following conditions exist: (1) vapors or mists of strong acids; (2) known or probable immediately dangerous to life and health (IDLH) atmospheres with dermally active compounds; (3) high atmospheric concentrations of compounds that can be absorbed through the skin; and (4) operations that must be conducted in a confined, poorly ventilated area, where conditions requiring Level A have not yet been eliminated. The fully encapsulating suit and the pressure-demand self-contained breathing apparatus (SCBA) or hoseline respirator are the key elements in Level A personal protective equipment (PPE).

Level A equipment includes the following items:

- SCBA (pressure demand) OR supplied air respirator (pressure demand with escape mask)
- total encapsulating suit
- coveralls (optional)

- long underwear
- gloves (outer, chemical-resistant)
- gloves (inner, chemical-resistant)
- boots (chemical-resistant, steel-toed, steel shank)
- hardhat (optional)
- disposable protective suit, gloves, and boots (to be worn over or under encapsulating suit)
- two-way radios

### E.2.2 Level B

Level B protection should be used when the type and atmospheric concentration of substances have been identified and require a high level of respiratory protection; however, the atmospheric contaminant, splashing liquid, or other direct contact will not adversely affect or be absorbed through any exposed skin. This includes atmospheres with IDLH concentrations of specific substances that do not (1) represent a severe skin hazard, or (2) meet the criteria for use of air-purifying respirators. Level B has the same respiratory protection criteria as Level A; however, dermal exposure is not as severe.

Level B equipment includes the following items:

- SCBA (pressure demand) OR supplied air respirator (pressure demand with escape SCBA)
- hooded chemical-resistant clothing (coated Tyvek)
- coveralls (optional)
- gloves (outer, chemical-resistant)
- gloves (inner, chemical-resistant)
- boots (chemical-resistant, steel-toed, steel shank)
- boot covers (chemical-resistant) (optional)
- hardhat (optional)
- two-way radio (to be worn under outside protective clothing)
- face shield (optional)

### E.2.3 Level C

Level C protection should be used when the atmospheric contaminant, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin. In addition, the types of air contaminants must have

been identified, the concentration measured, and an air-purifying respirator must be available that can remove the contaminants. An air-purifying respirator can only be used if the oxygen content in the air is at least 19.5 percent, the contaminant has adequate warning properties (e.g., odor, taste, and irritating effect thresholds within two times the Threshold Limit Value), the concentration of the contaminant does not exceed the IDLH, and the worker has been fit-tested. Level C has the same splash protection as Level B; however, cartridge respirators are used instead of SCBAs.

Level C equipment includes the following items:

- full-face respirator (cartridge)
- hooded chemical-resistant clothing (coated Tyvek)
- coveralls (optional)
- gloves (inner, chemical-resistant)
- gloves (outer, chemical-resistant)
- boots (chemical-resistant, steel-toed, steel shank)
- boot covers (chemical-resistant) (optional)
- hardhat (optional)
- escape mask (optional)
- two-way radios (worn under outside protective clothing)
- face shield (optional)

#### E.2.4 Level D

Level D is a work uniform affording minimal protection and is used for nuisance contaminants only. Level D protection should only be used when the atmosphere contains no known hazard, all potential airborne contaminants can be monitored for, and work functions preclude splash, immersion, or the potential for unexpected inhalation or contact with hazardous levels of any chemical.

Level D equipment includes the following items:

- coveralls
- gloves (optional)
- boots (chemical-resistant, steel-toed, steel shank)
- boot covers (chemical-resistant) (optional)
- safety glasses or chemical splash goggles (optional)
- hardhat (optional)
- escape mask (optional)
- face shield (optional)

**APPENDIX F MONITORING EQUIPMENT**

## APPENDIX F MONITORING EQUIPMENT

The work environment will be monitored to ensure that IDLH or other dangerous conditions are identified. At a minimum, monitoring will include evaluations for combustible atmospheres, oxygen-deficient environments, hazardous concentrations of airborne contaminants, and radioactivity.

### F.1 AIR SAMPLING: EQUIPMENT, CALIBRATION, AND MAINTENANCE

To the extent feasible, the presence of airborne contaminants will be evaluated through the use of direct-reading instrumentation. Information gathered will be used to ensure the adequacy of the levels of protection being used at the site, and may be used as the basis for upgrading or downgrading levels of protection, at the discretion of the site HSO.

#### F.1.1 ISC MX-241 Dual Detector

This meter monitors for combustible gases and oxygen. It can be used to determine (1) if an area contains concentrations of combustible gases with readings in percentage of the lower explosive limit (LEL); and (2) the percentage of oxygen. This equipment will be calibrated in accordance with the manufacturer's instructions.

This instrument also is calibrated to methane and monitors combustible gases in the percentage of the lower explosive limit. It will be calibrated in accordance with the manufacturer's instructions.

#### F.1.2 ISD HS267

This instrument monitors for the presence of hydrogen sulfide in parts per million (ppm). It will be calibrated in accordance with the manufacturer's instructions.

#### F.1.3 Photovac Organic Vapor Analyzer 10S50

The Organic Vapor Analyzer (OVA) is a total organic vapor analyzer capable of detecting volatile organic compounds (VOCs) that can be ionized by ultraviolet (UV) light. Model 10S50 is commonly used onsite to estimate the presence of VOCs for purposes of crew protection, well screen placement, and selection of samples for further analysis. The principle of operation is twofold: (1) the ambient temperature gas chromatograph, which breaks down mixtures of VOCs into individual components identified by retention time; and (2) detection accomplished by ionization in UV light. The charged component then moves to an electrode which, in turn, results in a meter deflection proportional to the concentration of the contaminant. This instrument does not read out directly in ppm unless calibrated against the material being measured; therefore, results must be interpreted conservatively and with care. Calibration and maintenance will be performed in accordance with the manufacturer's instructions.

#### **F.1.4 HNU IS101, OVM Model 580A, and Photovac TIP Photoionization Detector**

Like the OVA, the photoionization detector (PID) operates on the basis of ionization of the contaminant, which results in a meter deflection proportional to the concentration of the contaminant. In the PID, ionization is caused by a UV light source. The strength of the UV, measured in electron volts (eV), determines which contaminants can be ionized. The HNU can use three different-strength UV sources, including 9.6, 10.2, and 11.7 eV; only the 10.2- and 11.7-eV probes are currently available for field use. The TIP operates using a UV light source of 10.6 eV. Calibration and maintenance will be performed in accordance with the manufacturer's instructions.

#### **F.1.5 Detector Tubes (MSA and Dräger)**

A colorimetric detector tube is a direct-reading instrument consisting of a glass tube impregnated with an indicating chemical, which is connected to a piston cylinder or bellows-type pump. A known volume of air is drawn through the glass tube. The contaminant in the air reacts with the indicator chemical, producing a stain the length of which is proportional to the contaminant's concentration. Care must be taken when using the detector tubes because reliability of the results depends on the proper pump calibration, the degree of stability of the reacting chemical, and the ambient temperature. Interfering gases or vapors can also positively or negatively affect measured results. Calibration and maintenance will be performed in accordance with the manufacturer's instructions.

### **F.2 PERSONAL MONITORING: EQUIPMENT, CALIBRATION, AND MAINTENANCE**

Personal monitoring will be undertaken to characterize exposure of high-risk employees to hazardous substances encountered onsite.

#### **F.2.1 Personal Sampling Pumps**

These devices can be worn by an employee to draw air samples through appropriate collection media. The units can be used to draw volumes from 2 to 3 liters per minute. Calibration will be conducted using standard industrial hygiene protocols before and after each sampling session (i.e., each day's use).

#### **F.2.2 Passive Dosimeters or Gas Badges**

These devices are nonmechanical collection devices used to monitor for organic vapors and various gases. The device is worn by an employee and then sent to an industrial hygiene laboratory for analysis.

#### **F.2.3 Thermoluminescent Dosimetry Body Badges**

These devices are nonmechanical collection devices used to monitor for x-ray, beta, and gamma radiation exposure. The badges are worn by ABB-ES employees and sent quarterly to Tech/Ops Landauer, Inc., for analysis.

**APPENDIX G ZONATION**

## APPENDIX G ZONATION

The site itself will normally be divided into three zones: (1) the majority of the work area, considered the Exclusion Zone; (2) limited areas serving as the Support Zone; and (3) an area for decontamination called the Contamination Reduction Zone (CRZ).

### G.1 EXCLUSION ZONE

The Exclusion Zone isolates the area of contaminant generation and restricts (to the extent possible) the spread of contamination from active areas of the site to support areas and offsite locations. The Exclusion Zone is demarcated by the Hot Line (i.e., a tape line or physical barrier). Personnel entering the Exclusion Zone must (1) enter through the CRZ; (2) wear the prescribed level of protection; and (3) be otherwise authorized to enter the Exclusion Zone. Any personnel, equipment, or materials exiting the Exclusion Zone will be considered contaminated. Personnel will be subject to decontamination; equipment and materials will either be subject to decontamination or containerized in uncontaminated devices.

Within the Exclusion Zone, specific locations or restricted areas (clearly marked or identified) will be established (as necessary) for particular locations or around specific site operations. In the case of well drilling or excavation operations, a restricted area will be established that includes a minimum 30-foot radius from the drill rig or excavation operation. Other restricted areas may include drum areas, active site areas, sources of combustible gases or air contaminants, or other dangerous areas as they are identified. Access for emergency services to areas of specific site operations will be established.

### G.2 CONTAMINATION REDUCTION ZONE

Moving out from the Exclusion Zone, starting at the Hot Line and continuing to the Contamination Control Line, is the CRZ. The CRZ is a transition zone between contaminated and uncontaminated areas of the site. When "hot" or contaminated personnel, equipment, or materials cross the Hot Line, they are assumed to be as hot or contaminated as they are going to be from site operations. Being subjected to the decontamination process, they become less contaminated; when they reach the Contamination Control Line, they are clean and can exit the CRZ without spreading contamination.

Within the CRZ is the Contamination Reduction Corridor, where materials necessary for full personnel and portable equipment decontamination are kept. A separate facility will be established for heavy equipment decontamination. In addition, certain safety equipment (e.g., emergency eye wash, fire extinguisher, stretcher, and first aid kit) are staged in this zone.

### G.3 SUPPORT ZONE

The Support Zone is the outermost zone of the site, separated from the CRZ by the Contamination Control Line; it is considered a clean area. Movement of personnel and materials from the Support Zone into the CRZ is generally unrestricted, except as required through access points controlled for administrative purposes. However, only uncontaminated/decontaminated personnel or materials may enter the Support Zone from the CRZ.

The Support Zone contains the necessary support facilities (including personal hygiene facilities) for site operations. It also serves as the communications center and source of emergency assistance for operations in the Exclusion Zone and CRZ. A log of all persons entering the site will be maintained by the HSO, the field operations leader, or the site designee.

**APPENDIX H WORK PRACTICES**

## APPENDIX H WORK PRACTICES

### H.1 GENERAL

Workers will be expected to adhere to the established safe work practices for their respective specialties (e.g., drilling, laboratory analysis, and construction). The need to exercise caution in the performance of specific work tasks is made more acute due to (1) weather conditions; (2) restricted mobility and reduced peripheral vision caused by the protective gear itself; (3) the need to maintain integrity of the protective gear; and (4) the increased difficulty in communicating caused by respirators. Work at the site will be conducted according to established protocol and guidelines for the safety and health of all involved. Among the most important of these principles for working at a hazardous waste site are the following:

- In any unknown situation, always assume the worst conditions and plan responses accordingly.
- Use the buddy system. Under no conditions will any person be permitted to enter the Exclusion Zone alone. Establish and maintain communications. In addition to radio communications, it is advisable to develop a set of hand signals, because conditions may greatly impair verbal communications.
- Because no personal protective equipment is 100 percent effective, all personnel must minimize contact with excavated or contaminated materials. Plan work areas, decontamination areas, and procedures accordingly. Do not place equipment or drums on the ground. Do not sit on drums or other materials. Do not sit or kneel on the ground in the Exclusion Zone or CRZ. Avoid standing in or walking through puddles or stained soil.
- Disposable items will be used, when possible, to minimize risks during decontamination and possible cross-contamination during sample-handling.
- Smoking, eating, or drinking in the work area and before decontamination will not be allowed. Oral ingestion of contaminants is a likely means of introducing toxic substances into the body.
- Avoid heat and other work stresses related to wearing protective gear. Work breaks should be planned to prevent stress-related accidents or fatigue.
- Maintain monitoring systems. Conditions can change quickly if subsurface areas of contamination are penetrated.
- Conflicting situations that may arise concerning safety requirements and working conditions must be addressed and resolved rapidly by the HSO to avoid any motivation or pressure to circumvent established safety policy.

- To the extent feasible, handling of contaminated materials should be done in a remote area, particularly when drummed or other containerized hazardous waste materials are found onsite. Every effort should be made to identify the contents of containers found onsite before they are subject to material-handling applications.
- Personnel must be observant of not only their own immediate surroundings but also that of others. Everyone will be working under constraints; therefore, a team effort is needed to notice and warn of impending dangerous situations. Extra precautions are necessary when working near heavy equipment while using personnel protective gear because vision, hearing, and communication can be restricted.
- Contact lenses are not allowed to be worn onsite; if corrosive or lachrymose substances enter the eyes, proper flushing is impeded.
- All facial hair that interferes with the face piece fit must be removed before donning a respirator at all sites requiring Level C or Level B protection.
- Rigorous contingency planning and dissemination of plans to all personnel minimizes the impact of rapidly changing safety protocols in response to changing site conditions.
- Personnel must be aware that chemical contaminants may mimic or enhance symptoms of other illnesses or intoxication. Avoid excess use of alcohol or working while ill during field investigation assignments.
- The site leader, HSO, and sampling personnel will maintain project records in a bound notebook (e.g., daily activities, meetings, incidents, and data). Notebooks will remain onsite for the project duration so that replacement personnel may add information, thereby maintaining continuity. The notebooks and daily records will become part of the permanent project file.

## H.2 SITE ENTRY PROCEDURES

In most cases, ABB-ES teams are not the first onsite investigators. Considerable knowledge of site history and current status allows preparation of a HASP with reasonable assurance that personnel are adequately protected. In the event that sufficient site information is not available to perform a summary risk assessment and assign the appropriate level of personal protective equipment, the following procedures should be followed. It must be understood that verification of the level of contamination (even with background information) will always require some of the following steps.

1. Recognize that ABB-ES's presence onsite implies a perceived contamination potential by the client.
2. Assume that the site is contaminated and conduct a site safety reconnaissance, consisting of the following activities:

- Establish a CRZ (decontamination area).
  - Survey the site at the highest level of protection practicable, beginning with a perimeter survey and gradually covering all areas of proposed activity with the following (as appropriate):
    - HNU PI meter or equivalent
    - OVA
    - radiation survey meter
    - personal air sampling pumps
    - chemically reactive indicator tubes
    - oxygen-deficiency meter
    - explosive mixture meter
  - Establish a "hot zone."
  - Review data, assess risk, and select the appropriate level of protection.
3. Prepare a summary site HASP and document all data acquired.

**APPENDIX I PERMIT-REQUIRED CONFINED SPACES**

## APPENDIX I PERMIT-REQUIRED CONFINED SPACES

### I.1 INTRODUCTION

A worker entering a confined space can be exposed to multiple hazards if conditions are not understood or safety regulations are not enforced. Most accidents result from failure of workers to recognize a confined space as a potential hazard. Ignorance and negligence have led to a number of deaths each year by asphyxiation, fire and explosion, and/or fatal exposure to toxic materials (Table I-1). Because of this, OSHA developed the Permit-Required Confined Spaces Standard (29 CFR 1910.146).

ABB-ES associates may encounter a variety of confined spaces when working at hazardous waste sites. As the confined spaces found at hazardous waste sites are typically unknown and usually require only a single entry, all spaces will be considered permit-required unless otherwise allowed by the Health and Safety Manager (HSM).

Before entry into a confined space is permitted, the Health and Safety Officer (HSO) will ensure that the Health and Safety Plan (HASP) addresses the entry and that the entry permit has been issued. Items that will be addressed in the HASP and/or the Permit will include the following:

- Measures to use to prevent unauthorized entry.
- Identification and evaluation of the hazards.
- Means, procedures, and practices necessary for safe entry.
- Availability and proper use of required equipment.
- Procedures to determine if acceptable entry conditions exist and that they are maintained before and during entry.
- Testing or monitoring of space to ensure acceptable conditions are maintained.
- Identification of associates with active roles such as authorized entrants, attendants, entry supervisor, and rescue including assignment of duties.
- Training
- Rescue procedures
- Permit preparation, issuance, use, and cancellation.
- Coordination of entry with subcontractor.
- Review of entry operations

**TABLE I-1  
ACCIDENTS AND ILLNESS TYPE  
CONFINED SPACE (CS)**

<b>REF. NO.</b>	<b>ACCIDENT AND ILLNESS TYPE</b>	<b>EVENTS</b>	<b>INJURIES</b>	<b>FATALITIES</b>
1	Atmospheric Condition in CS	80	72	78
2	Explosion or Fire in CS	15	49	15
3	Explosion or Fire at Point-of-Entry to CS	23	20	32
4	Electrocution or Electrical Shock	11	2	9
5	Caught In/Crushing of CS	10	3	10
6	Trapped in Unstable Materials in CS	16	0	16
7	Struck by Falling Objects in CS	15	1	14
8	Falls (while in CS; not into CS)	27	26	1
9	Ingress/Egress of CS	33	30	3
10	Insufficient Maneuverability in CS	15	15	0
11	Eye Injury in CS	10	10	0
12	Contact with Temperature Extreme in CS	7	4	3
13	Noise in CS	1	1	0
14	Vibration in CS	1	1	0
15	Stress from Excess Exertion in CS	12	0	12
<b>Totals</b>		<b>276</b>	<b>234</b>	<b>193</b>

Safety Sciences, San Diego, California - 1977 [1]

## I.2 MEASURES TO PREVENT UNAUTHORIZED ENTRY

Depending on site conditions, the actual confined space plus a suitable area around the entrance will be considered the Exclusion Zone. Only those who meet the training requirements of The Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) and the Permit-Required Confined Spaces (29 CFR 1910.146) will be allowed in this area.

The perimeter of the Exclusion Zone will be identified by flagging or some other method. The actual confined space will remain sealed, locked, or otherwise protected until authorization for entry is given. If the entryway into the confined space cannot be protected from unauthorized entry, a sign stating **DANGER - PERMIT REQUIRED CONFINED SPACE, DO NOT ENTER** will be placed on or near the entry. It is the responsibility of the HSO to ensure that the above procedures are followed.

## I.3 IDENTIFICATION AND EVALUATION OF HAZARDS

When evaluating a confined space and determining its exposure potential, both physical and chemical hazards must be considered.

### I.3.1 Physical Classification

Confined Spaces are defined as areas large enough and so configured that an employee can enter the space and perform assigned work, has limited or restricted access, and is not designed for continuous occupancy. Confined spaces can be categorized generally as those with open tops and a depth that restricts the natural movement of air, and those with very limited openings for entry. In either case, the space may contain electrical or mechanical equipment with moving parts. Any combination of these parameters changes the nature of the hazards encountered. Degreasers, pits, and certain types of storage tanks may be classified as open-top confined spaces that usually contain no moving parts. However, gases that are heavier than air (i.e., butane, propane, and other hydrocarbons) remain in depressions and will flow to low points where they are difficult to remove. Open-top water tanks or test pits that appear harmless may develop toxic atmospheres (e.g., hydrogen sulfide or chlorinated hydrocarbons) from the vaporization of contaminated water or soil. Therefore, these heavier-than-air gases are a primary concern when entering such a confined space. Other hazards may develop due to the work performed in the confined space or corrosive residues that accelerate the decomposition of scaffolding supports and electrical components.

Confined spaces such as sewers, casings, tanks, silos, vaults, and compartments of ships usually have limited access. The problems associated with entry into these areas are similar to those that occur in open-top confined spaces. However, limited access increases the risk of injury. Heavier-than-air gases (e.g., carbon dioxide and propane) may lie in a tank or vault for hours or even days after the container is opened. Because some gases are odorless, the hazard may be overlooked, with fatal results. Lighter-than-air gases may also be trapped within an enclosed-type confined space, especially those with access from the bottom or sides.

The most hazardous confined space is one that combines limited access and mechanical or electrical devices. All the hazards of open-top and limited-access confined spaces may be present, together with the additional hazard of moving parts. Digesters and boilers usually contain power-driven equipment which, unless properly isolated, may inadvertently be activated after entry. Such equipment may also contain physical hazards that further complicate the work environment and the entry and exit process.

**I.3.1.1 Physical Hazards.** Physical hazards that may be encountered in a confined space include non-chemical, physiologic stresses such as thermal effects (heat and cold), noise, vibration, radiation, and fatigue.

**I.3.1.1.1 Thermal Effects.** Four factors influence the interchange of heat between humans and the environment:

- air temperature
- air velocity
- moisture contained in the air
- radiant heat

Because of the nature and design of most confined spaces, moisture content and radiant heat are difficult to control. As the body temperature rises progressively, a worker continues to function until the body temperature reaches 38.3° to 39.4°C (101° to 103°F). When this body temperature is exceeded, the worker is less efficient, and is prone to heat exhaustion, heat cramps, or heat stroke. In a cold environment, certain physiologic mechanisms come into play that tend to limit heat loss and increase heat production. The most severe strain in cold conditions is the chilling of extremities so that activity is restricted. Special precautions must be taken in cold environments to prevent frostbite, trench foot, and general hypothermia.

**I.3.1.1.2 Noise.** Noise problems are usually intensified in confined spaces because the interior tends to cause sound to reverberate, thus exposing the worker to audio levels higher than in an open environment. Intensified noise increases the risk of hearing damage to workers, which could result in temporary or permanent hearing loss, and/or could cause disorientation and affect the workers' ability to function even to the extent that they are unable to escape from the space. Noise in a confined space that may not be intense enough to cause hearing damage may still disrupt verbal communication with the emergency standby person outside the confined space. If the workers inside cannot hear commands or danger signals due to excessive noise, the probability of severe accidents can increase.

**I.3.1.1.3 Other Physical Hazards.** Some physical hazards cannot be eliminated because of the nature of the confined space or the work to be performed, including items such as scaffolding, surface residues, and structural hazards. The use of scaffolding in confined spaces has contributed to many accidents caused by workers or materials falling, improper use of guardrails, and lack of maintenance to ensure worker safety. The choice of material used for scaffolding depends on the type of work to be performed, the calculated weight to be supported, the surface on which the scaffolding is placed, and the substance previously stored in the confined space.

Surface residues in confined spaces can increase the already hazardous conditions of electrical shock, reaction of incompatible materials, liberation of toxic substances, and bodily injury due to slips, trips, and falls. Without protective clothing, additional health hazards may arise due to surface residues.

Structural hazards within a confined space (e.g., baffles in horizontal tanks, trays in vertical towers, bends in tunnels, overhead structural members, or scaffolding installed for maintenance) constitute physical hazards that are exacerbated by the physical surroundings. In dealing with structural hazards, workers must review and enforce safety precautions to ensure safety.

Rescue procedures may require withdrawal of an injured or unconscious person. Careful planning must be given to the relationship between the internal structure, the exit opening, and the worker. Provisions must be made so the victim is positioned in front of the opening in such a configuration that he/she can be removed from the space. If the worker is above the opening, the system must include a rescue arrangement operated from outside the confined space, if possible, by which the worker can be lowered and removed without injury.

### **I.3.2 Chemical Classifications**

Confined spaces are also classified according to existing or potential chemical hazards. The classification is based on characteristics of the confined space, oxygen level, flammability, and toxicity. Table I-2 defines the parameters of each classification. If any of the hazards present a situation that is Immediately Dangerous to Life and Health (IDLH), the confined space is designated as Class A and requires Level A or B personal protective equipment. The classification is determined by the most hazardous condition of entering, working in, and exiting a confined space. Class B confined spaces have the potential for causing injury and illness, but are not IDLH (Level B or C personal protective equipment). A Class C confined space is one in which the chemical hazard potential is minimal and does not require any special modification in work procedures (Level D personal protective equipment).

#### **I.3.2.1 Hazardous Atmospheres**

Hazardous atmospheres encountered in confined spaces can be divided into four categories: (1) oxygen-deficient, (2) flammable, (3) toxic, and (4) irritant and/or corrosive.

**I.3.2.1.1 Oxygen-Deficient Atmosphere.** The normal atmosphere is composed of approximately 20.9 percent oxygen, 78.1 percent nitrogen, and 1 percent argon, with small amounts of various other gases. Reduction of oxygen in a confined space may be the result of either consumption or displacement.

The consumption of oxygen occurs during combustion of flammable substances, as in welding, heating, cutting, and brazing. A more subtle consumption of oxygen occurs biologically (e.g., during the bacterial action of the fermentation process). Oxygen may also be consumed during chemical reactions (e.g., formation of rust [iron oxide] on the exposed surface of the confined space).

A second cause of oxygen deficiency is displacement by another gas. Helium, argon, and nitrogen are examples of gases that are intentionally used to displace air and which therefore reduce the oxygen level. Carbon dioxide may be

**Table I-2  
Confined Space Classification Table**

PARAMETERS	CLASS A (LEVEL A OR B PPE)	CLASS B (LEVEL B OR C PPE)	CLASS C (LEVEL D PPE)
Characteristics	Immediately dangerous to life: rescue procedures require the entry of more than one individual fully equipped with life-support equipment; maintenance of communication requires an additional standby person stationed within the confined space.	Dangerous, but not immediately life-threatening: rescue procedures require the entry of no more than one individual fully equipped with life-support equipment; indirect visual or auditory communication with workers.	Potential hazard requires no modification of work procedures: standard rescue procedures, direct communication with workers from outside the confined space.
Oxygen	19.4 percent or less *(122-mm Hg) or greater than 23.5 percent *(190-mm Hg)	19.5 to 20.9 percent *(122- to 147-mm Hg) or 20.9 to 23.5 percent (163- to 190-mm Hg)	19.5 to 20.9 percent *(148- to 163-mm Hg)
Flammability Characteristics	20 percent or greater LEL	10 to 19 percent LEL	10 percent LEL or less
Toxicity	**IDLH	Between the TLV/PEL and the **IDLH. If air-purifying respirators are used, maximum level based on breakthrough time (1,000 ppm maximum).	Less than the TLV/PEL.
Respiratory Protection	SCBA or supplied air respirator with escape bottle.	SCBA, supplied air respirator with escape bottle or air-purifying respirator.	None.

\* Based on total atmospheric pressure of 760-millimeter mercury (Hg) (sea level).

\*\* Immediately Dangerous to Life and Health, as referenced in NIOSH Registry of Toxic and Chemical Substances, Manufacturing Chemists data sheets, industrial hygiene guides, or other recognized authorities.

Notes: PPE = personal protective equipment.  
LEL = lower explosive limit.  
TLV = threshold limit value.  
PEL = permissible exposure limit.  
ppm = parts per million.  
mm = millimeter.  
Hg = mercury.  
SCBA = self-contained breathing apparatus.

intentionally introduced to displace air, but can also naturally displace air (e.g., in sewers, storage bins, wells, tunnels, wine vats, and grain elevators).

**I.3.2.1.2 Flammable Atmosphere.** A flammable atmosphere generally arises from vaporization of flammable liquids, by-products of work, chemical reactions, enriched-oxygen atmospheres, concentrations of combustible dusts, and desorption of chemicals from inner surfaces of the confined space. An atmosphere becomes flammable when, in the presence of oxygen, the concentration is neither too rich nor too lean to burn. Combustible gases or vapors will accumulate when there is inadequate ventilation in an area (e.g., a confined space). Flammable gases (e.g., acetylene, butane, propane, hydrogen, methane, natural or manufactured gases, or vapors from liquid hydrocarbons) can be trapped in a confined space. Heavier-than-air gases will seek lower levels (as in pits, sewers, and various types of storage tanks and vessels). In a closed-top tank, lighter-than-air gases may rise and develop a flammable concentration if trapped at the top of the tank.

**I.3.2.1.3 Toxic Atmosphere.** The substances regarded as toxic in a confined space can cover the entire spectrum of gases, vapors, and finely divided airborne dust in industry. The forces of toxic atmospheres encountered may arise from the manufacturing process (e.g., in producing polyvinyl chloride, hydrogen chloride is used, as well as a vinyl chloride monomer, which is carcinogenic); the product stored (e.g., removing decomposed organic material from a tank can liberate toxic substances such as hydrogen sulfide); and the operation performed in the confined space (e.g., welding or brazing with metals capable of producing toxic fumes).

**I.3.2.1.4 Irritant (Corrosive) Atmosphere.** Irritant or corrosive atmospheres can be divided into primary and secondary groups. Primary irritants show responses at the point of contact and generally exert no systemic toxic effects. Examples of primary irritants are chlorine, ozone, hydrochloric acid, hydrofluoric acid, sulfuric acid, nitrogen dioxide, ammonia, and sulfur dioxide. A secondary irritant is one that may produce systemic toxic effects in addition to surface irritation; for example, benzene, carbon tetrachloride, ethyl chloride, 1,1,1-trichloroethane, trichloroethylene, and 3-chloropropylene.

Prolonged exposure to irritant or corrosive concentrations in a confined space may produce little or no evidence of irritation. This has been interpreted to mean that the worker has adapted to the harmful agent involved. In reality, it means there has been a general weakening of the body's defense reflexes due to damage of the nerve endings in the mucous membranes of the conjunctive and upper respiratory tract. The danger in this situation is that the worker is usually not aware of any decrease in his/her reaction to the toxic substance.

### **I.3.3 General Safety Hazards**

**I.3.3.1 Communication Problems.** Communication between the worker inside a confined space and the standby person outside is of utmost importance. If the worker suddenly feels distressed and is not able to summon help, this condition could result in a fatality. Frequently, the body positions assumed in a confined space make it difficult for the standby person to detect an unconscious worker. When visual monitoring of the worker is not possible because of the design of the

confined space or location of the entry hatch, a voice- or alarm-activated, explosion-proof-type communication system is necessary.

Suitable and approved illumination is required to provide sufficient visibility for work. Illumination must be intrinsically safe and explosion-proof.

**I.3.3.2 Entry and Exit.** Entry and exit time can be of major significance if the physical limitations of the entryway hinder the rescue of an injured person. The degree of significance is directly related to the potential hazard of the confined space. The extent of precautions taken and the standby equipment needed to maintain a safe work area are determined by the means of access and rescue. The following should be considered: type of confined space to be entered; access to the entrance; number and size of openings; barriers within the space; maximum occupancy; and time required for exiting in the event of fire or vapor incursion, or to rescue injured workers.

#### **I.4 GENERAL WORK PRACTICES**

Before entry into a confined space is allowed, the HSO will ensure that procedures necessary to ensure safe permit entry are, identified, developed and implemented. These procedures may include purging and ventilation, and isolation (lock-out/tag-out),

##### **I.4.1 Purging and Ventilation**

For entering and working in a confined space, environmental control is accomplished by purging and ventilation. Purging is the initial step in adjusting the atmosphere in a confined space to acceptable standards (i.e., Permissible Exposure Limits [PELs], Threshold Limit Values [TLVs], and LELs). This is accomplished either by displacing the atmosphere in the confined space with fluid or vapor (i.e., inert gas, water, steam, and/or cleaning solution) or by forced-air ventilation.

The method used to purge or ventilate the confined space will be determined by the potential hazards that arise due to the product stored or produced, the suspected contaminants, the work to be performed, and the design of the confined space. When ventilating and/or purging operations are to be performed, the blower controls must be at a safe distance from the confined space. When a ventilation system is operational, air flow measurements (as well as atmosphere testing) must be made before each entry to ensure that a safe environmental level is maintained. Initial testing of the atmosphere should be performed from outside the confined space before ventilation begins to determine precautions necessary for purging and ventilating. Testing of more remote regions within the confined space may be performed once the immediate area within the confined space has been made safe. Exhaust systems should be designed to protect workers in the surrounding area from exposure to contaminated air. If flammable concentrations are greater or equal to 10 percent of the LEL, all electrical equipment must be intrinsically safe and explosion-proof. Continuous ventilation is required by OSHA where ever feasible. The atmosphere must be tested until acceptable levels of oxygen and contaminants are continuously maintained for three tests at 5-minute intervals. Care must be taken to prevent recirculation of contaminated air and interaction of airborne contaminants.

Continuous general ventilation should be maintained where toxic atmospheres may develop due to the nature of the confined space or the activities being performed, as in the case of desorption from walls or evaporation of residual chemicals. General ventilation is an effective procedure for distributing contaminants from a local generation point throughout the work space to obtain maximum dilution. However, special precautions must be taken if the ventilating system partially blocks the exit opening, including methods for providing respirable air to each worker for the time necessary to exit and for maintaining communications.

#### I.4.2 Isolation/Lock-out/Tagging

Isolation procedures must be specific for each type of confined space. Safety equipment required during this procedure will be designated by the HSO and will depend on potential hazards involved. A Class A or B confined space must be completely isolated from all other systems by physical disconnection, double-block and bleed, or blanking off all lines. In continuous systems, where complete isolation is not possible (e.g., sewers or utility tunnels), specific written safety procedures must be used. Shutoff valves, serving the confined space, must be locked in the closed position and tagged for identification. In addition to blanking, pumps and compressors serving the lines entering the confined space must be locked out to prevent accidental activation. If a drain line is located within the confined space, provision must be made, when necessary, to tag it and leave it open; this will be recorded in the HASP.

Electrical isolation of the confined space to prevent accidental activation of moving parts that would be hazardous to workers is achieved by locking circuit breakers and/or disconnects in the open (off) position with a key-type padlock. The only key to the padlock is to remain with the person working inside the confined space. If more than one person is inside the confined space, each person must place his own lock on the circuit breaker. In addition to the lockout system, there must be an accompanying tag that identifies the operation and prohibits use.

Mechanical isolation of moving parts can be achieved by disconnecting linkages or removing drive belts or chains. Equipment with moving mechanical parts must also be blocked to prevent accidental rotation.

#### I.5 EQUIPMENT

The HSO will ensure that prior to entering a confined space, all required equipment is present on site, in good working order, and that all associates are knowledgeable in their use. The HASP and entry Permit will include a list of necessary protective equipment to be used in the confined space, as determined by the HSO. Items to consider include head, eye, face, and foot protection against traumatic injury, respiratory, hand, and body protection for chemical hazards injuries, as well as ventilating, monitoring and rescue equipment.

Equipment that may be required on sites includes the following:

- Testing and monitoring equipment
- Ventilating equipment
- Communication equipment

- Personal protective equipment
- Lighting equipment
- Barriers and shields
- Ladders or other means of ingress or egress
- Rescue and emergency equipment
- Other

Standard items required at all sites are identified on the entry permit.

#### **I.5.1 Eye and Face Protection**

If eye-irritating chemicals, vapors, or dusts are present, safety goggles are required, unless a full-face respirator is used. If both the face and eyes are exposed to a hazard (e.g., during scraping scale), a full-face shield and goggles must be used. For those who wear corrective glasses, prescription safety glasses or goggles can be acquired through ABB-ES. As a general safety precaution, eye protection meeting the requirements and specifications of American National Standards Institute (ANSI) Standard Z89.1-1981 Class B should be worn at all times while in the confined space.

#### **I.5.2 Head Protection**

Hard hats must be worn if working directly under the manhole or entryway, if there is any danger of items falling on the worker's head, or as an adjunct to face protection. All hard hats must meet the requirements and specifications of ANSI Standard 289.1-1968.

#### **I.5.3 Foot Protection**

Steel-toe, steel-shank, chemical-resistant boots (or boot covers) must be worn when entering a confined space if there is a danger of falling objects, stepping on a sharp object or nail, and/or chemical contaminants. All safety-toe footwear must meet the requirements and specifications of ANSI Standard 241.1-1967.

#### **I.5.4 Body Protection**

The level of dermal protection to be worn by all personnel entering the confined space will be determined by the HSO, based on all data available. In choosing the level of protection, the HSO must consider the chemical hazard present, as well as the potential for heat and cold stress.

#### **I.5.5 Hearing Protection**

A hearing conservation program must be implemented if sound pressure levels equal or exceed 85 dBA (decibels on the A scale), based on an 8-hour, time-weighted average (TWA). Hearing protection is mandatory for noise levels above 90 dBA, and optional between 85 and 90 dBA. If noisy conditions are expected within the confined space, the HSO should notify the Health and Safety Manager (HSM) or the Health and Safety Supervisor (HSS) and make arrangements to have ear plugs at the site.

### **I.5.6 Respiratory Protection**

The HSO will determine the level of respiratory protection, based on conditions and test results of the confined space and the work activity to be performed. (See Appendix G2 for selection guidelines.)

### **I.5.7 Hand Protection**

Gloves of impervious rubber or similar material are to be worn to protect against toxic or irritating materials. If rough surfaces or sharp edges are expected, canvas or metal mesh can be worn over the rubber gloves. Where isolation of the electrical system is impossible, and current flow of more than 5 milliamperes through the body could potentially occur due to contact with energized electrical equipment, insulating gloves should be worn. These gloves must meet the requirements and specifications of ANSI Standard J6.6-1967.

### **I.5.8 Safety Belt/Harness**

Non-entry rescue (e.g., retrieval systems) must be used whenever an authorized Entrant enters a permit space, unless the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue of the entrant. Each Entrant shall use a chest or full body harness with a retrieval line attached at the center of the Entrants back near shoulder level or above the Entrants head. Wristlets may be used in lieu of the chest or full body harness if the ABB-ES can demonstrate that the use of a chest or full body harness is infeasible or creates a greater hazard and that the use of wristlets is the safest and most effective alternative (e.g., opening is less than 18 inches in diameter). The other end of the retrieval line must be attached to a mechanical device or fixed point outside the permit space in such a manner that rescue can begin as soon as the rescuer becomes aware that rescue is necessary. A mechanical device must be available to retrieve personnel from vertical type spaces of greater than 5 feet deep.

### **I.5.9 Other**

When employees enter a confined space, a barricade must be erected if inadvertent entry poses a problem. The barricade must have a mechanism to prevent closure of the escapeway, signs warning of the danger present, a physical barrier (i.e., fence) to keep the area clear, and an adequate platform (a minimum size of 3 by 3 feet) for entry or exit. Added features such as a tripod with either block and tackle or a mechanical pulley mechanism should be used in situations where quick removal of a worker may be required. Communications equipment (i.e., intercoms or radio systems) should be considered when the entry plan is formulated.

### **I.5.10 Equipment and Tools**

Equipment and tools to be used in a confined space must be carefully inspected, and must meet the following requirements:

- Hand tools must be kept clean and in good repair.
- Portable electric tools, equipment, and lighting must be equipped with a ground fault circuit interrupter. All grounds must be checked before electrical equipment is used in a confined space.

- All electrical cords, tools, and equipment must be heavy duty, with heavy duty insulation, and inspected for visually detectable defects before use in a confined space. For use in a flammable atmosphere, their design must be explosion-proof and intrinsically safe.
- Air-driven power tools must be used when flammable liquids are present. The use of air-driven power tools will only reduce the risk of explosion, not eliminate it. Explosions can result from tools overheating (e.g., drilling), sparks produced by striking (e.g., percussion), grinding, or discharge of accumulated electrostatic charges developed from the flow of compressed air.
- Lighting used in Class A and Class B confined spaces must be explosion-proof and intrinsically safe and, where necessary, equipped with guards. Only equipment listed by the Underwriters Laboratories for use in Division 1, atmospheres of the appropriate class and group, or approved by U.S. Bureau of Mines, Mining Enforcement and Safety Administration, Mine Safety and Health Administration, or the U.S. Coast Guard should be used. Lighting should not be hung by electrical cords, unless specifically designed for that purpose. The illumination of the work area must be sufficient to provide for safe working conditions. Under no circumstances will matches or open flames be used in a confined space for illumination.
- Cylinders of compressed gas must never be taken into a confined space, and should be turned off at the cylinder valve when not in use. Exempt from this rule are cylinders that are part of self-contained breathing apparatus (SCBA) or resuscitation equipment.
- Ladders should be adequately secured, or of a permanent type that provides the same degree of safety.
- Scaffolding and staging must be properly designed to carry maximum expected load (safety factor of four), and be equipped with traction-type planking.
- Only hose lines and components specially designed for the compressed gas and working pressure should be used, and such systems must have a pressure relief valve outside the confined space.

## I.6 TESTING AND MONITORING

Prior to entry into a confined space, workers must know its potential hazards. Deaths have occurred because a presumably safe space was not tested before initial entry. The OSHA Permit-Required Confined Space standard requires the following sequence of testing, in the order given, prior to entry into confined spaces:

1. Oxygen Content
2. Flammability
3. Toxic Chemicals

In addition to testing for chemical hazards, harmful physical agents (e.g., explosive dusts, noise, etc.) should also be conducted.

Specific instruments are required to test the atmosphere for these conditions. For example, combustible gas indicators are designed to measure the concentration of flammable gases, and will not measure or indicate the presence of carbon monoxide (CO) at toxic levels; conversely, a CO detector is designed to measure CO only. Combustible gas indicators respond differently to different flammable hydrocarbons; therefore, entry into confined spaces with flammable gas concentrations above 20 percent of the Lower Explosive Limit (LEL) should be avoided. The flammability measurement may be erroneous if the oxygen level is less than or greater than normal atmospheric concentrations. Therefore, it is required that the oxygen level be determined prior to flammability testing to make any necessary corrections in the flammability measurement.

The oxygen-deficiency measuring instrument is designed to measure the volume of oxygen present, usually scaled with a range of zero to 25 percent. If the oxygen level in a confined space atmosphere is less than 19.5 or greater than 23.5 percent, special precautions must be taken. In accordance with Occupational Safety and Health Administration (OSHA) Standard 29 CFR Part 1910 and other references, a minimum oxygen level of 19.5 percent has been adopted for worker safety. (This assumes that the 1.4 percent displaced oxygen was replaced with a nonhazardous substance.) The upper oxygen limit has been set at 23.5 percent because an increase above this level will greatly increase the rate of combustion of flammable materials.

Continuous and/or frequent monitoring becomes necessary in cases where the work being performed within the confined space has the potential of generating toxic agents. Data collected for the National Institute for Occupational Safety and Health (NIOSH) show that in 28 of 80 accident events, the toxic gas or oxygen deficiency was not in the confined space at the time of entry, but was either generated by the work occurring in the space, or by gas being unexpectedly admitted into the confined space after the worker had entered. In these cases, only continuous and/or frequent monitoring would be a possible countermeasure.

## I.7 ENTRY PERMIT

Before entry into a confined space is authorized, the HSO must document the completion of all required safety measures required by the OSHA Permit-Required Confined Space Standard. Documentation of these measures is done on the Confined Space Entry Permit (see Appendices G2 and G3). Entry into any confined space is by permit only unless first cleared by the HSM. The entry permit is an authorization and approval, in writing, that specifies the personnel permitted to enter the space and the location and type of work to be done. It certifies that all known hazards have been evaluated and necessary protective measures have been taken to ensure the safety of each worker. The entry permit will identify the permit space to be entered, the purpose of the entry, the date and authorized duration of the entry, the authorized entrants, the authorized attendants, the name and signature of the HSO, the hazards, measures used to isolate or eliminate the hazards, acceptable entry conditions, results of initial and periodic air monitoring, rescue and emergency procedures, communication procedures, equipment, as well as any other pertinent information or permits (e.g. for hot work) required.

At the site, the HSO acts as the Entry Supervisor and is responsible for the completion of the Confined Space Entry Permit and/or the Manhole/Sewer Entry Permit, ensuring that atmospheric testing has been conducted and all safety precautions have been addressed. The Permit will be posted at or near the entry portal so that all associates can confirm that pre-entry preparations have been completed. The entry permit applies only to the task or job identified and entry into the confined space cannot exceed the time required to complete the assigned task or job.

The HSO will terminate entry and cancel the entry permit when entry operations covered by the permit have been completed or a condition not allowed by the permit arises in or near the confined space. If problems are encountered during the entry operation, the HSO shall note it on the permit.

THE COMPLETED PERMIT MUST BE SENT TO THE HSM AS ABB-ES MUST RETAIN AND REVIEW EACH CANCELED PERMIT ANNUALLY.

## **I.8 TRAINING/HEALTH MONITORING**

ABB-ES personnel required to work in confined spaces, or in support of those working (if their duties include emergency rescue) in confined spaces, must be in the Health Monitoring Program and have received the 40-hours of initial hazardous waste site training, initial Confined Space Entry training, and site specific training. In addition, associates who act as Rescue personnel must maintain current certification in first aid and CPR and be trained in and have practiced rescue procedures immediately prior to entry.

As ABB-ES workers encounter a variety of confined spaces at a various locations, site specific training plays an important role in informing associates of the hazards associated with the entry. Site specific training shall be conducted prior to each entry, whenever there is a change in operations which an associate has not previously been trained, when there is a reason to believe that there are deviations from the permit space entry procedures, or inadequacies in the associate's knowledge or use of the procedures.

Training will include, but limited to, a review of the contents of the HASP and permit, verification of associate knowledge and/or training on the use all equipment to be used, emergency procedures, site specific hazards and the duties of their assigned role.

## **I.9 ROLES AND RESPONSIBILITIES**

### **I.9.1 Duties of Authorized Entrants**

The authorized entrants are the workers who actually enter the confined space and are therefore at the greatest risk. Because of this added degree of risk, these workers must be knowledgeable of the hazards they may be faced with during entry, including the mode, signs or symptoms, and consequences of the exposure and have the knowledge and skills necessary to recognize a prohibited condition or dangerous situation. The Entrants must be made aware of and know the use of all the equipment they are required to use while in the confined space.

Communication is very important while workers are in a confined space. Entrants and Attendant must be in constant communication with each other to:

- Enable the Attendant to monitor the Entrants status
- To allow the Entrant to alert the Attendant whenever the Entrant recognizes any warning sign or symptom of exposure to a dangerous situation, or when the Entrant detects a prohibited condition.
- To have the Entrant exit from the permit space as soon as possible whenever an order to evacuate is given by the Attendant or the HSO, when the Entrant recognizes any warning sign or symptom of exposure to a dangerous situation, when the Entrant detects a prohibited condition, or when an evacuation alarm is detected.

### **I.9.2 Duties of Attendants**

The Attendant is responsible for ensuring the safety of the Entrants into a confined space and therefore must not perform any other duties that might interfere with the Attendants primary duty of monitoring and protecting the Entrants. The Attendant must be aware of the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure. The Attendants must be aware of the possible behavioral effects of the hazard exposure and continuously maintain an accurate count and identification of the authorized entrants in the space. The Attendant remains outside the permit space at all times during entry operations until he/she is relieved by another attendant. The Attendant must be in constant communication with the Entrants to monitor their status and to alert entrants of the need to evacuate the space. The Attendant monitors activities inside and outside the space to determine if it is safe to remain in the space and orders the Entrants to evacuate immediately under any of the following conditions:

- The Attendant detects a prohibited condition
- The Attendant detects the behavioral effects of a hazard exposure
- The Attendant detects a situation outside the space that could endanger the Entrants.
- The Attendant cannot effectively and safety perform all his/her duties.

The Attendant is responsible for summoning rescue and other emergency services as soon as the Attendant determines that the Entrants may need assistance and warns unauthorized persons that they must stay away or exit the space immediately should they approach or enter the confined space while entry is underway. Should unauthorized persons approach or enter the confined space, the Attendant must inform the HSO immediately.

The attendant is allowed to perform non-entry rescue only unless they meet the requirements to be on the Rescue Team and they are first relieved by another attendant.

### I.9.3 Duties of Entry Supervisors (HSO)

The Entry Supervisor (HSO) has overall responsibility for the entry into the confined space. They are required to be knowledgeable of the hazards associated with the entry, including information on the mode, signs or symptoms, and consequences of exposure. The HSO is responsible for verifying, by checking, that the appropriate entries have been made on the permit, that all tests have been conducted, and that all procedures and equipment specified by the permit or in the HASP are in place before endorsing the permit and allowing entry. In addition, the HSO is responsible for terminating the entry and canceling the permit whenever entry operations covered by the permit have been completed or if conditions not allowed under the entry permit arises in or near the space.

The HSO is required to ensure that all affected workers are properly trained and receive site specific training. The HSO is required to verify that the rescue services are available and the means for summoning them are operable. If ABB-ES rescue team is used, the HSO is responsible for ensuring that all Rescue team members have practiced rescues from the actual or a representative space prior to (within the last 12 months) authorizing entry into the confined space.

He/she is responsible for removing unauthorized individuals who enter or attempt to enter the confined space during entry operations. If the responsibility for a confined space is transferred or at predetermined intervals based on the hazards and operations performed within the space, he/she determines that entry operations remain consistent with the terms of the permit and that acceptable entry conditions are maintained.

### I.9.4 Duties of Rescue and Emergency Services

Non-entry rescue (e.g., retrieval systems) must be used whenever an authorized Entrant enters a permit space, unless the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue of the entrant.

The HSO must identify and verify that rescue and emergency services are available prior to allowing entry into a confined space. Rescue and emergency services personnel can be ABB-ES associates only if the following conditions are met.

Each member of the rescue team has received the following training:

- Proper use of personal protective equipment
- Proper use of rescue equipment necessary for making rescues from permit spaces
- Assigned Rescue duties
- Duties of the authorized Entrants.
- First aid
- CPR

The Rescue team must practice making confined space rescues at least once every 12 months from the actual or a representative confined space. A representative space is one in which the opening size, configuration, and accessibility is

similar to the actual confined space. As it will be difficult to anticipate the types of spaces that ABB-ES associates encounter, the practice rescue will more than likely have to take place immediately prior to entry using the actual confined space. When simulating rescue operations, workers must practice removing dummies, manikins, or actual persons from the confined space (or a representative space).

If an outside service is to be used for rescue, the HSO must inform the rescue service of the hazards involved with entry into the space, and provide access to all the confined space(s) so that they can develop appropriate rescue plans and practice rescue operations.

#### **I.10 RESCUE PROCEDURES**

Rescue procedures to be used are site specific and will be developed as part of the HASP.

#### **I.11 HOST EMPLOYER/CONTRACTOR/SUBCONTRACTOR**

When confined space entry procedures are done in conjunction with another company (host employer/contractor/subcontractor), the entry will be coordinated to ensure that is done in a safe manner for all concerned. If the host employer or Contractor has existing confined space entry procedures, ABB-ES will attempt to obtain and review these procedures as well as all available information regarding the space and the hazards associated with it. If the host employer's/contractor's procedures meet ABB-ES minimum safety procedures, those precautions and procedures will be used. If ABB-ES feels that more stringent entry procedures are warranted, they will notify the host employer of the methods they will use when entering the confined space.

If ABB-ES is the General Contractor at the site, they will notify the subcontractor of the existence of permit-required confined spaces and that entry is allowed only through compliance with an Confined Space Entry Program. ABB-ES will notify the subcontractor of the hazards, precautions, and procedures ABB-ES has implemented for working in or near the space.

All entries will be coordinated with the host employer, contractor, or subcontractor personnel as required. ABB-ES will debrief the subcontractor or inform the host employer/contractor at the conclusion of the entry operations of any hazards confronted or created in the confined space.

#### **I.12 REVIEW OF PERMIT-REQUIRED CONFINED SPACE PROGRAM**

The HSM will review the Permit-Required Confined Spaces program on an annual basis or whenever there is reason to believe that measures taken under the program may not protect ABB-ES associates. The HSM will review the Program using the completed permits as well as all other available information as a guide. Based on the findings, the HSM will revise the Program, as appropriate to correct deficiencies to ensure that associates are protected from permit space hazards. No associate will be allowed to enter a confined space until all deficiencies are corrected.

## I.13 GENERAL ENTRY PROCEDURES

This subsection describes general entry procedures for confined spaces. The actual procedures used on a site may vary, depending on site conditions and the hazards associated with the confined space.

### I.13.1 Team Size

A minimum of two workers are required for each confined space activity, one Entrant and One Attendant/Entry Supervisor (HSO). This is for a relatively non-hazardous space where a non-entry retrieval system is being used. Arrangements for a rescue team must still be done, however, they do not have to present during the entry. Additional personnel will be needed for larger, hazardous, more complex entries, especially where there is a possibility that a rescue team may need to enter the space to rescue the Entrant. In these circumstances, a minimum of four workers are required, one Entrant, one Attendant, one HSO, and one Rescue.

These are the minimum numbers required, in most cases. Additional crew members may be needed if entering a Class A or Class B confined spaces, or specialty tasks must be completed. Additional crew could include additional Entrants, decontamination personnel, etc.

### I.13.2 General Entry Procedures

The following steps must be taken when entering a confined space:

- (1) Check and calibrate all pieces of equipment to ensure they are in good working order. **DO NOT ENTER A CONFINED SPACE WITH DEFECTIVE EQUIPMENT!**
- (2) Conduct a background check to identify all potential hazards that may be encountered in the confined space. Determine if there is a potential for fire/explosion hazards, as well as a toxic or oxygen-deficient atmosphere.
- (3) Define and demarcate the exclusion zone with flagging or some other method. Ensure that the entrance into the confined space remains locked, blocked, or otherwise protected until workers are ready to enter the space. If the entrance cannot be protected from unauthorized entry, place a sign one or near the entry stating **DANGER - PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER.**
- (3) Before entry, test the atmosphere inside the confined space. An attempt should be made to test the atmosphere without opening the entryway (i.e., through a vent line or a small opening). If the entryway must be opened to test and only low levels are expected in the confined space, crack open the entryway, test the breathing zone first, and then test the confined space. If potentially high levels are expected in the breathing zone, respiratory protection should be worn while opening the entryway cover.

- (4) If an oxygen deficient, explosive, or toxic atmosphere is detected, purge or ventilate the confined space before entry. Retest the atmosphere three times at 5-minute intervals. A person can enter the confined space without respiratory protection only if all three test results are below the PEL/TLV, 10 percent of the LEL, and above 19.5 percent oxygen (all three conditions must be met). (NOTE: Any downward deflection of the readings on the oxygen meter from background [i.e., 20.9 percent] should be viewed as a potential for an IDLH atmosphere. Unless contaminants are known to be nontoxic, do not enter the confined space without respiratory protection if the oxygen level is below background.
- (5) Blank, block, or otherwise isolate, lock-out, and tag all chemical, physical, and/or electrical hazards, wherever possible.
- (6) If Entrants are using an air-purifying respirator or if an IDLH and/or explosive atmosphere exists, air monitoring must be on a continuous basis. If respiratory protection is not used and there is potential for atmospheric conditions to change due to work practices or conditions, air monitoring should be done continuously or periodically as site conditions warrant. In all these cases, a 5-minute escape pack must be used.
- (7) Record all results of the tests for hazardous conditions, including the location, time, date, weather (if applicable), and readings on the photoionization detector (PID), combustible gas meter, oxygen-deficiency meter, Dräger tubes, and any other equipment used on the Confined Space Entry Permit.
- (8) Wear appropriate clothing for site conditions, as determined by the HSO.
- (9) Wear a safety belt or harness with lifeline when entering a confined space unless their use is not feasible or is a safety hazard. If the diameter of the entryway is less than 18 inches, the wrist-type harness must be use, and special provisions made if a supplied-air respirator is necessary.
- (10) The HSO must check to ensure that the Confined Space Entry Permit is completed and all associates are adequately trained before authorizing entry.
- (11) One person (Attendant) must remain at the entryway at all times and must maintain continuous contact with the person entering the confined space. Contact can be maintained by line of sight, listening for sounds, the safety line, and/or radio. The Attendant must not enter the confined space unless the non-entry retrieval is inoperable or infeasible, they are a trained rescuer, another trained person is available to act as an Attendant, and he/she is equipped with adequate respiratory and dermal protection. (In most cases, respiratory protection would be an airline respirator or SCBA.)

- (12) Do not smoke when working in or near confined spaces, and do not take flash-lit photographs when explosive gases are known or suspected to be present.
- (13) Do not rely on permanent ladders because they are often in poor condition. If they must be used, be sure of footing. Inspect permanent ladders for deterioration before entering and while descending. Try each step with one foot, while standing on the step above. When in doubt, use a portable ladder of adequate height to reach 3 feet above opening, or a rope ladder, or lower the entry person using the tripod. If a portable ladder is used, it should be tied off, if possible; otherwise, it should be held in place by the standby person.
- (14) Do not work without adequate lighting. Use only explosion-proof lights or hand lamps.
- (15) The entry person must not remain in the confined space if he/she becomes even slightly drowsy, faint, dizzy, or otherwise uncomfortable. Many gases that cause the most problems are odorless, tasteless, and invisible.
- (16) THE HSO MUST CANCEL THE PERMIT, NOTE AND PROBLEMS ENCOUNTERED AND SEND COMPLETED FORM TO THE HSM IN PORTLAND MAINE.

### **I.13.3 Manhole or Sewer Entry**

When preparing to enter a manhole or sewer, the following safety measures must be taken.

- (1) Check all pieces of equipment to ensure they are in good working order. DO NOT ENTER THE MANHOLE WITH DEFECTIVE EQUIPMENT!
- (2) Park the vehicle near the manhole (DO NOT leave the vehicle running). If the manhole is in the street, it is best to park so as to detour oncoming traffic around the manhole. The vehicle's emergency flashers and portable yellow warning beacon must be ON. The vehicle serves as protection from oncoming traffic, can be used to store emergency equipment (e.g., SCBA and first-aid kit), and can be used in extreme emergency to slowly pull an injured person from the confined space if a tripod with hoist attachment is unavailable or inoperable.
- (3) When appropriate, erect portable barricades or cones around the manhole and in front of the vehicle to adequately divert traffic and to prevent pedestrians from falling in. Reflective vests should be worn so that workers are visible to approaching traffic.
- (4) If there are openings large enough to admit sampling tubes, test for the presence of explosive and toxic gases before removing each manhole cover. Otherwise, raise one side of the cover using the cover hook or pick, prop it slightly open, and conduct the tests.

- (5) If toxic or explosive gases are detected in the sewer that could be indicative of a spill, leak, or otherwise hazardous condition, report this immediately to the local fire department and/or department of public works.
- (6) On the Manhole/Sewer Entry Permit, record the results of tests for hazardous conditions, including location, manhole number (if applicable), time, date, weather (if applicable), and readings on the PID, combustible gas meter, oxygen-deficiency meter, and Dräger tube. Once the Manhole/Sewer Entry Permit is completed, the HSO will verify all information before authorizing entry.
- (7) Remove manhole covers with a cover hook or pick; do not improvise. Be careful of fingers and toes; the cover is usually heavy and difficult to handle. Unless the cover is extremely heavy, it is safer for only one worker to handle it.
- (8) Test the atmosphere; if a toxic, flammable, or oxygen-deficient atmosphere exists, ventilate the sewer. Depending on the hazard, ventilation can be accomplished in several ways; for example: (1) remove and vent the adjoining upstream and downstream manhole covers, as soon as possible, and well in advance of entering the manhole (high hazard); and (2) vent the manhole in which entry will occur (very low hazard). If a blower is used, it is desirable to establish a flow of air in the sewer; that is, in one manhole and out another. Ensure that the air intake is well away from automobile exhaust, and combustible and/or toxic atmospheres. Appropriate traffic control measures must be taken by barricading or otherwise marking the open manholes.
- (9) After ventilating, test for explosive and toxic gases and oxygen deficiency in the manhole at ground level and at the bottom; record the results. If entering the sewer itself, perform the same tests at the manholes at either end. If ventilation is necessary, monitor the atmosphere in the manhole while work progresses, or continue operation of the blower. Continuous monitoring (i.e., equipment ON during entire entry) is imperative because conditions within the sewer may change rapidly. Do not enter a manhole while there is an oxygen deficiency without a pressure-demand, air-supplied breathing apparatus. If the oxygen level is lower than 20.9 percent of background, caution must be taken because an IDLH atmosphere may exist.
- (10) When entering manholes or tanks, wear hard hats, protective clothing, and appropriate respiratory protection and safety belt or harness with lifeline (when appropriate). If the manhole is less than 18 inches in diameter, a wrist-type harness must be used and special provisions made if air-supplied respirators are necessary. When working in manholes deeper than 12 feet, in the sewer itself, or where potential exists for gases to appear unexpectedly, a 5-minute emergency egress air supply is required (unless the time required to don the emergency respirator is greater than what would be needed to exit the manhole).

- (11) At least one person (i.e., standby) must remain at the manhole at all times and must maintain continuous contact with the person entering the sewer. Contact can be maintained by line of sight, listening for prearranged sounds, and the safety line signals and/or radio. The standby person must not enter the manhole unless another trained person is available to act as standby and has adequate respiratory and dermal protection available. (In most cases, respiratory protection will be an airline respirator or SCBA.) The standby/rescue person should be suited up (but not yet on air) before the work crew enters the confined space.
- (12) Do not smoke when working in or near manholes. Do not take flash-lit photographs when explosive gases are known or suspected to be present.
- (13) Do not rely on the manhole ladders because they are often in poor condition. If they must be used, be sure of footing. Inspect manhole ladders for deterioration before entering and while descending. Try each step with one foot, while standing on the step above. When in doubt, use a portable or rope ladder of adequate height to reach 3 feet above the manhole opening, or lower the entry person using the tripod. If a portable ladder is used, it should be tied off if possible; otherwise, it should be held in place by the standby person.
- (14) Do not work without adequate lighting. Use only explosion-proof lights or hand lamps in the manhole or sewer.
- (15) The entry person must not remain in the manhole or sewer if he/she becomes even slightly drowsy, faint, dizzy, or otherwise uncomfortable. Remember that CO, carbon dioxide, methane, and hydrogen sulfide, which cause the most trouble, are odorless (e.g., hydrogen sulfide has a distinct odor only during initial exposure), tasteless, and invisible gases.
- (16) Once the permitted work is completed, the HSO will cancel the permit, note any problems, and send it to the HSM in Portland Maine.

#### **I.13.4 Alternate Procedures**

ABB-ES may use the alternate procedures described below for entering a confined space when they can demonstrate and document, through monitoring and inspection data, that the only hazards associated with the space are atmospheric and that continuous forced air ventilation alone is sufficient to maintain the space safe for entry. If workers must first enter the space to obtain the data required to demonstrate that alternate procedures can be used, the entry shall be done through the use of a permit in compliance with the all sections of the Permit-Required Confined Spaces standard.

By definition, if a space requires Level C or B PPE during entry, or if the work conducted within the space can create a hazardous situation, then the alternate procedures cannot not be used. (Note: The use of respiratory protection may only be used when first opening the entrance cover if an exposure to a hazardous

atmosphere is possible. Respiratory protection should be discontinued once forced air ventilation has eliminated the atmospheric hazards.)

- (1) Review all available information to ensure alternate procedures can be used for entry into the space. If any hazards exist or can be generated, aside from atmospheric, (e.g., engulfment, entrapment, electrical, mechanical, any other serious safety or health hazard), these procedures cannot be used. (See Section G.13.0 - General Entry Procedures).
- (2) All workers must have certificates stating that they have attended a Confined Space Entry training course.
- (3) Inspect and calibrate all pieces of equipment to ensure they are in good working condition. DO NOT ENTER A CONFINED SPACE WITH DEFECTIVE EQUIPMENT!
- (4) Evaluate the conditions around the entrance cover to the confined space. Any existing conditions that make it unsafe to remove the cover must be eliminated. These conditions include both chemical and physical hazards.
- (5) Once the entrance cover is removed, the entryway shall be immediately guarded by a railing, temporary cover, danger tape, or some other temporary barrier that will prevent an accidental fall through the opening and that will protect each employee working in the space from foreign objects entering the space.
- (6) Monitor the breathing zone and then the entryway in the following order: 1) oxygen; 2) LEL; and 3) toxic chemicals. When monitoring for toxic chemicals, use one or any combination of the following meters as appropriate: PID, FID, Hydrogen Sulfide Meter, and/or Dräger tubes. Other meters may also be used as appropriate. NOTE: If there is a potential for high concentrations of  $H_2S$  (above the PEL/TLV) then respiratory protection during this stage is mandatory.
- (7) Monitor the internal atmosphere (top, middle, and bottom) for the following in the order given: 1) oxygen; 2) LEL, 3) toxic chemicals. If the largest reading is:
  1.  $\leq 19.5$  % Oxygen
  2.  $\geq 10$  % LEL
  3.  $\geq \frac{1}{2}$  PEL/TLV

than the space must be ventilated using forced air ventilation. If all the readings (top, middle, and bottom) within the space are within acceptable ranges for entry, than entry can be conducted without ventilation.

- (8) If forced air ventilation is required, it must be directed so as to ventilate the immediate area(s) where associates are working and will continue until all associates have left the confined space.

- (9) The air supply for the forced air ventilation must be from a clean source, and not located near running vehicles, motors, or some other sources of contamination.
- (10) The atmosphere within the space must be periodically tested, as necessary, to ensure that the continuous forced air ventilation is preventing the accumulation of a hazardous atmosphere. In addition, as the exhaust for the contaminated air will more than likely be through the entryway, the breathing zone of any workers standing outside the space should also be periodically monitored to ensure the levels are within acceptable ranges.
- (11) If a hazardous atmosphere is detected during entry, each associate must leave the space immediately and the space evaluated to determine how the hazardous atmosphere developed. Measures must then be taken to prevent a reoccurrence of the situation leading to the development of the hazardous atmosphere before allowing any subsequent entry. If a reoccurrence cannot be prevented, entry must then be conducted using a permit in compliance with the entire Permit-Required Confined Spaces standard.
- (12) The HSO must verify that the space is safe for entry and that all the required measures have been take. Once verification has taken place, the HSO will ensure all sections of the Confined Space Entry - Alternate Procedures form is completed and has his/her signature certifying the space is safe for entry.
- (13) All entrants are required to review and sign the Confined Space Entry - Alternate Procedures form.

The following sections of the Permit-Required Confined Spaces standard are not required when using the Alternate Procedures:

- A written Permit-Required Confined Space Program.
- The establishment of a permit system.
- The use of an Entry Permit.
- Specific training and responsibilities for an Entrant.
- Specific training and responsibilities for an Attendant.
- Specific training and responsibilities foe an Entry Supervisor.
- Specific training and responsibilities for Rescue and Emergency personnel.

## DEFINITIONS AND ACRONYMS

ABB-ES	ABB Environmental Services, Inc.
ANSI	American National Standards Institute
Atmosphere	Refers to the gases, vapors, mists, fumes, and dusts within a confined space.
Attendant	The individual stationed outside one or more permit spaces who monitors the authorized entrants and who performs all attendant's duties assigned in the employer's permit space program
Blanking/Blocking	The absolute closure of a pipe, line, or duct by fastening of a solid plate (such as a spectacle blind or a skillet blind) that completely covers the bore and that is capable of withstanding the maximum pressure of the pipe, line, or duct with no leakage beyond the plate.
Ceiling Level	The maximum airborne concentration of a toxic agent to which an employee may be exposed for a specified period of time.
CO	carbon monoxide
Combustible Dust	A dust capable of undergoing combustion or burning when subjected to a source of ignition.
Confined Space	A space that is large enough and so configured that an associate can bodily enter and perform assigned work; has limited or restricted means for entry or exit; and is not designed for continuous use. Confined spaces include, but are not limited to, storage tanks, compartments of ships, process vessels, pits, silos, vats, degreasers, reaction vessels, boilers, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines.
Confined Space, Class "A"	A confined space that presents situations that are IDLH. These include, but are not limited to, oxygen deficiency, explosive or flammable atmospheres, and/or concentrations of toxic substances.
Confined Space, Class "B"	A confined space that has the potential for causing injury and illness, if preventive measures are not used, but not IDLH.
Confined Space, Class "C"	A confined space in which the potential hazard would not require any special modification of the work procedure.

CPR	Cardiopulmonary Resuscitation
Double Block and Bleed	The closure of a line, duct, or pipe by closing and locking or tagging two in-line valves and by opening and locking or tagging a drain or vent valve in the line between the two closed valves.
Engulfment	The surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.
Entry	The action by which a person passes through an opening into a permit-required confined space. Entry includes ensuring work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.
Entry Supervisor	The person (such as the employer, foreman, or crew chief) responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by 1910.146. (Note: the Entry Supervisor may also serve as the attendant or as an authorized entrant as long as that person is trained and equipped as required for each role he/she/fills.)
HASP	Health and Safety Plan
HSO	Health and Safety Officer
HSM	Health and Safety Manager
HSS	Health and Safety Supervisor
Hot Work	Any work involving burning, welding, riveting, or similar fire-producing operations, as well as work that produces a source of ignition (e.g., drilling, abrasive blasting, and space heating).
IDLH	Immediately Dangerous to Life and Health
Inerting	Displacement of the atmosphere by a nonreactive gas (e.g., nitrogen) to such an extent that the resulting atmosphere is noncombustible.
Isolation	A process whereby the confined space is removed from service and completely protected against the inadvertent release of material by the following: blanking off (skillet type metal blank between flanges),

misaligning sections of all lines and pipes, a double block and bleed system, electrical lock-out of all sources of power, and blocking or disconnecting all mechanical linkages.

Lower Explosive Limit	The minimum concentration of a combustible gas or vapor.
(LEL)	in air (usually expressed in percentage by volume at sea level), which will ignite if any ignition source (sufficient ignition energy) is present.
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
Oxygen Deficiency	Refers to an atmosphere with a partial pressure of oxygen (PO <sub>2</sub> ) less than 132-mm Hg. Normal air at sea level contains approximately 21 percent oxygen at a PO <sub>2</sub> of 160-mm Hg. At an altitude of 5,280 feet, normal air contains approximately 21 percent O <sub>2</sub> at a PO <sub>2</sub> of 132-mm Hg.
Oxygen-enriched	Any oxygen concentration greater than 23.5 percent PO <sub>2</sub> .
Atmosphere	190-mm Hg) at normal atmospheric pressure.
Permissible Exposure Limit (PEL)	The maximum 8-hour, TWA of any airborne contaminant which an employee may be exposed. At no time shall the exposure level exceed the ceiling concentration for that contaminant, as listed in 29 CFR Part 1910 Subpart Z.
Permit-Required	A confined space that has one or more of the following
Confined Space	characteristics: 1) contains or has a potential to contain a hazardous atmosphere; 2) contains a material that has the potential for engulfing an entrant; 3) has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or 4) contains any other recognized serious safety or health hazard.
PID	Photoionization Detector
ppm	parts per million
Prohibited Condition	Any condition in a permit space that is not allowed by the permit during the period when entry is authorized.
psi	pounds per square inch

Purging The method by which gases, vapors, or other airborne impurities are displaced from a confined space.

Respirator (Approved) A device that has met the requirements of 30 CFR Part 11, is designed to protect the wearer from inhalation of harmful atmospheres, and has been approved by the Bureau of Mines and NIOSH, and the Mine Safety and Health Administration (formerly, Mining Enforcement and Safety Administration).

SCBA self-contained breathing apparatus

Standby Person A person trained in emergency rescue procedures, assigned to remain outside the confined space and to be in communication with those working inside.

Threshold Limit Value (TLV) The maximum 8-hour, TWA of any airborne contaminant to which an employee may be exposed as recommended by the American Conference of Governmental Industrial Hygienists.

TWA time-weighted average

**CONFINED SPACE ENTRY PERMIT**

# CONFINED SPACE ENTRY PERMIT

29 CFR 1910.146

Name: \_\_\_\_\_ Site Location: \_\_\_\_\_  
 Purpose of Entry: \_\_\_\_\_  
 Contaminants: \_\_\_\_\_  
 Type of Confined Space: \_\_\_\_\_  
 Date and Time of Entry: \_\_\_\_\_ Date and Time Permit Expires: \_\_\_\_\_

**POTENTIAL HAZARDS: (Check all that apply)**

<input type="checkbox"/> Flammable	<input type="checkbox"/> Moving Parts	<input type="checkbox"/> Radioactive	<input type="checkbox"/> Entrapment
<input type="checkbox"/> O <sub>2</sub> Deficiency	<input type="checkbox"/> Valves & Pipes	<input type="checkbox"/> Noise	<input type="checkbox"/> Engulfment
<input type="checkbox"/> Toxic	<input type="checkbox"/> Electrical	<input type="checkbox"/> Heat	<input type="checkbox"/> Other _____

**EQUIPMENT REQUIRED: (Check all that apply)**

<input checked="" type="checkbox"/> LEL/O <sub>2</sub> Meter	<input checked="" type="checkbox"/> Safety Harness	<input type="checkbox"/> Level A	<input checked="" type="checkbox"/> Standby SCBA
<input type="checkbox"/> PID	<input checked="" type="checkbox"/> Lifeline	<input type="checkbox"/> Level B	<input type="checkbox"/> Ladder
<input type="checkbox"/> FID	<input type="checkbox"/> Hoist	<input type="checkbox"/> Level C	<input type="checkbox"/> Barrier and shield
<input type="checkbox"/> Draeger Tubes	<input type="checkbox"/> Ventilation	<input type="checkbox"/> Mod. Level D	<input type="checkbox"/> Radio
<input type="checkbox"/> Hydrogen Sulfide	<input type="checkbox"/> Lighting	<input type="checkbox"/> Level D	<input type="checkbox"/> Cellular Telephone
<input type="checkbox"/> Other: _____			

**ACCEPTABLE ATMOSPHERIC LEVELS FOR ENTRY:**

> 19.5% = Oxygen  
 < 10%\* = LEL  
 < 10% = Hydrogen Sulfide Meter  
 \_\_\_\_\_ = PID/FID  
 \_\_\_\_\_ = Draeger Tube \_\_\_\_\_  
 \_\_\_\_\_ = Other \_\_\_\_\_

\* May use < 20% LEL as long as precautions are taken (e.g., non-sparking tools, intrinsically safe equipment)

**ATMOSPHERE TESTING RESULTS:**

Record time and results of readings at Entryway (prior to opening door or cover), Initial atmosphere (greatest of top, middle or bottom of space), when atmosphere has Stabilized after ventilation (greatest of top, middle, or bottom of space), and periodically thereafter in the worker's Breathing Zone.

	Entryway	Initial*	Stabilized	Breathing Zone	Breathing Zone	Breathing Zone	Breathing Zone
Time							
% Oxygen							
% LEL							
H <sub>2</sub> S Meter (ppm)							
PID/FID (ppm)							
Draeger Tube (ppm)							
Tube:							
ber (list)							

If initial readings are acceptable, workers can enter space in Level D or Modified Level D without ventilation.



**MANHOLE/SEWER ENTRY PERMIT**

# MANHOLE/SEWER ENTRY PERMIT

29 CFR 1910.146

Site Name: \_\_\_\_\_ Site Location: \_\_\_\_\_  
 Purpose of Entry: \_\_\_\_\_ Date and Time of Entry: \_\_\_\_\_

**ACCEPTABLE ATMOSPHERIC LEVELS FOR ENTRY:**

>19.5% = Oxygen \_\_\_\_\_ = PID/FID  
 <10%\* = LEL \_\_\_\_\_ = Draeger Tube \_\_\_\_\_  
 <10% = Hydrogen Sulfide Meter \_\_\_\_\_ = Other \_\_\_\_\_

\*May use <20% LEL as long as precautions are taken (e.g., non-sparking tools, intrinsically safe equipment)

**EQUIPMENT REQUIRED: (Check all that apply)**

<input checked="" type="checkbox"/> LEL/O <sub>2</sub> Meter	<input checked="" type="checkbox"/> Safety Harness	<input type="checkbox"/> Level A	<input checked="" type="checkbox"/> Stand by SCBA
<input type="checkbox"/> PID	<input checked="" type="checkbox"/> Lifeline	<input type="checkbox"/> Level B	<input type="checkbox"/> Ladder
<input type="checkbox"/> FID	<input checked="" type="checkbox"/> Hoist	<input type="checkbox"/> Level C	<input type="checkbox"/> Barrier and shield
<input type="checkbox"/> Draeger Tubes	<input type="checkbox"/> Ventilation	<input type="checkbox"/> Mod. Level D	<input type="checkbox"/> Radio
<input type="checkbox"/> Hydrogen Sulfide	<input type="checkbox"/> Lighting	<input type="checkbox"/> Level D	<input type="checkbox"/> Cellular Telephone
<input type="checkbox"/> Other: _____			

**ATMOSPHERE TESTING RESULTS:**

Record time and results of readings at Entryway (prior to opening door or cover), Initial atmosphere (greatest of top, middle or bottom of space), when atmosphere Stabilizes after ventilation (greatest of top, middle, and space), and periodically thereafter in the workers Breathing Zone.

	Entryway	Initial*	Stabilized	Breathing Zone	Breathing Zone	Breathing Zone	Breathing Zone
Time							
% Oxygen							
% LEL							
H <sub>2</sub> S Meter (ppm)							
PID/FID (ppm)							
Draeger Tube (ppm)							
Other (list)							

\*If initial readings are acceptable, workers can enter space in Level D or Modified Level D without ventilation.

**DESCRIPTION OF RESCUE PROCEDURES:**

Full chest of body harness with retrieval line connected in the center of back at shoulder level or above entrants head. Retrieval line will be connected to tripod with hoisting device. Non-entry retrieval will be conducted. If entry for rescue is required, workers will don Level B PPE.

# MANHOLE/SEWER ENTRY PERMIT

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Yes No N/A


- All identified atmospheric and physical hazards are controlled.
- All hazards introduced by the work performed are addressed (e.g., welding fumes).
- Air intake of the ventilation system is located in an area free of contaminants.
- All required equipment and rescue equipment is present and in good working condition.
- Non-sparking tools and intrinsically safe equipment and lighting are used if required.
- All monitoring instruments have been properly calibrated.
- All workers have initial confined space entry training certification.
- All workers received site specific confined space entry training.
- Rescue team members practiced rescue operations in space or similar space.

Practice Date: \_\_\_\_\_


- All rescue team members certified in first aid and CPR.
- Entry coordinated with subcontractors.

## PROBLEMS ENCOUNTERED:

Was rescue required? \_\_\_\_\_

## SIGNATURES:

I have reviewed the work authorized by this permit and the information contained here - in. Written instructions and safety procedures have been received and understood. I understand that this permit is not valid and the permit cannot be approved and entry conducted if any of the above squares are marked "NO" or if required sections are incomplete.

Entrants: \_\_\_\_\_  
Attendants: \_\_\_\_\_  
Rescue Team: \_\_\_\_\_  
Other: \_\_\_\_\_

Permit prepared by: \_\_\_\_\_  
Entry Authorized by (HSO): (Print) \_\_\_\_\_ (Signature) \_\_\_\_\_

## PERMIT CANCELLATION:

Reason: \_\_\_\_\_

HSO Signature: \_\_\_\_\_

Copy of form sent to Health and Safety Manager, Portland, ME. (mandatory)

**CONFINED SPACE ENTRY - ALTERNATE PROCEDURES FORM**

# CONFINED SPACE ENTRY – ALTERNATE PROCEDURES

## 29 CFR 1910.146

Alternate procedures can only be used for confined spaces where ABB-ES has demonstrated, through monitoring and inspection that: 1) the only hazard posed by the space is an actual or potential hazardous atmosphere; and 2) Continuous forced air ventilation alone is sufficient to ensure that the space is safe for entry.

Site Name: \_\_\_\_\_ Date of Entry: \_\_\_\_\_  
 Site Location: \_\_\_\_\_ Location Confined Space: \_\_\_\_\_  
 Justification for using alternate procedures: \_\_\_\_\_

YES	NO	N/A	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1. Do conditions exist making it unsafe to open entrance cover? (If yes, unsafe conditions must be eliminated before the cover is removed!)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2. Has entrance been protected? (e.g., railing, danger tape, etc.) Method being used: _____
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3. Internal atmosphere tested with direct reading instruments? (Record results below)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	4. Atmosphere acceptable for entry? (If no, continuous forced air ventilation is mandatory!)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5. Is continuous forced air ventilation being used? (No entry allowed until atmospheric conditions are safe.)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6. Are the immediate areas where associates are or will be present being ventilated? (If no, move ventilation.)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7. Is the air supply for the forced air ventilation from a clean source? (If no, provide a clean source of air.)

**ACCEPTABLE ATMOSPHERIC LEVELS FOR ENTRY:**

> 19.5% = Oxygen \_\_\_\_\_ = PID/FID  
 < 10% = LEL \_\_\_\_\_ = Draeger Tube: \_\_\_\_\_  
 < 10% = Hydrogen Sulfide \_\_\_\_\_ = Other: \_\_\_\_\_

\* May use < 20% LEL as long as precautions are taken (e.g., non-sparking tools, intrinsically safe equipment)

**ATMOSPHERE TESTING RESULTS:** (NOTE: Monitoring must be conducted in the order listed below.)  
 Record the time and the results of readings at the Entryway (prior to opening the door or cover), Initial atmosphere (greatest of top, middle, or bottom of space), when the atmosphere has Stabilized after ventilation (greatest of top, middle, or bottom of space), and periodically thereafter in the workers Breathing Zone.

	Entryway	Initial*	Stabilized	Breathing Zone	Breathing Zone	Breathing Zone	Breathing Zone
Time							
% Oxygen							
% LEL							
H <sub>2</sub> S Meter (ppm)							
PID/FID (ppm)							
Draeger Tube (ppm) Tube:							
Other (list)							

\* If initial readings are acceptable, workers can enter space in Level D without ventilation.

I certify that all safety precautions have been taken and that conditions are safe for entry.

Signature of HSO: \_\_\_\_\_ Date: \_\_\_\_\_

I certify that I have reviewed the information provided and the space has been certified as safe for entry

Signature of Entrants: \_\_\_\_\_ Date: \_\_\_\_\_  
 \_\_\_\_\_ Date: \_\_\_\_\_

**APPENDIX J EXCAVATION AND TRENCHING**

## APPENDIX J EXCAVATION AND TRENCHING

### J.1 EXCAVATION PROCEDURES

Because excavations and trenches pose a hazard to employees, structures, and equipment, all excavations created during site operations will be done in accordance with 29 CFR 1926 Subpart P. The following steps summarize the excavation procedures that will be followed by all ABB-ES personnel:

- Prior to excavating or trenching, all surface encumbrances located so as to create a hazard to the employees will be removed or supported, and all underground utilities will be determined and located.
- Entry into excavations will be avoided at all costs. If entry is unavoidable, the excavation will be considered a confined space; as such, entry will be done in accordance with the Confined Space Entry Program (see Appendix I).
- Under no circumstances will site personnel enter excavations that are not adequately protected from cave-ins by shoring or sloping.
- Stairways, ladders, or ramps will be located in trenches deeper than 4 feet and situated to require no more than 25 feet of lateral travel.
- Excavations below the base of a building or structure will not be permitted unless the building or structure is adequately supported or a registered professional engineer determines that the excavation will not pose a hazard to the employee.
- All equipment will be kept at least 2 feet from the edge of the excavation.
- Any excavation left open and unattended will be barricaded or covered until it can be backfilled.

### J.2 SLOPING

Acceptable options for sloping or benching include the following:

Option 1. A slope of 1½ horizontal to 1 vertical (34 degrees measured from the horizontal).

Option 2. Determination of the maximum allowable slope based on soil conditions and in accordance with the conditions and requirements set forth 22 CFR in 1926, Subpart P, Appendices A and B (see Attachment A).

Option 3. Designs of sloping or benching systems using tabulated data approved by a registered professional engineer.

Option 4. Other systems designed by a registered professional engineer.

### J.3 SHORING

Acceptable options for shoring include the following:

Option 1. Designs using Appendices A, C, and D of 1910.126 Subpart P (see Attachment A).

Option 2. Designs using manufacturers tabulated data.

Option 3. Designs using tabulated data approved by a registered professional engineer.

Option 4. Other support systems designed by a registered professional engineer.

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(ii) Installation of a support system shall be closely coordinated with the excavation of trenches.

(f) *Sloping and benching systems.* Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.

(g) *Shield systems—1) General.* (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to resist lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

(2) *Additional requirements for shield systems used in trench excavations.* Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

#### Appendix A to Subpart P

##### Soil Classification

(a) *Scope and application—1) Scope.* This appendix describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. The appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils.

(2) *Application.* This appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in § 1928.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1928, and when aluminum hydraulic shoring is designed in accordance with appendix D. This Appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in § 1928.652(c), and the use of the data is predicated on the use of the soil classification system set forth in this appendix.

(b) *Definitions.* The definitions and examples given below are based on, in whole or in part, the following: American Society for

Testing Materials (ASTM) Standards D550-65 and D2488; The Unified Soil Classification System; The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report 355-122.

*Cemented soil* means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

*Cohesive soil* means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical sidescrapes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when remoulded. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

*Dry soil* means soil that does not exhibit visible signs of moisture content.

*Fissured* means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

*Granular soil* means gravel, sand, or silt (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be moulded when moist and crumbles easily when dry.

*Layered system* means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

*Moist soil* means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

*Plastic* means a property of a soil which allows the soil to be deformed or moulded without cracking, or appreciable volume change.

*Saturated soil* means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or shear vane.

*Soil classification system* means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

*Stable rock* means natural solid mineral matter that can be excavated with vertical sides and remains intact while exposed.

*Submerged soil* means soil which is underwater or is free seeping.

*Type A* means cohesive soil with an unconfined compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are clay, silty clay, sandy clay, clay loam and, in some

cases, silty clay loam and sandy clay loam. Cemented soils such as sandstone and carbonaceous are also considered Type A, however, no soil is Type A if:

(i) The soil is fissured or  
(ii) The soil is subject to vibration from heavy traffic pile driving, or similar activity, or  
(iii) The soil has been previously disturbed or

(iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater, or

(v) The material is subject to other factors that would require it to be classified as a less stable material.

##### Type B means:

(i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa) or

(ii) Granular cohesionless soils including angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.

(iii) Previously disturbed soils except those which would otherwise be classed as Type C soil.

(iv) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

(v) Dry rock that is not stable, or  
(vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

##### Type C means:

(i) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less, or

(ii) Granular soils including gravel, sand, and loamy sand; or

(iii) Submerged soil or soil from which water is freely seeping; or

(iv) Submerged rock that is not stable, or  
(v) Material in a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or steeper.

*Unconfined compressive strength* means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

*Wet soil* means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

(c) *Requirements—1) Classification of soil and rock deposits.* Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this appendix.

(2) *Basis of classification.* The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Some analyses

shall be conducted by a competent person using tests described in paragraph (c) below or in other recognized methods of soil classification and testing such as those adopted by the American Society for Testing Materials, or the U.S. Department of Agriculture National Classification System.

(3) *Visual and manual analyses.* The visual and manual analyses, such as those noted as being supportive in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient qualitative and quantitative information as may be necessary to identify properly the proper factors, and conditions affecting the classification of the deposits.

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified separately where a more stable layer lies under a less stable layer.

(5) *Reclassification.* If other conditions deposit, the proper factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) *Acceptable visual and manual tests.*

(1) *Visual tests.* Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that crumbles easily and does not stay in clumps is granular.

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If clumps of soil spall off a vertical side, the soil could be fissured. Small roots are evidence of surface growth and are indications of potentially hazardous situations.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the exposed side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) *Manual tests.* Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

(i) *Plasticity.* Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as 1/8-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two-inch (50 mm) length of 1/8-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) *Dry strength.* If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular. Any clumping of gravel, sand, or silt. If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2950—Standard Recommended Practice for Description of Soils (Visual—Manual Procedure).) Type A soils with an unconfined compressive strength of 1.5 tsi can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsi can be easily penetrated several inches by the thumb, and can be indented by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of soil, as soon as practicable after excavation to avoid to a minimum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated observant.

(v) *Drying test.* The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.5 cm) and six inches (15.2 cm) in diameter until it is thoroughly dry.

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as a unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample crumbles easily by hand, it is either a fissured cohesive material or a

granular material. The distinction between the two, however, is the area between the sample by hand or by breaking on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

## Appendix B to Subpart P

### Sloping and Benching

(a) *Scope and application.* This appendix contains specifications for sloping and benching used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in § 1926.552(b)(4).

#### (b) Definitions.

*Actual slope* means the slope to which an excavation face is excavated.

*Distress* means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and raveling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and sliding or rolling down into the excavation.

*Maximum allowable slope* means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

*Short term exposure* means a period of time less than or equal to 24 hours that an excavation is open.

(c) *Requirements.* (1) *Soil classification.* Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) *Actual slope.* (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least 10 percent to one vertical (H:V) less steep than the maximum allowable slope.

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with § 1926.551(d).

(4) *Configurations.* Configurations of sloping and benching systems shall be in accordance with Figure B-1.

TABLE B-1  
MAXIMUM ALLOWABLE SLOPES

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V) FOR EXCAVATIONS LESS THAN 20 FEET DEEP (3)
STABLE ROCK TYPE A (2) TYPE B TYPE C	VERTICAL (90°) 3/4:1 (53°) 1:1 (45°) 1 1/2:1 (34°)

NOTES:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).
3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

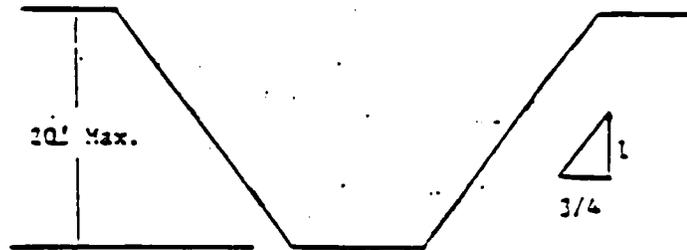
Figure B-

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

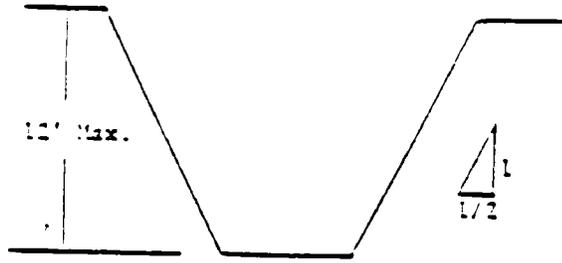
B-1.1 Excavations made in Type A soil

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of 3/4:1.



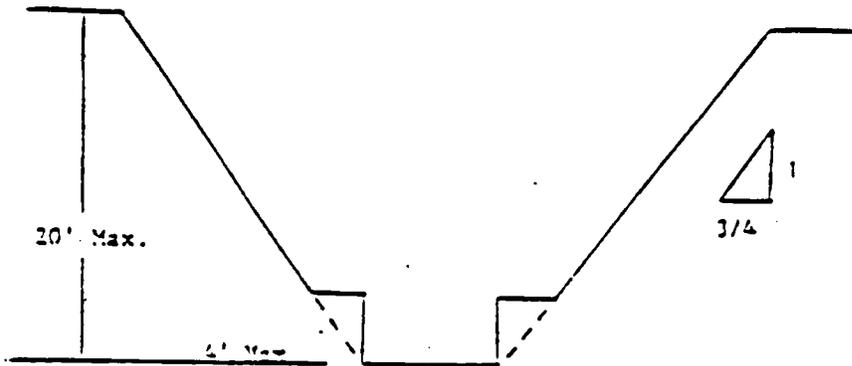
Simple Slope—General

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of 1/2:1.

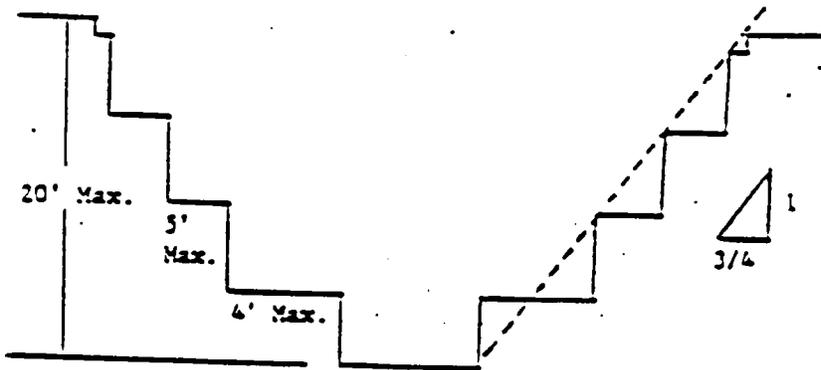


Simple Slope—Short Term

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of  $3/4$  to 1 and maximum bench dimensions as follows:

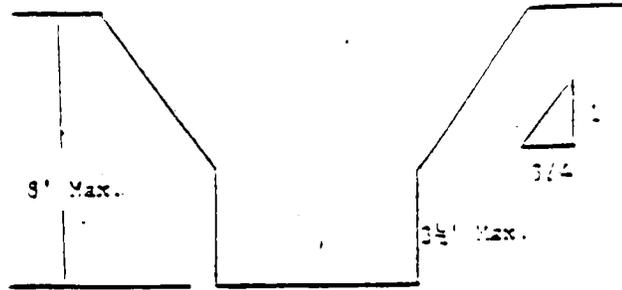


Simple Bench



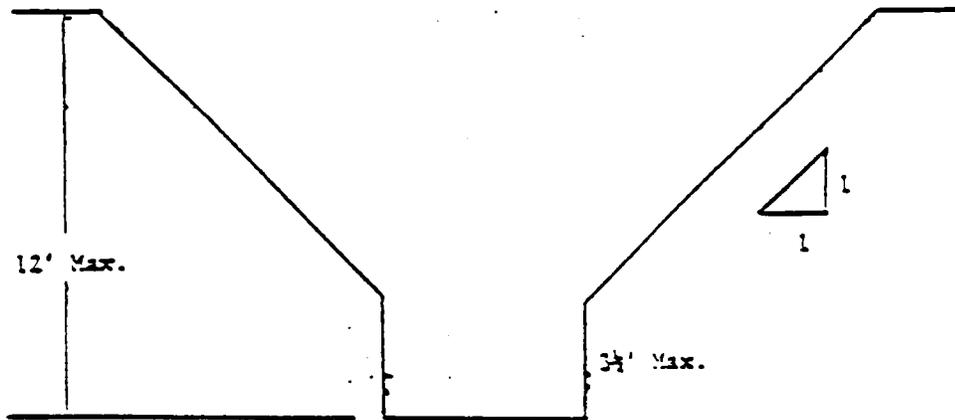
Multiple Bench

1. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of  $3/4$  feet.



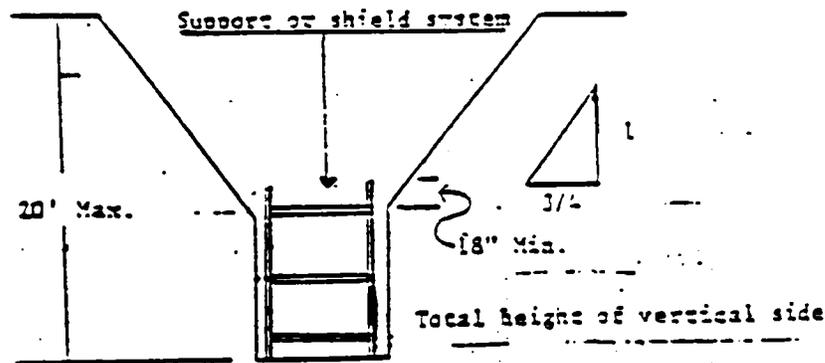
**Unsupported Vertically Sided Lower Portion—Maximum 8 Feet in Depth**

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3 1/4 feet.



**Unsupported Vertically Sided Lower Portion—Maximum 12 Feet in Depth**

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of 3/4. The support or shield system must extend at least 18 inches above the top of the vertical side.

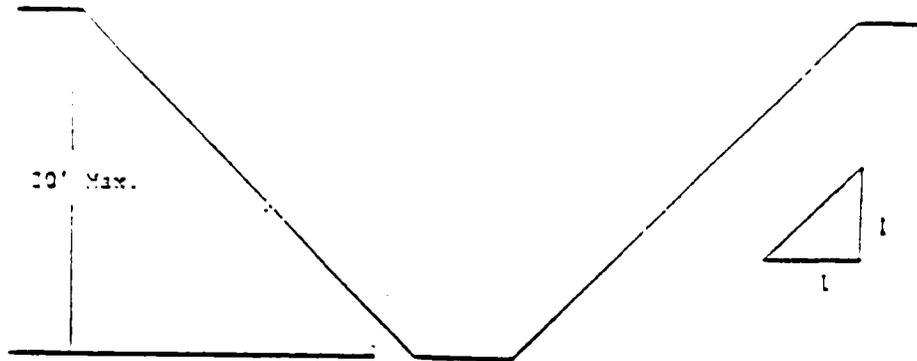


**Supported or Shielded Vertically Sided Lower Portion**

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under § 1926.852(b).

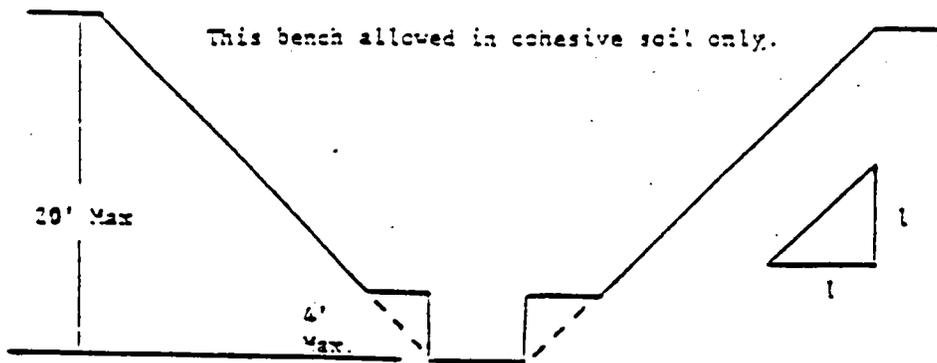
**B-1.2 Excavations Made in Type 3 Soil**

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

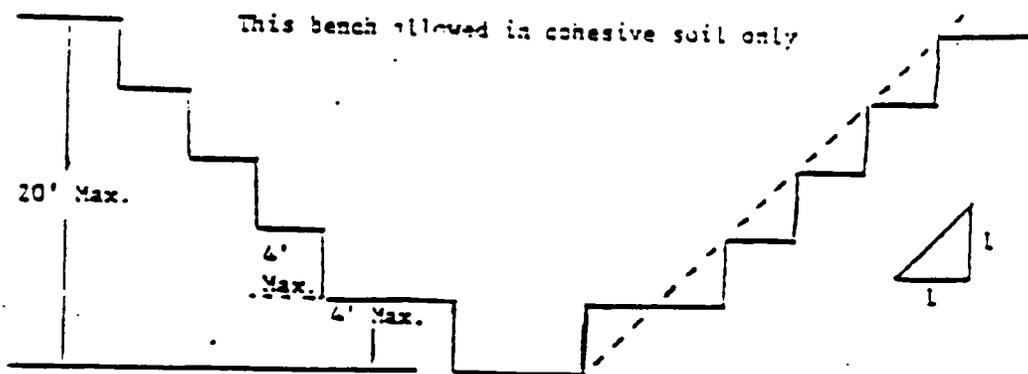


Simple Slope

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

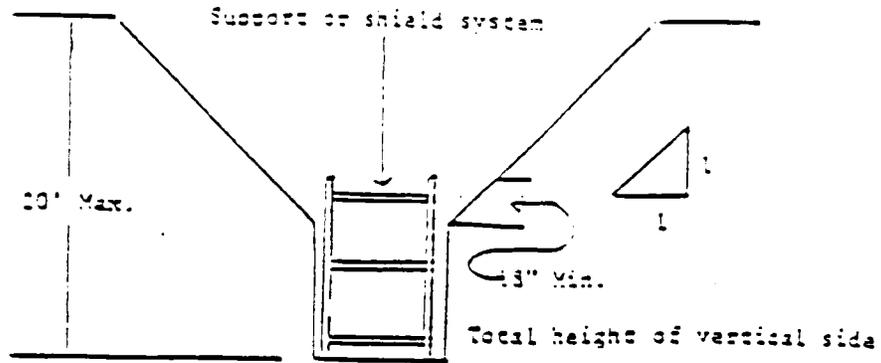


Single Bench



Multiple Bench

3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

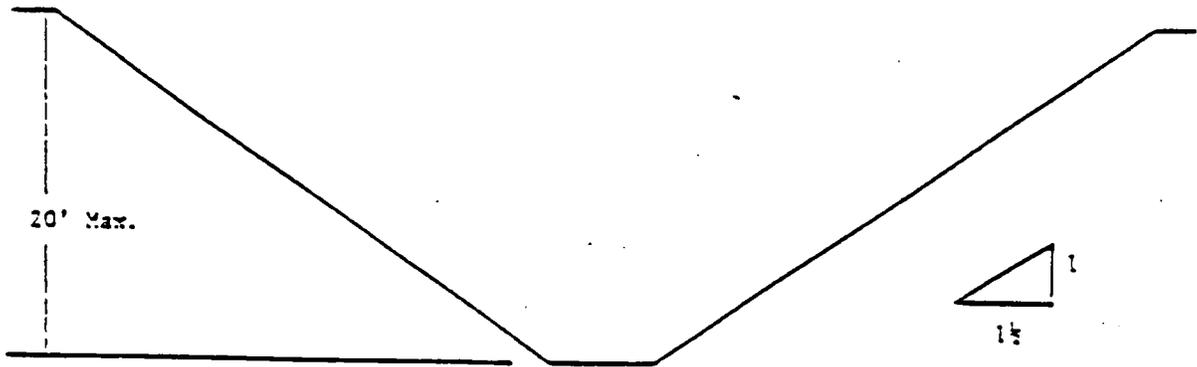


**Vertically Sided Lower Portion**

4. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

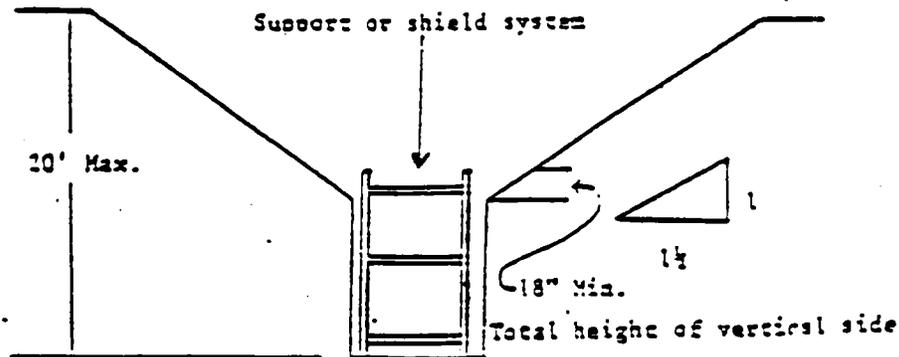
**B-L3 Excavations Made in Type C Soil**

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



**Simple Slope**

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

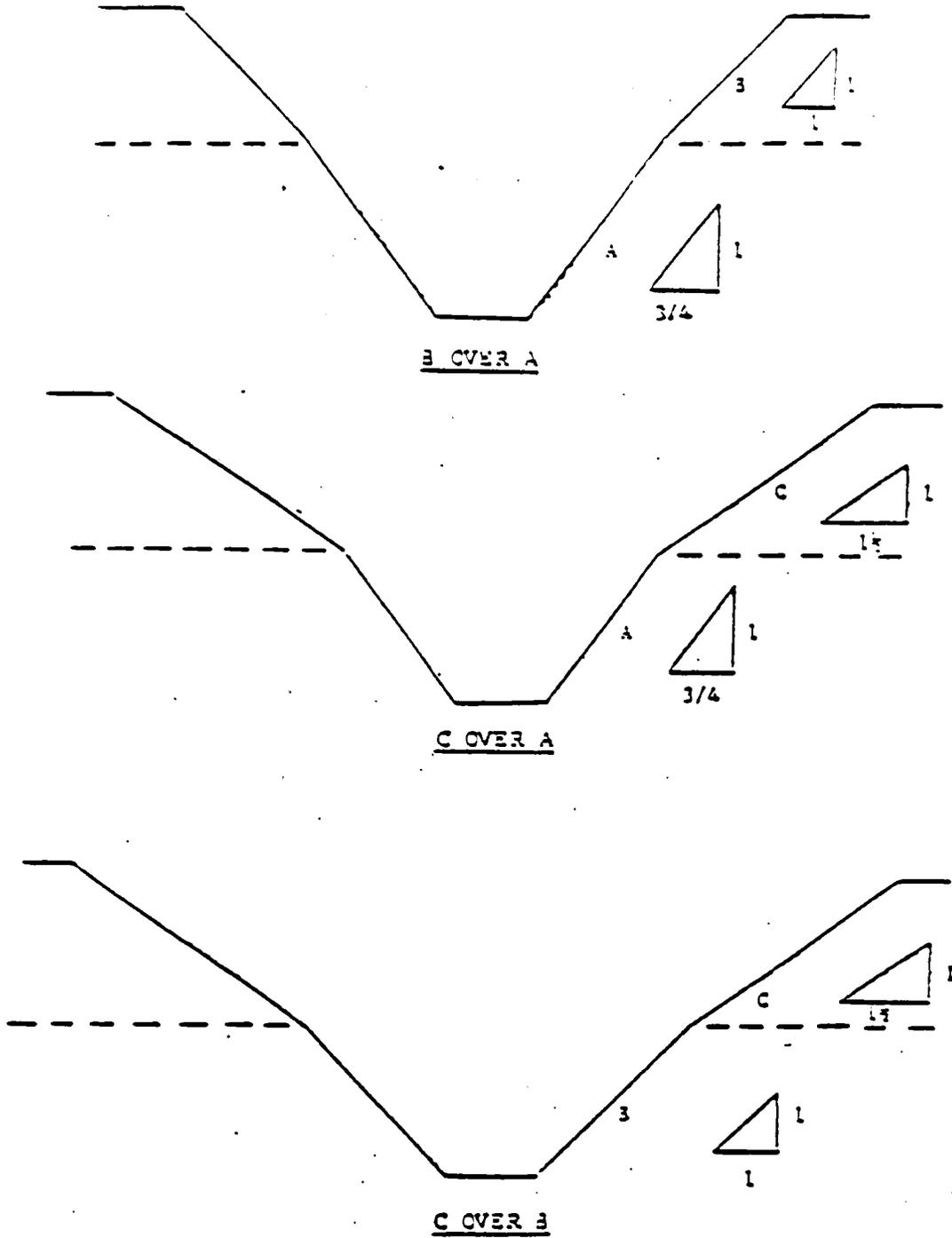


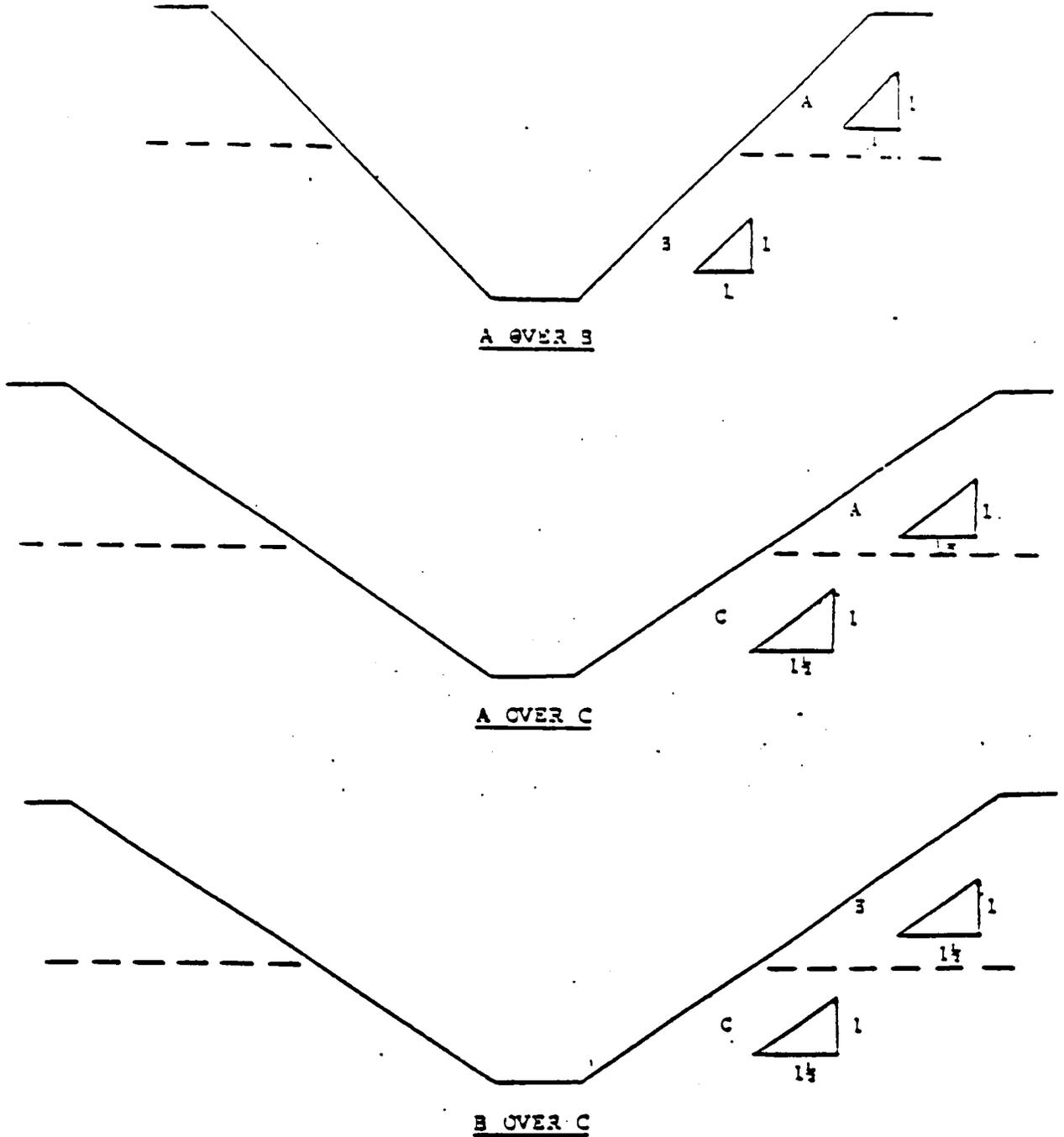
**Vertical Sided Lower Portion**

1. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

**B-L4 Excavations Made in Layered Soils**

1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.





2. All other sloped excavations shall be in accordance with the other options permitted in § 1928.652(b).

**Appendix C to Subpart P**  
**Timber Shoring for Trenches**

(a) *Scope.* This appendix contains information that can be used timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20

feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with § 1928.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing

systems must be designed in accordance with the requirements set forth in § 1928.652(b) and § 1928.652(c).

(b) *Soil Classification.* In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil

classification method set forth in appendix A of subpart P of this part.

(c) *Presentation of information.*

Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables C-1.1, C-1.2, and C-1.3, and Tables C-2.1, C-2.2, and C-2.3 following paragraphs (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or bottom of the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Slope rock is exempt from shoring requirements and therefore, no data are presented for this condition.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraphs (d) of this appendix and on the tables themselves.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous conditions regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data.*—(i) *Dimensions of timber members.* (i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report,

"Recommended Technical Provisions for Construction Practices in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the member. Employers wanting to use nominal size shoring are directed to Tables C-1.1 through C-1.3, and have one choice under § 1926.652(c)(3), and are referred to The Code of Engineers. The Bureau of Reclamation or data from other acceptable sources.

(2) *Limitation of application.* (i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in § 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with § 1926.652.

(A) When loads imposed by structures or by stored materials adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent"

as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless the sloped portion is sloped at an angle less steep than three horizontal to one vertical or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the top of the sloped portion.

(e) *Use of Tables.* The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to illustrate the Use of Tables C-1.1 through C-1.3.*

(1) *Example 1.*

A trench dug in Type A soil is 10 feet deep and five feet wide.

From Table C-1.1, for acceptable arrangements of timber can be used.

*Arrangement #1*

Space 4 X 4 crossbraces at six feet horizontally and four feet vertically. Wales are not required.

Space 3 X 8 uprights at six feet horizontally. This arrangement is commonly called "top shoring."

*Arrangement #2*

Space 4 X 6 crossbraces at eight feet horizontally and four feet vertically.

Space 6 X 8 wales at four feet vertically. Space 2 X 8 uprights at four feet horizontally.

*Arrangement #3*

Space 6 X 6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8 X 10 wales at four feet vertically.

Space 2 X 8 uprights at five feet horizontally.

*Arrangement #4*

Space 4 X 6 crossbraces at 10 feet horizontally and four feet vertically.

Space 10 X 10 wales at four feet vertically. Space 3 X 8 uprights at six feet horizontally.

(2) *Example 2.*

A trench dug in Type B soil is 13 feet deep and five feet wide. From Table C-1.2, three acceptable arrangements of members are listed.

*Arrangement #1*

Space 4 X 6 crossbraces at six feet horizontally and five feet vertically.

Space 8 X 8 wales at five feet vertically. Space 2 X 8 uprights at two feet horizontally.

*Arrangement #2*

Space 6 X 8 crossbraces at eight feet horizontally and five feet vertically.

Space 10 X 10 wales at five feet vertically. Space 2 X 8 uprights at two feet horizontally.

*Arrangement #3*

Space 8 X 8 crossbraces at 10 feet horizontally and five feet vertically.

Space 10 X 12 wales at five feet vertically. Space 2 X 8 uprights at two feet vertically.

(3) *Example 3.*

A trench dug in Type C soil is 13 feet deep and five feet wide.

From Table C-1.3, two acceptable arrangements of members can be used.

*Arrangement #1*

Space 8 X 8 crossbraces at six feet horizontally and five feet vertically.

Space 10 X 12 wales at five feet vertically. Position 2 X 8 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

*Arrangement #2*

Space 8 X 10 crossbraces at eight feet horizontally and five feet vertically.

Space 12 X 12 wales at five feet vertically. Position 2 X 8 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) *Example 4.*

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C-1.1. Only one arrangement of members is provided.

Space 8 X 10 crossbraces at six feet horizontally and five feet vertically.

Space 12 X 12 wales at five feet vertically.

Use 3 X 8 light sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) *Notes for all Tables.*

1. Member sizes at spacings other than indicated are to be determined as specified in § 1926.652(c), "Design of Protective Systems."

3. When conditions are saturated or submerged use **Tight Sheeting**. **Tight Sheeting** refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provides a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. **Close Sheeting** refers to the placement of planks side-by-side allowing as little space as possible between them.

1. All spacing indicated is measured center to center.

4. Walers to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance

shall not exceed 42 inches. Mudills are walers that are installed at the toe of the trench side.

6. Trench bracks may be used in lieu of or in combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

SHOULD COME ONE-TO-E

TABLE C-1.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS \*

SOIL TYPE A  $P_a = 25 \times H + 72$  psf (2 ft Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS **													
	HORIZ. SPACING (FEET)	CROSS BRACES					VERT. SPACING (FEET)	RAILES		UPRIGHTS				
		WIDTH OF TRENCH (FEET)						SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
	UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15						CLOSE	4	5	6
5 TO 10	UP TO 6	4x4	4x4	4x6	6x6	6x6	4	Not Req'd	---				2x6	
	UP TO 8	4x4	4x4	4x5	6x6	6x6	4	Not Req'd	---					2x8
10 TO 15	UP TO 10	4x6	4x6	4x6	6x6	6x6	4	8x8	4			2x6		
	UP TO 12	4x6	4x6	6x6	6x6	6x6	4	8x8	4				2x6	
10 TO 15	UP TO 6	4x4	4x4	4x6	6x6	6x6	4	Not Req'd	---				2x8	
	UP TO 8	4x6	4x6	6x6	6x6	6x6	4	8x8	4		2x6			
15 TO 20	UP TO 10	6x6	6x6	6x6	6x8	6x8	4	8x10	4			2x6		
	UP TO 12	6x6	6x6	6x6	6x8	6x8	4	10x10	4				2x8	
15 TO 20	UP TO 6	6x6	6x6	6x6	6x8	6x8	4	6x8	4	3x6				
	UP TO 8	6x6	6x6	6x6	6x8	6x8	4	8x8	4	3x6				
20 TO OVER 20	UP TO 10	8x8	8x8	8x8	8x8	8x10	4	8x10	4	3x6				
	UP TO 12	8x8	8x8	8x8	8x8	8x10	4	10x10	4	3x6				
OVER 20	SEE NOTE 1													

\* Mixed oak or equivalent with a bending strength not less than 850 psi.  
 \*\* Manufactured members of equivalent strength may be substituted for wood.

**TABLE C-1.2**

**TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS \***

SOIL TYPE B P<sub>u</sub> = 45 X 11 + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**													
	HORIZ. SPACING (FEET)	CROSS BRACES					VERT. SPACING (FEET)	RAILS		UPRIGHTS				
		WIDTH OF TRENCH (FEET)						SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
	UP TO	UP TO	UP TO	UP TO	UP TO				CLOSE	2	3			
5 TO 10	UP TO 6	4x6	4x6	6x6	6x6	6x6	5	6x8	5			2x6		
	UP TO 8	6x6	6x6	6x6	6x8	6x8	5	8x10	5			2x6		
	UP TO 10	6x6	6x6	6x6	6x8	6x8	5	10x10	5			2x6		
10 TO 15	See Note 1													
	UP TO 6	6x6	6x6	6x6	6x8	6x8	5	8x8	5		2x6			
	UP TO 8	6x8	6x8	6x8	8x8	8x8	5	10x10	5		2x6			
15 TO 20	UP TO 10	8x8	8x8	8x8	8x8	8x10	5	10x12	5		2x6			
	See Note 1													
	UP TO 6	6x8	6x8	6x8	8x8	8x8	5	8x10	5	3x6				
20 TO OVER 20	UP TO 8	8x8	8x8	8x8	8x8	8x10	5	10x12	5	3x6				
	UP TO 10	8x10	8x10	8x10	8x10	10x10	5	12x12	5	2x6				
	See Note 1													
OVER 20	SEE NOTE 1													

\* Mixed oak or equivalent with a bonding strength not less than 850 psf.

\*\* Manufactured members of equivalent strength may be substituted for wood.

TABLE C-1.3

**TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS \***  
 SOIL TYPE C P<sub>a</sub> - 80 X II + 72 paf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**													
	HORIZ. SPACING (FEET)	CROSS BRACES					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	UPRIGHTS				
		WIDTH OF TRENCH (FEET)								MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET) (See Note 2)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE				
5 TO 10	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	2X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
10 TO 15	UP TO 6	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 8	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
15 TO 20	See Note 1													
	UP TO 6	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
	See Note 1													
OVER 20	SEE NOTE 1													

\* Mixed Oak or equivalent with a bending strength not less than 850 paf.  
 \*\* Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS \*  
 SOIL TYPE A P<sub>u</sub> = 25 X II + 72 pcf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	HORIZ. SPACING (FEET)	GROSS BRACES					VERT. SPACING (FEET)	MALES		UPRIGHTS				
		WIDTH OF TRENCH (FEET)						SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
	UP TO	UP TO	UP TO	UP TO	UP TO						CLOSE	4	5	6
5 TO 10	UP TO 6	4X4	4X4	4X4	4X4	4X6	4	Not Req'd	Not Req'd				4X6	
	UP TO 8	4X4	4X4	4X4	4X6	4X6	4	Not Req'd	Not Req'd					4X8
	UP TO 10	4X6	4X6	4X6	6X6	6X6	4	8X8	4			4X6		
10 TO 15	UP TO 6	4X4	4X4	4X4	6X6	6X6	4	Not Req'd	Not Req'd				4X6	
	UP TO 8	4X6	4X6	4X6	6X6	6X6	4	6X8	4		4X6			
	UP TO 10	6X6	6X6	6X6	6X6	6X6	4	8X8	4			4X8		
15 TO 20	UP TO 12	6X6	6X6	6X6	6X6	6X6	4	8X10	4		4X6		4X10	
	UP TO 6	6X6	6X6	6X6	6X6	6X6	4	6X8	4	3X6				
	UP TO 8	6X6	6X6	6X6	6X6	6X6	4	8X8	4	3X6	4X12			
20 OVER 20	UP TO 10	6X6	6X6	6X6	6X6	6X8	4	8X10	4	3X6				
	UP TO 12	6X6	6X6	6X6	6X8	6X8	4	8X12	4	3X6	4X12			
OVER 20	SEE NOTE 1													

\* Douglas fir or equivalent with a bending strength not less than 1500 pcf.  
 \*\* Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS \*  
 SOIL TYPE B P - 45' X II / 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	HORIZ. SPACING (FEET)	CROSS BRACES					VERT. SPACING (FEET)	RAILS		UPRIGHTS				
		WIDTH OF TRENCH (FEET)						SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
	UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15						CLOSE	2	3	4
5 TO 10	UP TO 6	4X6	4X6	4X6	6X6	6X6	5	6X8	5			3X12 4X8		4X12
	UP TO 8	4X6	4X6	6X6	6X6	6X6	5	8X8	5		3X8		4X8	
	UP TO 10	4X6	4X6	6X6	6X6	6X8	5	8X10	5			4X8		
	See Note 1													
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5	3X6	4X10			
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5	3X6	4X10			
	UP TO 10	6X8	6X8	8X8	8X8	8X8	5	10X12	5	3X6	4X10			
	See Note 1													
15 TO 20	UP TO 6	6X8	6X8	6X8	6X8	8X8	5	8X10	5	4X6				
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X12	5	4X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6				
	See Note 1													
OVER 20	SEE NOTE 1													

\* Douglas fir or equivalent with a bending strength not less than 1500 psi.  
 \*\* Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS \*

SOIL TYPE C  $P_u = 80 \text{ X } 11 \text{ + } 72 \text{ psf (2 ft. Surcharge)}$

DEPTH OF TRENCH (FEET)	SIZE (SIZES) AND SPACING OF MEMBERS **													
	HORIZ. SPACING (FEET)	CROSS BRACES					VERT. SPACING (FEET)	RALES		UPRIGHTS				
		WIDTH OF TRENCH (FEET)						SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE				
5 TO 10	UP TO 6	6X6	6X6	6X6	6X6	8X8	5	8X8	5	3X6				
	UP TO 8	6X6	6X6	6X6	8X8	8X8	5	10X10	5	3X6				
	UP TO 10	6X6	6X6	8X8	8X8	8X8	5	10X12	5	3X6				
10 TO 15	See Note 1													
	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	10X10	5	4X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6				
15 TO 20	See Note 1													
	See Note 1													
	UP TO 6	8X8	8X8	8X8	8X10	8X10	5	10X12	5	4X6				
OVER 20	See Note 1													
	See Note 1													
	See Note 1													
OVER 20	SEE NOTE 1													

\* Douglas fir or equivalent with a bending strength not less than 1500 psi.  
 \*\* Manufactured members of equivalent strength may be substituted for wood.

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## Appendix D to Subpart P

## Aluminum Hydraulic Shoring for Trenches

(a) *Scope.* This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that do not exceed 10 feet (3.0m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with § 1925.552(c)(2).

(b) *Soil Classification.* In order to use data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables D-1.1, D-1.2, D-1.3 and D-1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. Tables D-1.1 and D-1.2 are for vertical shores in Types A and B soil. Tables D-1.3 and D-1.4 are for horizontal water systems in Types B and C soil.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous comments (footnotes) regarding Table D-1.1 through D-1.4 are presented in paragraph (g) of this appendix.

(6) Figures illustrating typical installations of hydraulic shoring, are included just prior to the Tables. The illustrations are entitled "Aluminum Hydraulic Shoring, Typical Installations."

(d) *Basis and Limitations of the Data.*

(1) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(2) Hydraulic cylinders *requirements.* (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(3) *Limitation of application.*

(i) It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly

experienced in current trenching practices.

Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in § 1925.552(c).

(ii) When any of the following conditions are present, the members identified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with § 1925.552(c).

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless the sloped portion is sloped at an angle less steep than three horizontal to one vertical or the members are selected from the tables for use at a depth which is determined from the top of the overall trench and not from the toe of the sloped portion.

(e) *Use of Tables D-1.1, D-1.2, D-1.3 and D-1.4.* The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a water system is used the vertical timber shoring to be used is also selected from these tables. The Tables D-1.1 and D-1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type B soils that may require sheeting, and Type C soils that always require sheeting are found in the horizontal wale Tables D-1.3 and D-1.4. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical spacing is held constant at four feet on center. The tables show the maximum horizontal spacing of cylinders allowed for each size of wale in the water system tables, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

(f) *Example to Illustrate the Use of the Tables*

(1) *Example 1:*

A trench dug in Type A soil is 8 feet deep and 3 feet wide. From Table D-1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

(2) *Example 2:*

A trench is dug in Type B soil that does not require sheeting, 10 feet deep and 3 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures 1 & 3 for typical installations.)

(3) A trench is dug in Type B soil that does not require sheeting, but does experience some minor raveling of the trench face. The trench is 10 feet deep and 9 feet wide. From

Table D-1.2: Find vertical shores and 2 inch diameter cylinder with special oversleeves as designated by footnote #10. Spaced 8.5 feet o.c. horizontally and 4 feet o.c. vertically. Plywood sheathing 2x12 spaced 24" vertically should be used behind the shores. (See Figures 2 & 3 for typical installations.)

(4) *Example 4:* A trench is dug in previously disturbed Type B soil with characteristics of a Type C soil and will require sheeting. The trench is 15 feet deep and 12 feet wide, 3 foot horizontal spacing between cylinders is desired for working space. From Table D-1.3: Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 2 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally. 2x12 timber shoring is required at close spacing vertically. (See Figure 4 for typical installation.)

(5) *Example 5:* A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D-1.4: Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 14.0 section modulus and 2 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically. 2x12 timber shoring is required at close spacing vertically. (See Figure 4 for typical installation.)

(g) *Footnotes, and general notes, for Tables D-1.1, D-1.2, D-1.3 and D-1.4.*

(1) For applications other than those listed in the tables, refer to § 1925.552(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet refer to § 1925.552(c)(7) and § 1925.552(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (2.5 X 2.5 X 0.273) oversleeves, or structural oversleeves of manufacturer's specification, extending the full collapsed length.

(3) Hydraulic cylinders capacities: (i) 2 inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1/2" thick softwood or 2x2 inch thick, 14 ply, arched white birch, Finland form. Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.

(8) See appendix C for amber specifications.

(9) Wales are calculated for simple span conditions.

(10) See appendix D, item (d), for basis and limitations of the data.

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# ALUMINUM HYDRAULIC SHORING TYPICAL INSTALLATIONS

FIGURE NO. 1

VERTICAL ALUMINUM  
HYDRAULIC SHORING  
(SPOT BRACING)

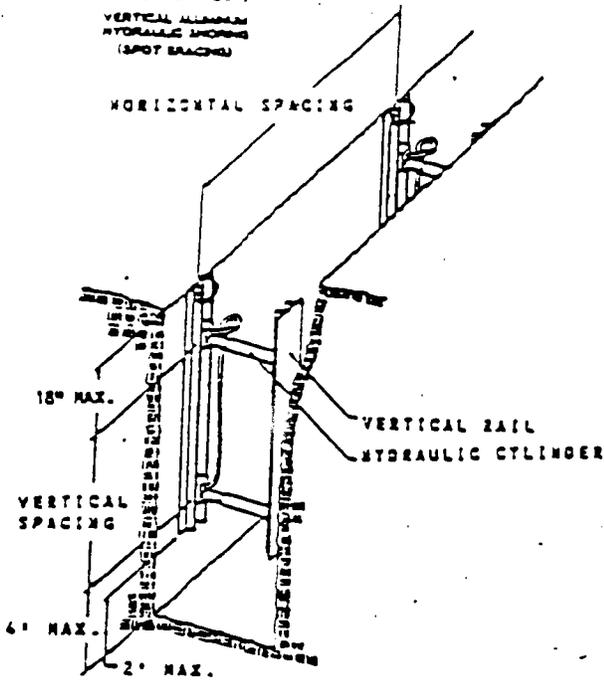


FIGURE NO. 2

VERTICAL ALUMINUM  
HYDRAULIC SHORING  
(WITH PLYWOOD)

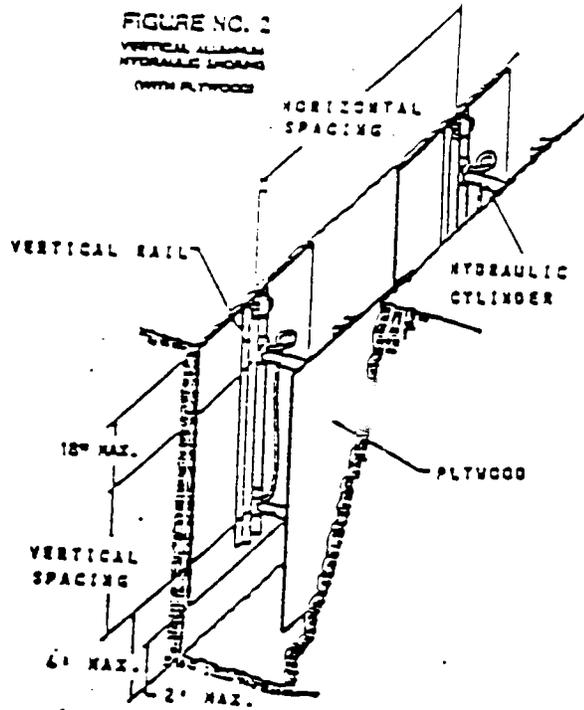


FIGURE NO. 3

VERTICAL ALUMINUM  
HYDRAULIC SHORING  
(STACKED)

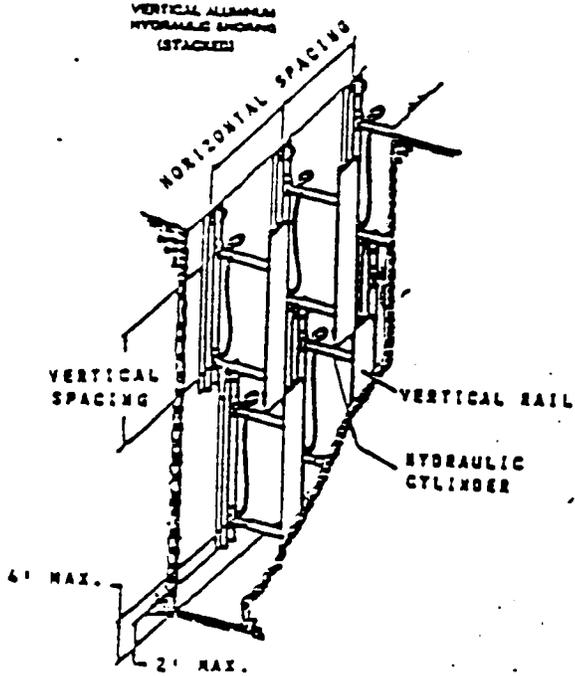
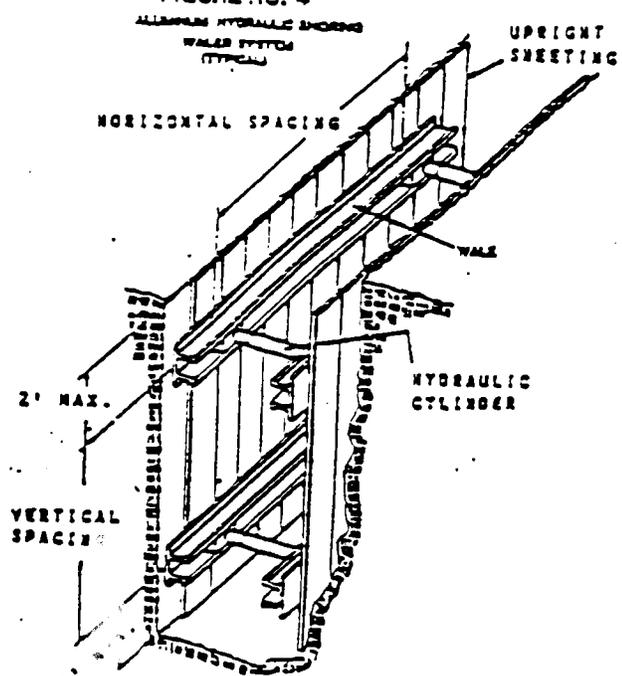


FIGURE NO. 4

ALUMINUM HYDRAULIC SHORING  
WALL SYSTEM  
(TYPICAL)



**TABLE D - 1.1  
ALUMINUM HYDRAULIC SHORING  
VERTICAL SHORES  
FOR SOIL TYPE A**

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	8				
OVER 15 UP TO 20	7				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Note (1): See Appendix D, Item (g) (1)

Note (2): See Appendix D, Item (g) (2)

**TABLE D - 1.2  
ALUMINUM HYDRAULIC SHORING  
VERTICAL SHORES  
FOR SOIL TYPE B**

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	6.5				
OVER 15 UP TO 20	5.5				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Note (1): See Appendix D, Item (g) (1)

Note (2): See Appendix D, Item (g) (2)

**TABLE D - 1.3  
ALUMINUM HYDRAULIC SHORING  
WALER SYSTEMS  
FOR SOIL TYPE B**

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
	VERTICAL SPACING (FEET)	SECTION MODULUS (IN <sup>4</sup> )	WIDTH OF TRENCH (FEET)						MAX. HORIZ. SPACING (ON CENTER)		
			UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	8.0	2 IN	8.0	2 IN NOTE(2)	8.0	3 IN			
		7.0	9.0	2 IN	9.0	2 IN NOTE(2)	9.0	3 IN			
		14.0	12.0	3 IN	12.0	3 IN	12.0	3 IN			
OVER 10 UP TO 15	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	—	3x12	—
		7.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 15 UP TO 20	4	3.5	5.5	2 IN	5.5	2 IN NOTE(2)	5.5	3 IN	3x12	—	—
		7.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
		14.0	9.0	3 IN	9.0	3 IN	9.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Notes (1): See Appendix D, item (g) (1)

Notes (2): See Appendix D, item (g) (2)

\* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

**TABLE D - 1.A  
ALUMINUM HYDRAULIC SHORING  
WALER SYSTEMS  
FOR SOIL TYPE C**

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
	VERTICAL SPACING (FEET)	SECTION MODULUS (IN <sup>4</sup> )	WIDTH OF TRENCH (FEET)						MAX HORIZ SPACING (ON CENTER)		
			UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	3x12	—	—
		7.0	6.5	2 IN	6.5	2 IN NOTE(2)	6.5	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 10 UP TO 15	4	3.5	4.0	2 IN	4.0	2 IN NOTE(2)	4.0	3 IN	3x12	—	—
		7.0	5.5	3 IN	5.5	3 IN	5.5	3 IN			
		14.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
OVER 15 UP TO 20	4	3.5	3.5	2 IN	3.5	2 IN NOTE(2)	3.5	3 IN	3x12	—	—
		7.0	5.0	3 IN	5.0	3 IN	5.0	3 IN			
		14.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Notes (1): See Appendix D, item (g) (1)

Notes (2): See Appendix D, item (g) (2)

\* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

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Appendix E to Subpart P—Alternatives to Timber Shoring

Figure 1. Aluminum Hydraulic Shoring

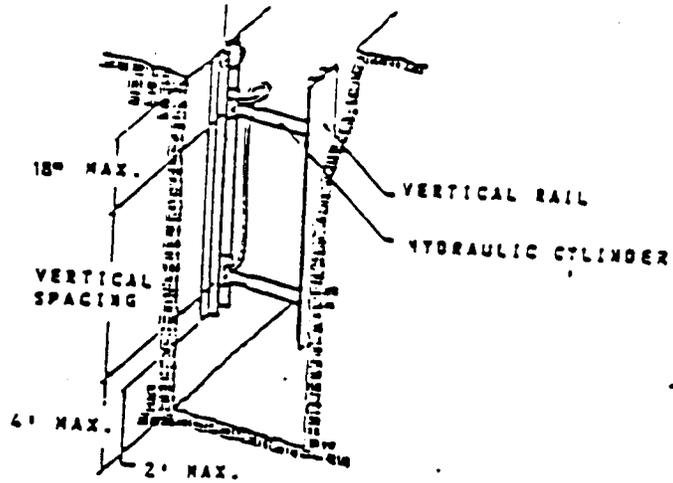
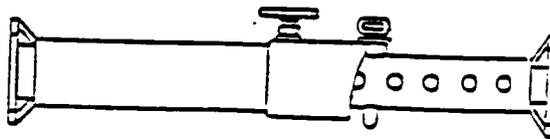
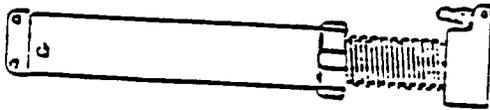


Figure 2. Pneumatic/hydraulic Shoring



BILLING CODE 4810-057

Figure 3. Trench Jacks (Screw Jacks)

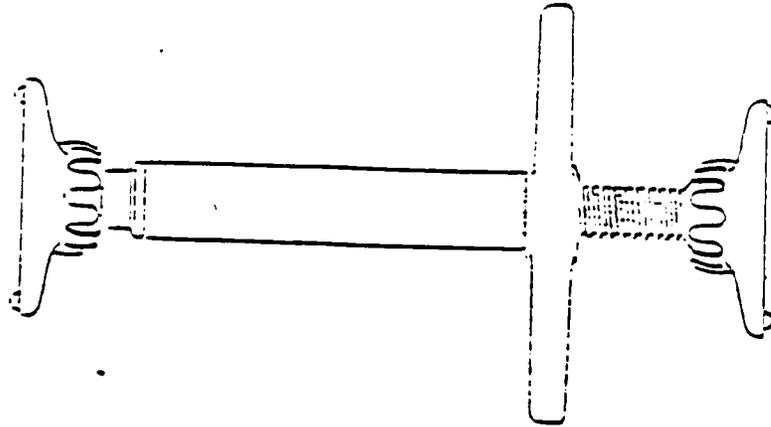
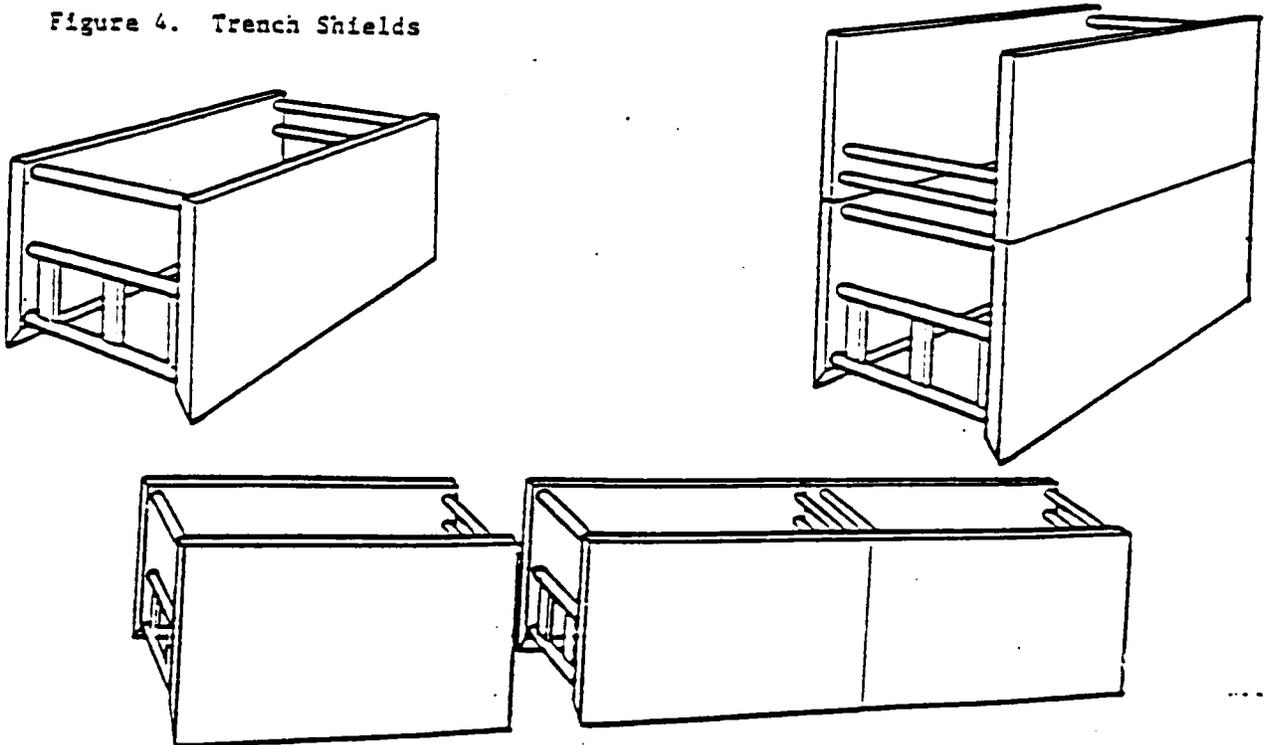


Figure 4. Trench Shields



Appendix F to Subpart P—Selection of Protective Systems

The following figures are a graphic summary of the requirements contained in subpart P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with § 1926.852 (b) and (c).

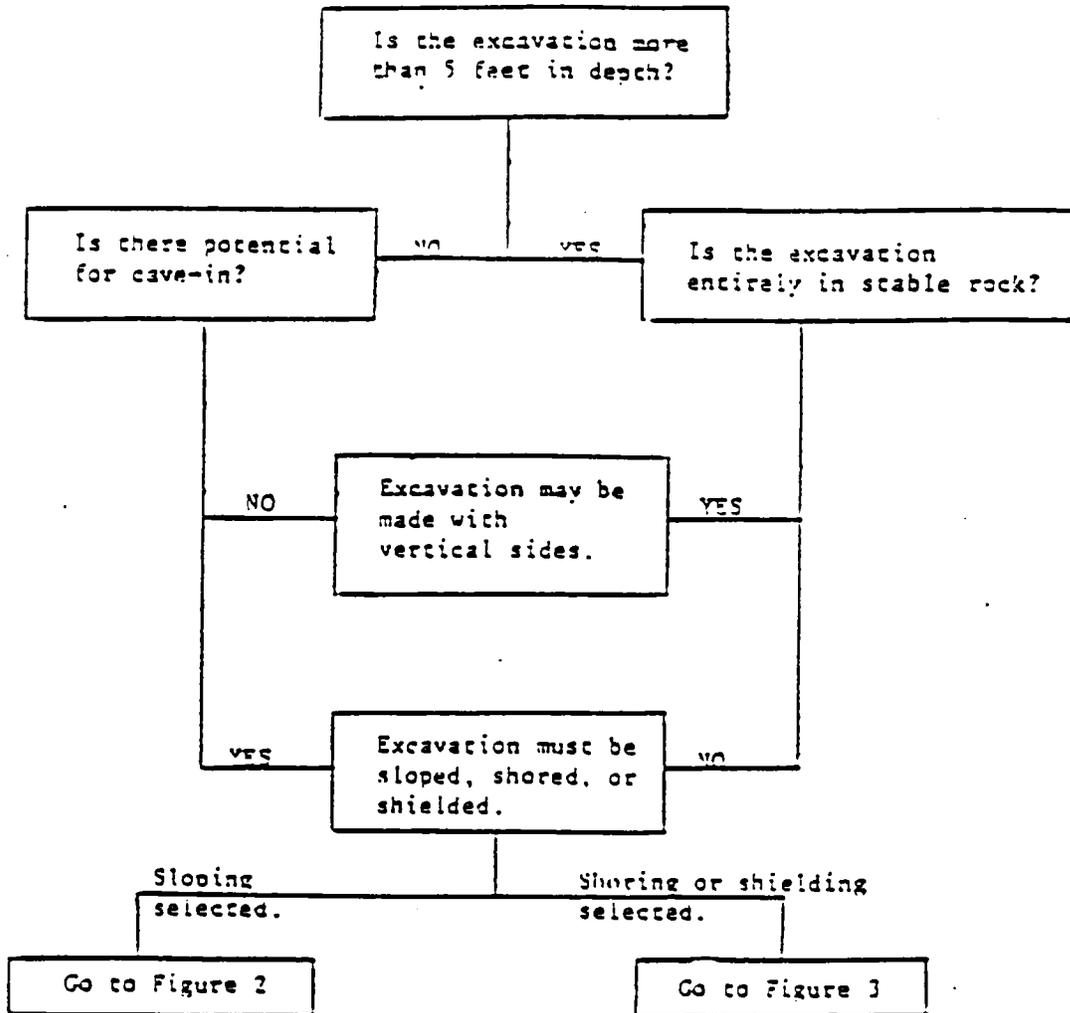


FIGURE 1 - PRELIMINARY DECISIONS

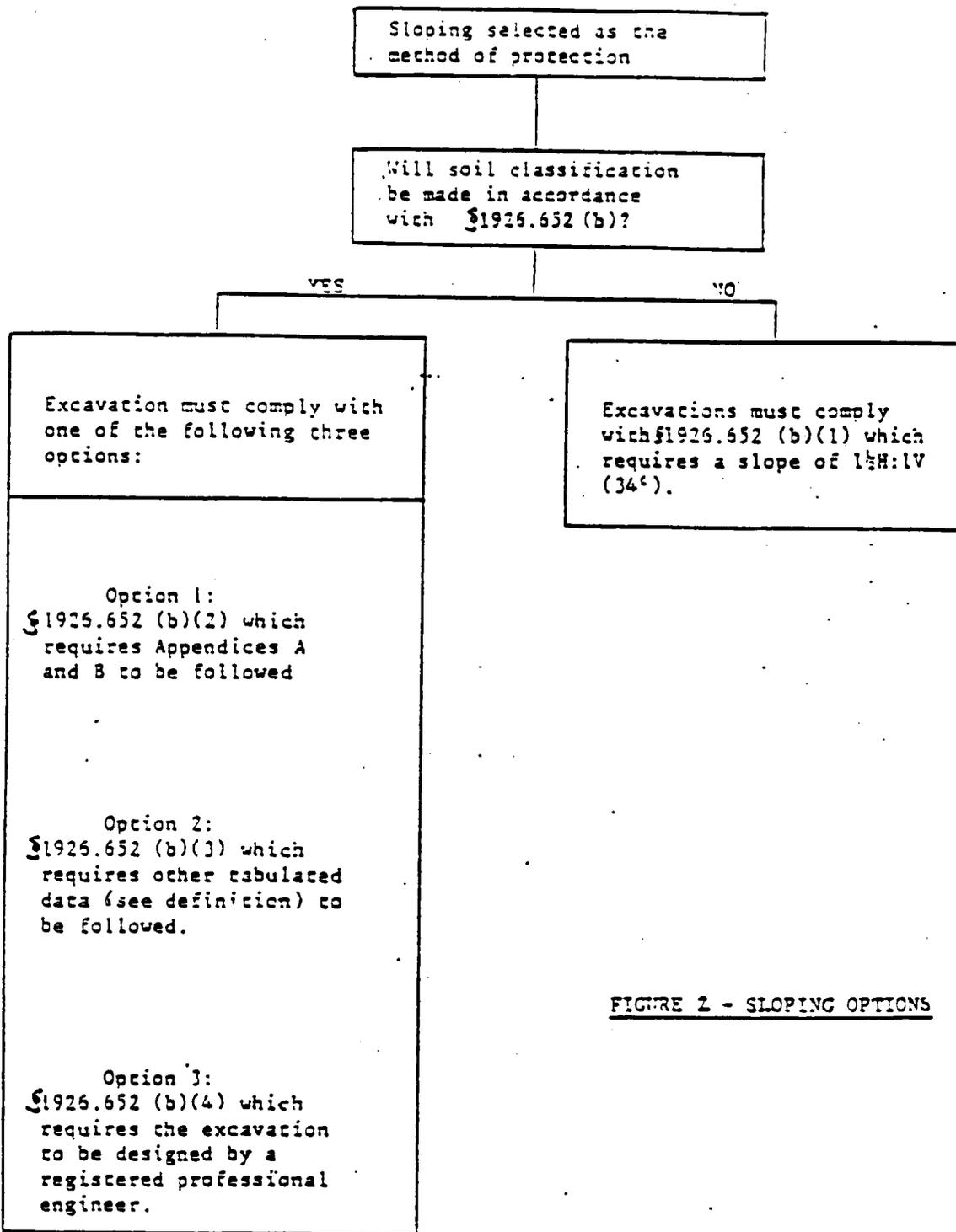


FIGURE 2 - SLOPING OPTIONS

Shoring or shielding selected  
as the method of protection.

Soil classification is required  
when shoring or shielding is  
used. The excavation must comply  
with one of the following four  
options:

Option 1

§1926.652 (c)(1) which requires  
Appendices A and C to be followed  
(e.g. timber shoring).

Option 2

§1926.652 (c)(2) which requires  
manufacturers data to be followed  
(e.g. hydraulic shoring, trench  
jacks, air shores, shields).

Option 3

§1926.652 (c)(3) which requires  
tabulated data (see definition)  
to be followed (e.g. any system  
as per the tabulated data).

Option 4

§1926.652 (c)(4) which requires  
the excavation to be designed  
by a registered professional  
engineer (e.g. any designed  
system).

**FIGURE 1 - SHORING AND SHIELDING OPTIONS**

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BILLING CODE 410-90-C

APPENDIX K TEMPERATURE EXTREMES

## APPENDIX K TEMPERATURE EXTREMES

### K.1 Heat Stress

Due to the increase in ambient air temperatures and the effects of protective outer wear decreasing body ventilation, there is increased potential for injury, specifically heat casualties. Site personnel will be instructed in the identification of a heat stress victim, the first-aid treatment procedures for the victim, and the prevention of heat stress casualties.

#### K.1.1 Identification and Treatment

##### K.1.1.1 Heat Exhaustion.

Symptoms. Heat exhaustion usually begins with muscular weakness, dizziness, nausea, and a staggering gait. Vomiting is frequent. The bowels may move involuntarily. The victim is very pale, the skin is clammy, and he or she may perspire profusely. The pulse is weak and fast; breathing is shallow. The victim may faint unless he or she lies down. This may pass; however, sometimes it persists and, while heat exhaustion is generally not considered life threatening, death could occur.

First Aid. Immediately remove the victim to the CRZ in a shady or cool area with good air circulation. Remove all protective outer wear. Call a physician. Treat the victim for shock (i.e., have the victim lie down, raise the feet 6 to 12 inches, and maintain body temperature but loosen all clothing). If the victim is conscious, it may be helpful to give sips of water. Transport the victim to a medical facility.

##### K.1.1.2 Heat Stroke.

Symptoms. This is the most serious of heat casualties because the body excessively overheats. Body temperatures often are between 107 and 110°F. The victim will have a red face and will not be sweating. First there is often pain in the head, dizziness, nausea, oppression, and dryness of the skin and mouth. Unconsciousness follows quickly and death is imminent if exposure continues. The attack will usually occur suddenly. Heat stroke is always serious.

First Aid. Immediately evacuate the victim to a cool and shady area in the CRZ. Remove all protective outer wear and all personal clothing. Lay the victim on his or her back with the head and shoulders slightly elevated. It is imperative that the body temperature be lowered immediately. This can be accomplished by applying cold wet towels or ice bags to the head and groin. Sponge off the bare skin with cool water or rubbing alcohol, if available, or even place the victim in a tub of cool water. The main objective is to cool without chilling. Do not give stimulants. Transport the victim to a medical facility as soon as possible.

#### K.1.2 Prevention of Heat Stress

One of the major causes of heat casualties is the depletion of body fluids and salts through sweating. Fluids should be maintained in the Support Zone. Salts can be replaced by either a 0.1 percent salt solution, more heavily salted foods,

or commercial mixes such as Gatorade. The commercial mixes are advised for personnel on low-sodium diets.

During warm weather, a work schedule will be established that allows most work to be conducted during the morning hours, before ambient air temperature levels reach highs.

A work/rest schedule will be implemented for personnel required to wear Level B or C protection (i.e., an impervious outer garment) with sufficient time allowed for personnel to "cool down" (this may require working in shifts). Two hours is the maximum time between breaks at Level B or C, regardless of temperature. At elevated temperatures, breaks should be scheduled as follows:

<u>Ambient Temperatures</u>	<u>Maximum Time Between Cool Down Breaks</u>
Above 90°F	¼ hour
85° to 90°F	½ hour
80° to 85°F	1 hour
70° to 80°F	1½ hours

### K.1.3 Heat Stress Monitoring

Monitoring of personnel wearing impervious clothing should commence when the ambient temperature reaches 70°F, with increased frequency if ambient temperature increases or as slow recovery rates are indicated. When temperatures exceed 85°F, workers should be monitored for heat stress after every work period. As a screening mechanism of the body's recuperative ability to excess heat, one or more of the following techniques should be used.

1. Measure the heart rate (HR) for 30 seconds, by radial pulse, as early in the resting period as possible. At the beginning of the rest period, the HR should not exceed 110 beats per minute. If the HR is higher, the next work period should be shortened by 10 minutes (or 33 percent), with the length of the rest period staying the same. If the pulse rate is still above 110 beats per minute at the beginning of the next rest period, the following work cycle should again be shortened by 33 percent.
2. Measure oral body temperature with a clinical thermometer, as early as possible in the resting period. At the beginning of the rest period, oral temperature (OT) should not exceed 99°F. If OT exceeds 99°F, the next work period should be shortened by 10 minutes (or 33 percent), with the length of the rest period staying the same. If the OT again exceeds 99°F at the beginning of the next period, the following work cycle should be further shortened by 33 percent. OT should also be measured at the end of the rest period to ensure that it has dropped below 99°F.
3. Maintain good hygienic standards by changing clothes frequently, showering daily, and allowing clothing to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

## K.2 Cold Stress

Cold weather may often cause problems for personnel working outside, even at temperatures above freezing. As temperatures drop below freezing, the potential for cold weather injuries increases dramatically, as does the potential for equipment failure. Because of the considerable danger to personnel, outdoor work should be suspended if the ambient temperature drops below 0°F (-18°C) or if the windchill factor drops below -29°F (-34°C). These levels represent guidelines that should be used as an action level unless the HSO determines and documents otherwise. Table K-1, which shows equivalent temperatures (i.e., windchill) for a range of ambient conditions, should also be referred to.

Snow and ice increase the risks to personnel and operations through reduced visibility, increased potential for falling injuries, reduced onsite mobility, and the increased time required to access the site (or offsite support services).

In view of these factors, it is critical that the HSO establish site-specific safety and operating protocols, and that all onsite personnel be made aware of the risks.

### K.2.1 Local Cold Injuries

Local cold injuries affect specific areas of the body (e.g., fingers, ears, or toes), including the more commonly recognized injuries described in the following subsections.

**K.2.1.1 Chilblains.** Chilblains is a chronic condition affecting the skin and peripheral capillary circulation, resulting from prolonged exposure of the bare skin, primarily in the extremities, to temperatures at or below 60°F. The best method of preventing and treating chilblains is to cover and protect the skin, thereby avoiding prolonged exposure to the cold.

**K.2.1.2 Frostbite.** Frostbite is freezing of the hands, feet, ears, and exposed parts of the face as a result of exposure to very low temperatures. Frostbite occurs when ice crystals form in the fluid in cells of the skin and tissue. As long as blood circulation remains good, frostbite will not occur.

There are three stages of frostbite: incipient frost bite (frostnip), superficial frostbite, and deep frostbite. The classification depends on severity and can range from incipient frostbite (frostnip), which affects the skin; to superficial frostbite, which involves the skin and the tissues immediately beneath it; to deep frostbite, which is much more serious with damage that may affect deeper tissue and even bone.

Symptoms. Symptoms for each of the three stages of frostbite are described as follows.

- Frostnip. Skin first turns red and then later becomes pale or waxy white. There may be tingling, stinging, aching, an uncomfortable sensation of coldness or numbness, or no noticeable symptoms.
- Superficial Frostbite. The skin turns white or gray-white and is waxy in appearance. It is firm to touch (i.e., does not move

**TABLE K-1**  
**COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED**  
**AS AN EQUIVALENT TEMPERATURE (UNDER CALM CONDITIONS)**

**HEALTH AND SAFETY PLAN**  
**PART II**

ESTIMATED WIND SPEED (in mph)	ACTUAL TEMPERATURE READING (°F)												
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60	
	EQUIVALENT CHILL TEMPERATURE (°F)												
calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60	
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68	
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95	
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112	
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-124	
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133	
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140	
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145	
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148	
(Wind speeds greater than 40 mph have little additional effect.)	LITTLE DANGER In 1 hour with dry skin. Maximum danger of false sense of security.			INCREASING DANGER Danger from freezing of exposed flesh within 1 minute.					GREAT DANGER Flesh may freeze within 30 seconds.				

Trenchfoot and immersion foot may occur at any point on this chart.

Source: Developed by U.S. Army Research Institute of Environmental Medicine, Natick, Massachusetts.

easily) and the tissue beneath the skin is soft and resilient. There is a lack of sensation in the area.

- Deep Frostbite. The tissue is pale, cold, and solid with possible blisters and swelling. The hands and feet are especially susceptible to deep frostbite.

Emergency Treatment of Frostbite. Frostnip is easily treated in the field by the application of body heat, which should be applied before the affected area becomes numb. If frostnip affects your fingers and hands, place them against the skin of your chest or in your armpits. To warm your face, hold a mitten or scarf over the lower part of your face and breathe into it. Thaw frozen spots immediately. Do not rub affected areas.

Superficial frostbite usually responds to the application of body heat, as described previously. If the skin does not respond to body heat or if it resembles the early stages of deep frostbite, follow the emergency treatments listed in the following paragraphs. DO NOT rub affected areas.

For deep frostbite, if possible, the injured person should be taken to a heated shelter to avoid further frostbite. If it can be done without the danger of further frostbite, remove all constricting items (e.g., boots, gloves, and socks) from the injured area. RAPID REWARMING WILL MINIMIZE TISSUE LOSS. If possible, warm the extremities in a carefully controlled water bath (104 to 106°F) until tips of the fingers or toes turn pink and feeling is restored. If a water bath is not available, either apply wet packs (100 to 112°F) to the person's body, or gently wrap frostbitten area in blankets or some other warm material.

DO NOT attempt to thaw the affected parts by exercising them or heating them in front of an open fire, heat lamp, radiator, or stove. The person could receive a heat injury as a result of sensation loss.

DO NOT use snow to thaw frostbite. DO NOT rub, massage, or use pressure on the affected areas. Keep the frostbitten parts elevated if possible. Watch to see if CPR is necessary. Give the victim warm drinks such as tea, coffee, or soup. DO NOT GIVE ALCOHOLIC BEVERAGES. Have the victim exercise fingers or toes as soon as possible, but only after they are warmed. DO NOT allow a person with frostbitten feet to walk; walking may cause additional damage.

#### Medical Treatment of Frostbite.

- Frostnip. Usually does not require medical care.
- Superficial Frostbite. Blisters may require medical care.
- Deep Frostbite. EARLY MEDICAL TREATMENT IS URGENT! Transport the victim to medical care facilities at once.

Prevention of Frostbite. It is far easier to prevent or stop frostbite in earlier stages than to thaw and take care of badly frozen flesh. To protect the body against frostbite, the following precautions should be taken:

- Wear enough clothing to protect against the cold and wind.

- Wear warm gloves and boots.
- Pull a scarf or jacket flap over the lower part of the face or pull a hood tightly around the face.
- Occasionally exercise the face, fingers, and toes to keep them warm and to detect any areas that may have become numb.
- Crew members should watch each other closely, especially the face, for signs of frostbite.

**K.2.1.3 Immersion Foot.** Immersion foot (formerly called trenchfoot) is a cold injury resulting from prolonged exposure to near-freezing temperatures when standing or walking on wet or swampy ground.

Symptoms. In the early stages, the feet and toes are pale, cold, numb, and stiff, and walking is difficult. If preventive action is not taken, the feet will swell and ache; in extreme cases, this may result in irreversible damage to the tissues of the foot or leg.

Emergency Treatment of Immersion Foot. Handle feet very gently. DO NOT rub or massage. If necessary, clean feet carefully with soap and warm water, then dry, elevate, and expose to warm but not hot air.

Prevention of Immersion Foot. Because the early stages of immersion foot are not painful, crew members must be constantly on the alert and check feet often when working in cold, wet conditions. Keep feet dry by wearing waterproof footgear and changing socks frequently because perspiration, trapped inside waterproof boots or heavy footgear, can contribute to immersion foot symptoms. Avoid standing in wet areas. If feet get wet, dry them as soon as possible, warm them with your hands, then use foot powder, and change to dry socks. If you cannot change wet boots and socks, exercise your feet frequently by wiggling your toes and moving your ankles. Never wear tight boots.

## **K.2.2 Systemic Cold Injuries**

Systemic injuries are those that affect the entire body system. Severe body cooling, known as systemic hypothermia, can occur at temperatures well above freezing. Hypothermia, which can be fatal, is the progressive lowering of body temperature accompanied by rapid, progressive mental and physical collapse. A large percentage of wilderness deaths are the result of hypothermia.

Hypothermia is caused by exposure to cold, and is aggravated by moisture, cold winds, fatigue, hunger, inadequate clothing or shelter, and excessive perspiration from strenuous exercise followed by too rapid cooling.

Hypothermia often occurs between temperatures of 30 to 50°F, which most people believe are not dangerous. Crew members should be alert for symptoms of hypothermia, especially when temperatures are dropping rapidly or when they must work in rain, snow, or ice.

Hypothermia may occur on land or following submersion in even moderately cold water (i.e., 65°F or lower). On land, hypothermia may take a full day or more

of exposure to develop; however, if the conditions are extremely severe, death may occur within a few hours of initial symptoms.

In cold water, death may seem to be from drowning; in reality, it is usually the result of hypothermia. In water, skin and nearby tissues chill very fast; in 10 to 15 minutes, the temperature of the heart and brain may drop. When the core (i.e., internal body) temperature reaches 90°F, unconsciousness may occur; when body temperature drops to 80°F, heart failure is possible.

**K.2.2.1 Symptoms.** In the early stages of hypothermia, the body begins to lose heat faster than it can be produced, making an effort to stay warm by shivering. When the body can no longer generate enough heat to overcome heat loss and the energy reserves of the body become exhausted, body temperature begins to drop. This affects the ability of the brain to make judgments and also results in loss of muscular control. As the body temperature drops, hypothermia symptoms become increasingly severe, as shown in the following table:

**TABLE K-2  
SYMPTOMS OF HYPOTHERMIA**

<b>SYMPTOMS OF HYPOTHERMIA</b>	<b>APPROXIMATE CORE TEMPERATURE</b>
Person is conscious, alert with increased respiration. Shivering may become uncontrollable as core temperature nears 95°F.	Above 95°
Person is conscious but disoriented and apathetic. Shivering is present but diminishes as temperature drops. Below 92°F, respiratory rate gradually diminishes and pupils begin to dilate.	95° to 90°F
Person is semiconscious. Shivering is replaced by muscular rigidity. Pupils are fully dilated at about 86°F.	90° to 86°F
Unconscious; diminished respiration.	Below 86°F
Barely detectable or nondetectable respiration.	Below 80°F

Note: °F = degrees Fahrenheit.

**K.2.2.2 Emergency Treatment of Hypothermia.** Move hypothermia victim to shelter and warmth as rapidly as possible. In very mild cases, dry clothing and shelter may be all that is needed. Gently remove all of the victim's wet clothing (so energy is not expended by warming and drying wet clothing) and replace it with a dry set. Give the person something warm to drink. **DO NOT GIVE ALCOHOLIC BEVERAGES.**

ALL OTHER HYPOTHERMIA CASES SHOULD BE CONSIDERED MEDICAL EMERGENCIES. PROVIDE EXTERNAL HEAT IN ANY WAY POSSIBLE! A warm bath (with the water kept between 105° and 110°F) is the most effective way of warming a victim of hypothermia. NEVER put an UNCONSCIOUS VICTIM in a bathtub.

If it is not possible to give the person a warm bath, use one of the following ALTERNATE METHODS:

- Wrap warm moist towels (or other fabric) around the victim's head, neck, sides, and groin. As the packs cool, rewarm them by adding warm water (approximately 105°F). Check the temperature of the water with your elbow or the inside of your arm; it should be warm but not hot.
- If you are at a remote outdoor location and cannot use the other method, make a "human sandwich" by placing the unclothed victim in a sleeping bag (or between blankets) with two other undressed persons to provide body-to-body heat transfer. **THIS WILL SAVE LIVES.** Additional sleeping bags or blankets can be placed over and under the victim.

DO NOT wrap a hypothermia victim in a blanket without an auxiliary source of heat unless it is to protect against any further heat loss before treatment can begin, or you need to go for help and there is no other alternative.

Continue treatment once the victim has stabilized. Give warm liquids and nourishing food if the person is conscious. Check the person for symptoms of frostbite and if necessary, give treatment.

Handle the patient gently and do not allow him or her to walk. Exertion can circulate cold stagnant blood from extremities to the central body and cause "after-drop," in which the patient's core temperature drops below the level that will sustain life. ALCOHOL CONTRIBUTES TO AFTER-DROP.

**K.2.2.3 Medical Care for Hypothermia.** HYPOTHERMIA IS A SEVERE EMERGENCY. GET MEDICAL TREATMENT AS SOON AS POSSIBLE. Even persons with mild hypothermia should see a doctor.

**K.2.2.4 Prevention of Hypothermia.** In cold weather, never go into the field without wearing adequate clothing. Take a complete change of warm clothes and one or two extra pairs of socks (in plastic bags). Wear or carry a windproof, water-resistant outer jacket and, in rain or snow, wear adequate raingear.

Stay dry. If your clothing becomes wet from perspiration, rain, snow, or immersion in water, change it as soon as possible. If you start to shiver in a prolonged or violent way, seek shelter at once. Shivering may produce heat but it also uses up energy. Violent shivering may be an early sign of hypothermia.

Avoid accidental immersion in water. Practice boat safety and learn cold water survival techniques. If you fall into water and you are not very close to shore, remain quiet. Keep your head out of water, climb onto the boat, or hold or climb onto any other object that will support you and keep you up out of the water.

### K.2.3 Safety and First Aid Equipment

In view of the causes, results, and appropriate treatment of cold weather injuries discussed previously, as a minimum, the following safety equipment should be included during cold weather operations:

- extra clothing for all personnel
- blankets and/or sleeping bag
- high-energy food and drinking water supply
- toboggan
- tow ropes

In extreme cold conditions, add the following safety items:

- electric blanket (if an electrical source is available)
- portable emergency generator (with fuel, oil, and cords)
- space heater and fuel

### K.2.4 General Winter Operations

Cold weather conditions can severely affect winter operations. The Site Manager and HSO must plan work schedules and project tasks accordingly.

**K.2.4.1 Preliminary Assessment.** If you will be working outdoors in cold weather, assess the local weather conditions through the news media (i.e., radio, television, and newspapers) to determine whether work should progress and/or the amount of preparation needed. Carefully consider questions such as the following:

- What are the typical wind and weather conditions for the period in which you will be working?
- Are the areas in which you will work sheltered or open to the wind?
- Is there a place nearby for periodic warming breaks? Can you obtain or heat warm food and beverages there? Is there a source of drinking water?
- Are there ways to minimize the length of time that crew members will have to work outdoors in the cold?
- If you use a vehicle for a warming area or will use a heater in a closed room, how can you ensure there is adequate ventilation to prevent carbon monoxide poisoning?

**K.2.4.2 Scheduling.** Wherever possible, try to schedule work during the least severe weather. Rotate crew members to keep cold exposures short and allow sufficient time for frequent warming breaks. Remember that workers in heavy clothing often need more time to complete the tasks and may become fatigued more

easily. Be aware that operations may have to be discontinued if winds increase or the temperature drops.

Because winter days are short, scheduling should allow time for taking care of equipment and supplies before nightfall. Once it becomes dark, it is more difficult to gauge terrain, and temperatures are likely to drop.

**K.2.4.3 Site Access.** Snow and ice could make travel on site access roads impossible, or treacherous at best. Personnel should not be allowed to work onsite if conditions could severely hamper the arrival or departure of emergency vehicles. If the route to offsite medical facilities is blocked by snow or ice, an otherwise minor injury could result in a major medical emergency. If conditions warrant, the following provisions should be made:

- snow removal/plowing services for site access roads
- a dependable, four-wheel-drive vehicle available to onsite personnel for transporting an injured person to an offsite medical facility
- sleeping bags, blankets, a food supply, and water kept onsite in the event a sudden storm requires personnel to remain overnight

The HSO is responsible for deciding when weather conditions make site access unsafe, thereby requiring work to stop until conditions improve.

**K.2.4.4 Equipment and Supplies.** Obtain equipment and supplies that will help prevent cold stress and will help in the treatment of cold stress disorders. Required equipment includes a reliable ambient temperature thermometer, a wind gauge, and a windchill chart. If the site is potentially windy due to a lack of natural or manmade windbreaks (e.g., trees, valleys, and structures), try to provide means of shielding workers from the wind. If working at a remote location, carry extra food and water because hunger and dehydration contribute to cold stress. If possible, make provisions for hot food and beverages. Ensure that emergency communication equipment is available and operational for crew members working in the cold, at heights, or in remote locations.

Close attention must be given to the effects of cold weather on field equipment. Batteries can be severely affected by cold resulting in disabled radios, air monitoring equipment, sampling pumps, and vehicles. A supply of fresh batteries, a sufficient number of charging units, and a set of automotive jumper cables should be maintained onsite. In addition, the electronics in many field instruments such as PI, LEL, and oxygen meters, as well as the chemical reactions in detector tubes (e.g., Dräger tubes) can also be adversely affected by the cold. The manufacturers' literature must be consulted for minimum operating temperatures.

If at all possible, monitoring well sampling tasks should not be scheduled during cold weather. These tasks generally require the use of relatively delicate pumps; long, uninsulated stretches of tubing; and significant quantities of decontamination solutions. Unless considerable effort is expended to prevent pumps, hoses, decontamination solutions, and sample containers from freezing, attempting to sample monitoring wells in cold weather may be counter-productive. Portable shelters should be considered if cold weather sampling is necessary.

**APPENDIX L DECONTAMINATION**

## APPENDIX L DECONTAMINATION

This appendix describes ABB Environmental Services, Inc. (ABB-ES), procedures.

### L.1 PERSONNEL DECONTAMINATION

Decontamination procedures are followed by all personnel leaving hazardous waste sites. Under no circumstances (except emergency evacuation) will personnel be allowed to leave the exclusion and contaminant reduction zones prior to decontamination. A typical personnel decontamination station is shown in Figure L-1. Generalized procedures for removal of protective clothing are as follows:

1. Drop tools, monitors, samples, and trash at designated drop stations (i.e., plastic containers or drop sheets).
2. Step into the designated shuffle pit area and scuff feet to remove gross amounts of dirt from outer boots.
3. Scrub outer boots and outer gloves with decon solution or detergent and water. Rinse with water.
4. Remove tape from outer boots and remove boots; discard tape and boots in disposal container.
5. Remove tape from outer gloves and remove gloves; discard tape and gloves in disposal container.
6. If the worker has left the Exclusion Zone to change the air tank on the SCBA or the canister on the air-purifying respirator, this will be the last step in the decontamination procedure. The tank or cartridge should be exchanged, new outer gloves and boot covers donned, and the joints taped; the worker then returns to duty.
7. Remove outer garments and discard in disposal container.
8. Remove respirator and place or hang in the designated area.
9. Remove inner gloves and discard in disposal container.
10. If the site requires use of a decontamination trailer, all personnel must shower before leaving the site at the end of the work day.

NOTE: Disposable items (i.e., Tyvek coveralls, inner gloves, and latex overboots) will be changed daily unless there is reason to change sooner. Dual respirator canisters will be changed daily, unless more frequent changes are deemed appropriate by site surveillance data or personnel assessment.

Maximum and minimum decontamination layouts for PPE Levels A through C are shown in Figures L-2 through L-6.

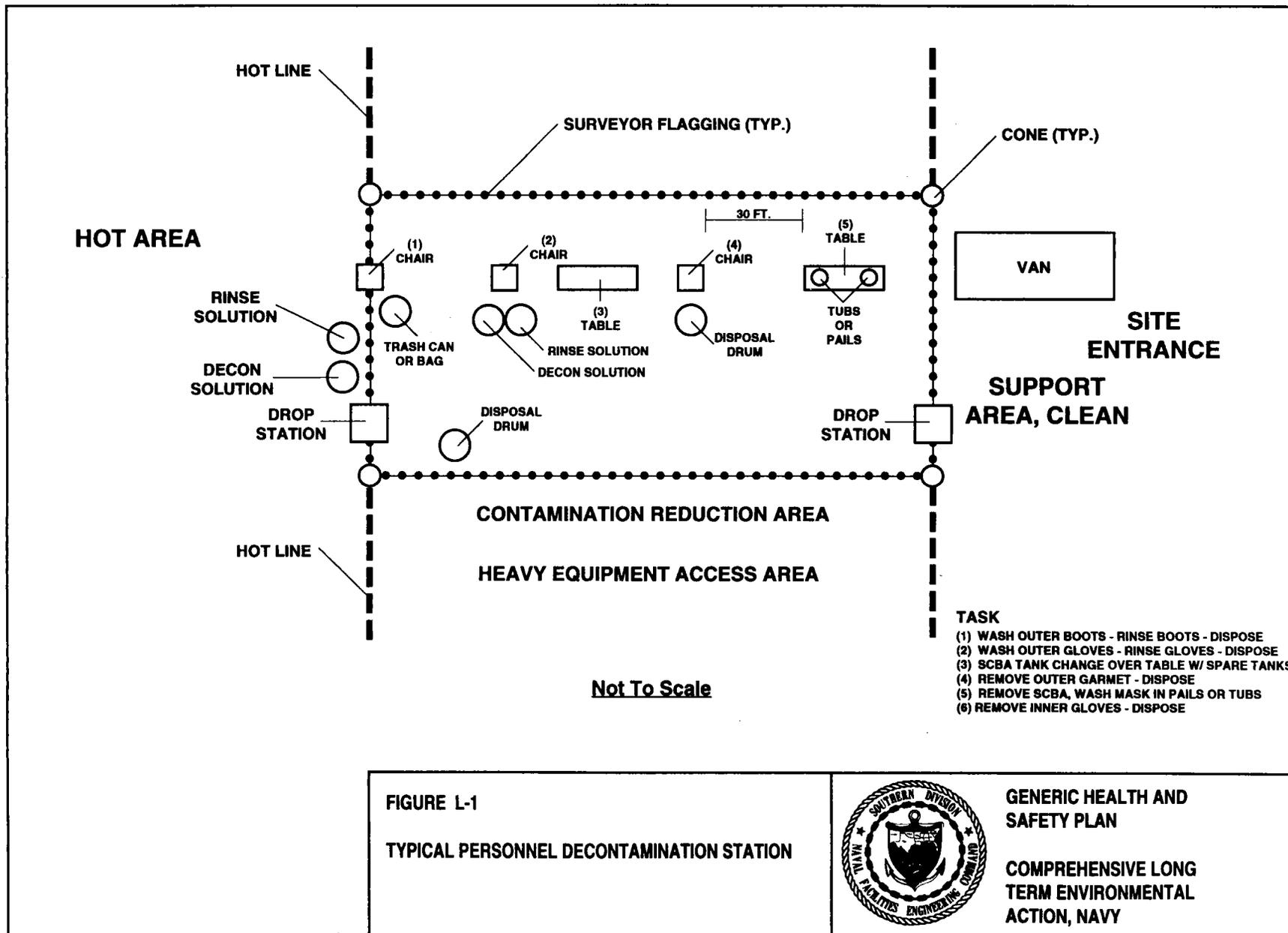
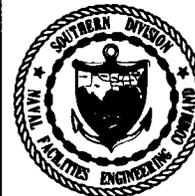


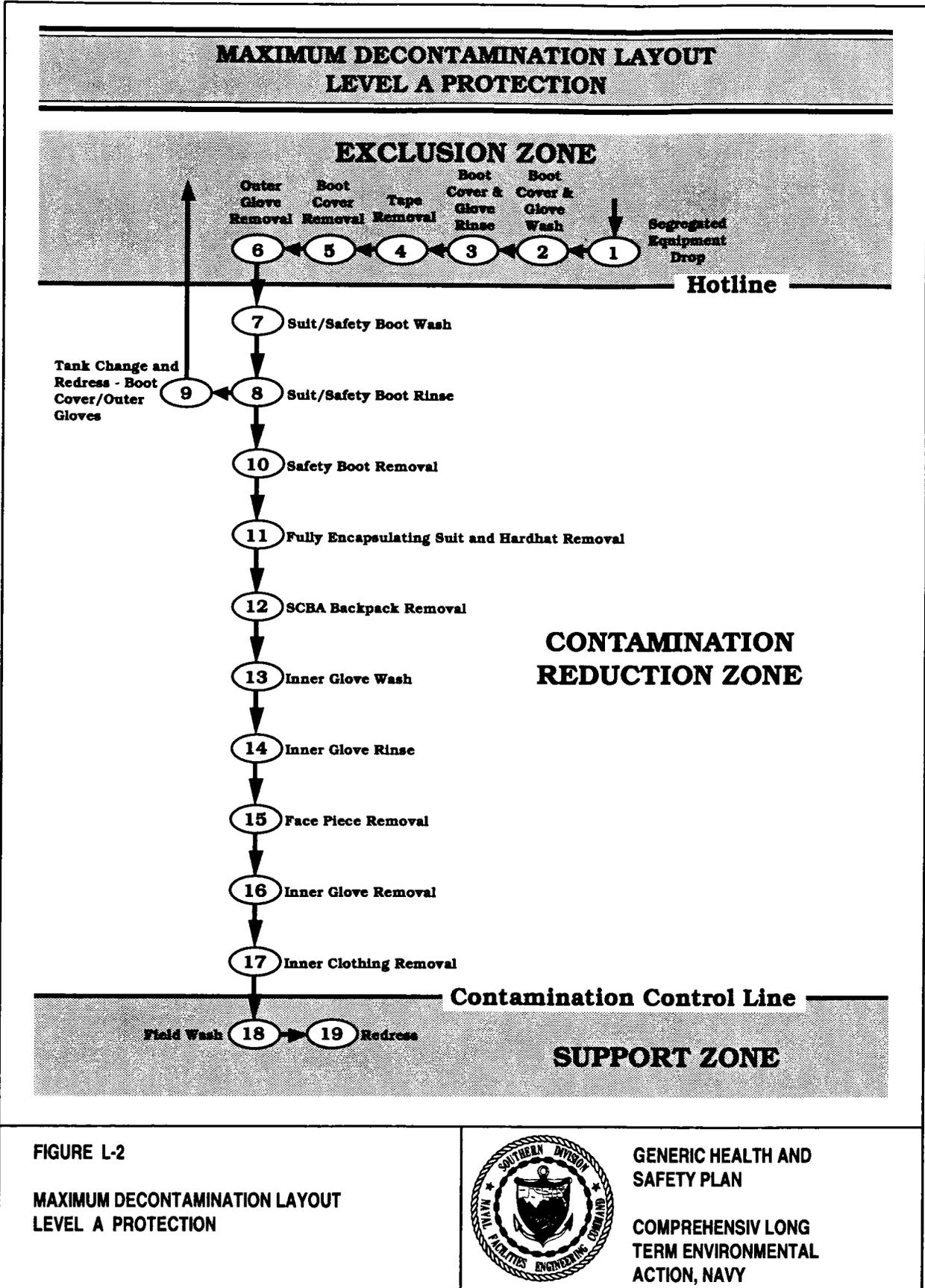
FIGURE L-1

TYPICAL PERSONNEL DECONTAMINATION STATION



GENERIC HEALTH AND SAFETY PLAN

COMPREHENSIVE LONG TERM ENVIRONMENTAL ACTION, NAVY



**MAXIMUM DECONTAMINATION LAYOUT  
LEVEL B PROTECTION**

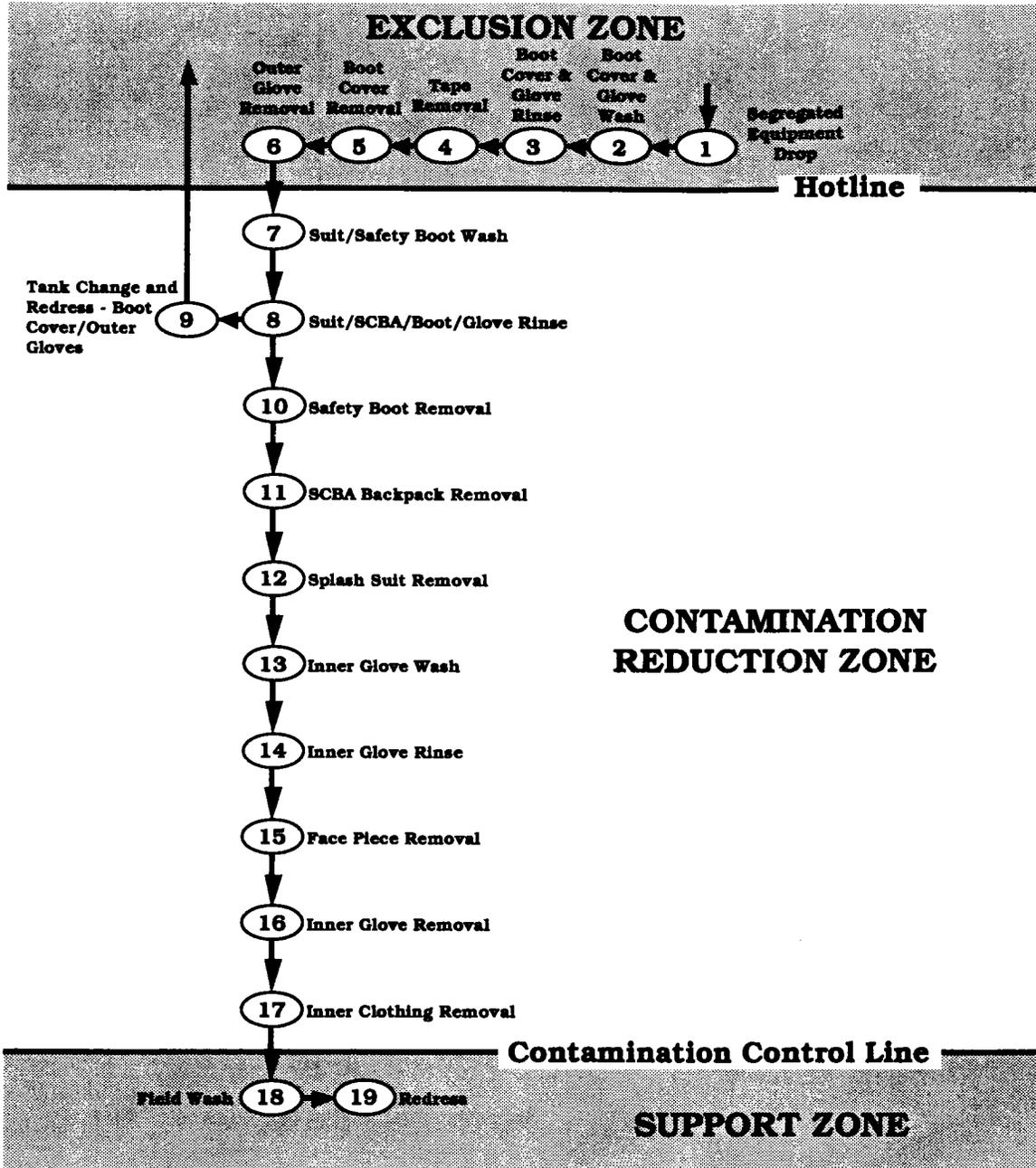


FIGURE L-3

MAXIMUM DECONTAMINATION LAYOUT  
LEVEL B PROTECTION



GENERIC HEALTH AND  
SAFETY PLAN

COMPREHENSIV LONG  
TERM ENVIRONMENTAL  
ACTION, NAVY

**MAXIMUM DECONTAMINATION LAYOUT  
LEVEL C PROTECTION**

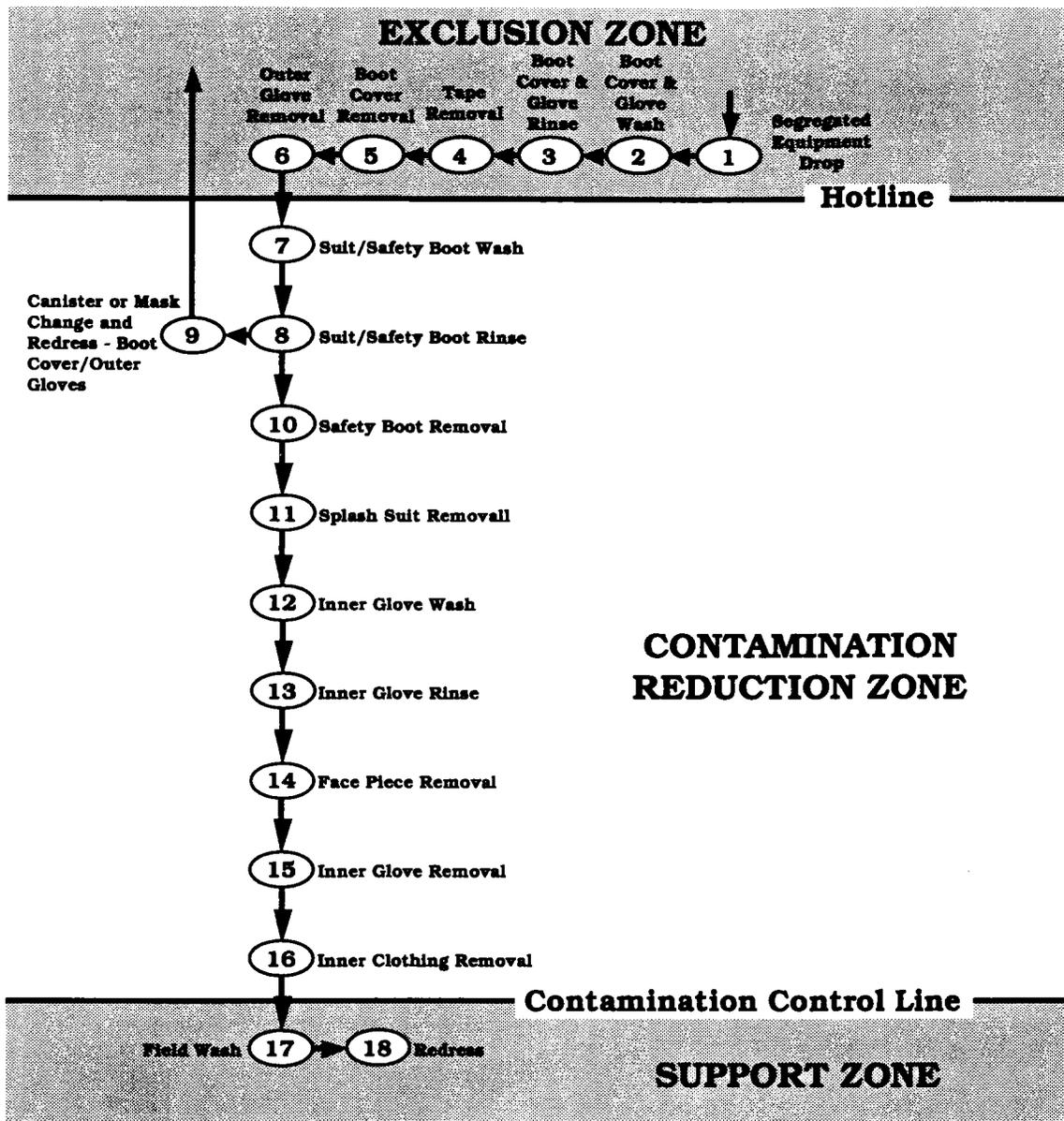


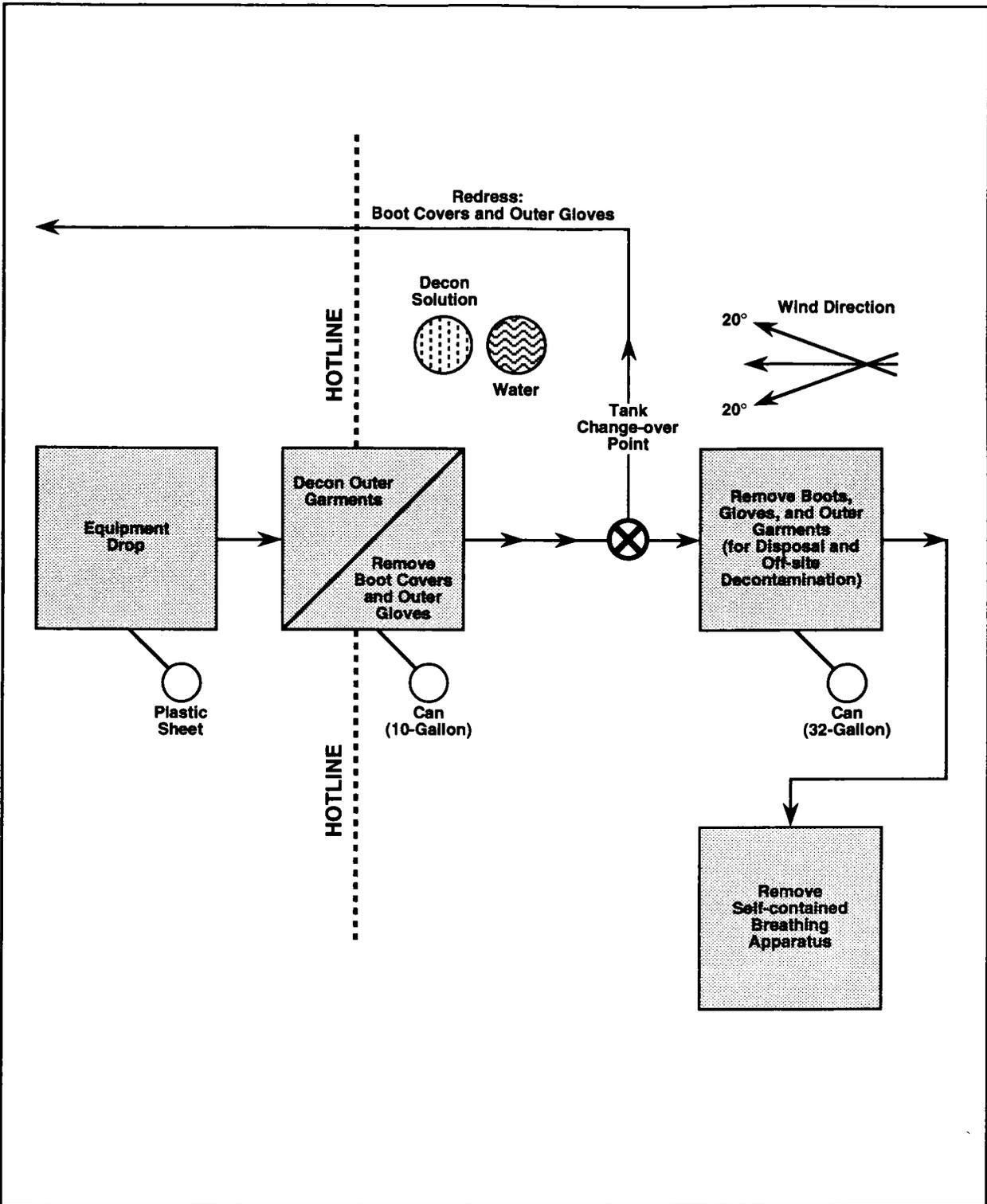
FIGURE L-4

MAXIMUM DECONTAMINATION LAYOUT  
LEVEL C PROTECTION



GENERIC HEALTH AND  
SAFETY PLAN

COMPREHENSIVE LONG  
TERM ENVIRONMENTAL  
ACTION, NAVY



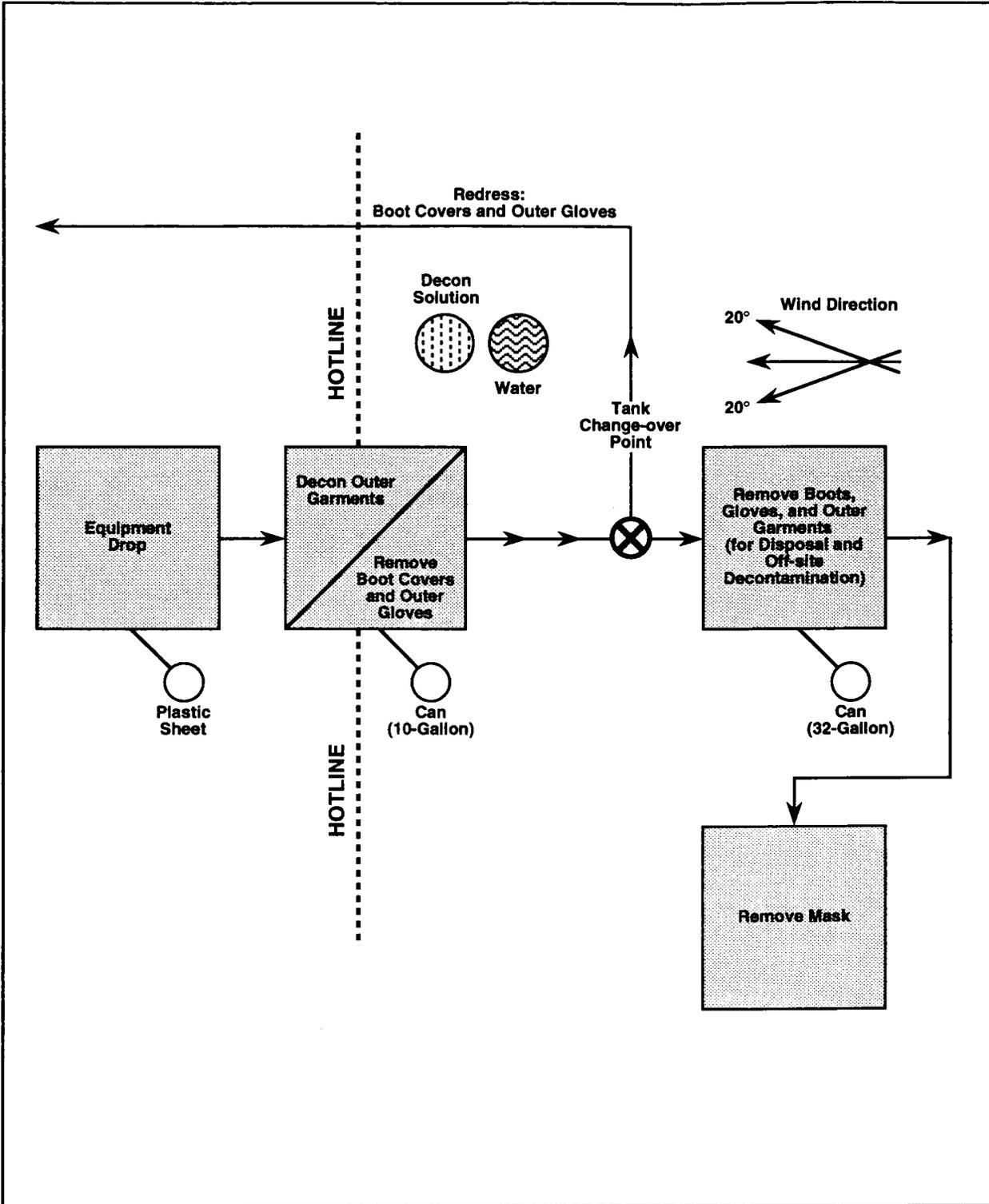
**FIGURE L-5**

**MINIMUM DECONTAMINATION LAYOUT  
LEVEL A AND B PROTECTION**



**GENERIC HEALTH AND  
SAFETY PLAN**

**COMPREHENSIVE LONG  
TERM ENVIRONMENTAL  
ACTION, NAVY**



**FIGURE L-6**

**MINIMUM DECONTAMINATION LAYOUT  
LEVEL C PROTECTION**



**GENERIC HEALTH AND  
SAFETY PLAN**

**COMPREHENSIVE LONG  
TERM ENVIRONMENTAL  
ACTION, NAVY**

Pressurized sprayers or other designated equipment will be available in the decontamination area for washdown and cleaning of personnel, samples, and equipment.

Respirators will be decontaminated daily and taken from the drop area. The masks will be disassembled, the cartridges set aside, and all other parts placed in a cleansing solution. Parts will be pre-coded (e.g., #1 on all parts of Mask #1). After an appropriate time in the solution, the parts will be removed and rinsed with tap water. Old cartridges will be marked to indicate length of use (i.e., if it is possible to evaluate the remaining utility of the cartridge), or discarded in the contaminated trash container for disposal. In the morning, the masks will be reassembled and new cartridges installed, if appropriate. Personnel will inspect their own masks and readjust the straps for proper fit.

## L.2 SMALL EQUIPMENT DECONTAMINATION

Small equipment will be protected from contamination as much as possible by draping, masking, or otherwise covering the instruments with plastic (to the extent feasible), without hindering operation of the unit. For example, the PI meter can be placed in a clear plastic bag to allow for reading the scale and operating the knobs. The PI meter can be partially wrapped, keeping the sensor tip and discharge port clear.

The contaminated equipment will be taken from the drop area and the protective coverings will be removed and disposed of in appropriate containers. Any dirt or obvious contamination will be brushed or wiped with a disposable paper wipe. The units can then be taken inside in a clean plastic tub, wiped off with damp disposable wipes, and dried. The units will be checked, standardized, and recharged as necessary for the next day's operation, and then prepared with new protective coverings.

## L.3 HEAVY EQUIPMENT DECONTAMINATION

It is anticipated that drilling rigs and backhoes will become contaminated during borehole and test-pitting activities. They will be cleaned with high-pressure water or steam, followed by a soap and water wash and rinse. Loose material will be removed with a brush. The person performing this activity will usually be at least at the level of protection used during the personnel and monitoring equipment decontamination.

## L.4 DISPOSAL OF DECONTAMINATED MATERIALS

All protective gear, decontamination fluids (for both personnel and equipment), and other disposable materials will be disposed of at each site.

Decontamination fluids identified to be contaminated by site contaminants (i.e., Liqui-nox, used to decontaminate sampling equipment such as split spoons and groundwater sampling pumps) will be stored in DOT-approved 55-gallon drums. Contaminated disposable materials (e.g., gloves and Tyveks) will be double-bagged and stored as is, or placed in DOT-approved 55-gallon drums.

APPENDIX M EMERGENCY PLANNING

## APPENDIX M EMERGENCY PLANNING

### M.1 EMERGENCY MEDICAL SERVICES

Prior to site investigation or activity on hazardous sites, nearby health facilities will be evaluated to determine their ability to provide for the needs of onsite project staff. Criteria such as emergency department physician coverage, decontamination capabilities, and available medical specialists will be evaluated.

#### M.1.1 Onsite First Aid

An industrial first-aid kit will be provided at the work site; contents of the kit will be checked weekly and restocked as necessary. Other equipment may include oxygen, backboard and straps, splints, and a cervical collar.

At least one person qualified to perform first aid will be present onsite at all times during work activity. This person will have earned a certificate in first-aid training from the American Red Cross or will have received equivalent training. Designated first aides will receive regular review training from the American Red Cross or the equivalent.

An eye-wash station will be provided at the work site, as well as flushing water for decontamination of boots, gloves, clothing, and tools.

#### M.1.2 Transportation to Emergency Treatment

A vehicle will be available at all times to transport personnel to the hospital (in the event an ambulance is unnecessary or unavailable). Stretchers will be located at the work site to transport personnel to the vehicle. Under no circumstances will injured persons transport themselves to a medical facility for emergency treatment.

### M.2 CONTINGENCY PLANNING

Prior to commencement of onsite activities, the HSO will review safety considerations with the field crew. The HSO has overall responsibility for adherence to the designated safety precautions and assumes the role of onsite coordinator in an emergency response situation.

All onsite personnel will be familiarized with both the primary and secondary route to the nearest hospital (which may be shown on a figure or a local map), as well as the location of the nearest working telephone or radio communication device. A list of emergency telephone numbers will be posted in the trailer.

The local hospital and emergency response team will be advised in advance of the work to be performed. The hospital will also be briefed on the availability of personnel health data and technical support through Environmental Medicine Resources, Inc.

Emergency communication will be required to ensure positive preplanned notification of emergency authorities in the event of episodes requiring initiation of

contingency plans. Emergency communication will include all or parts of the following:

- Coordinate with local agencies, fire and police departments, the ambulance service, and the hospital emergency room.
- Establish two-way radio communication and a site alarm capable of warning site personnel and summoning assistance (i.e., airhorn).
- Design an emergency evacuation plan for residents of nearby homes. Although evacuation is an unlikely event, as a contingency, the HSO will be designated as onsite coordinator and will be responsible for implementing the plan. The HSO will be made aware of the total number of households within a 2,000-foot radius. The Health and Safety Plan will provide the emergency contacts required and a table will provide a list of residences and identifiable operations in the area in the event that evacuation is deemed a possibility for a particular site.
- Investigate possible routes of evacuation prior to any activity.
- If an accident occurs, a copy of an accident report form, provided in Appendix N, should be filled out by the HSO and filed with the individual's supervisor, the HSM or HSS, and Human Resources. A copy should also be retained in the project records.

### **M.3 POTENTIAL HAZARDS**

The most common hazards associated with hazardous waste site investigation include (1) accidents; (2) inhalation, contact, or ingestion of hazardous materials; (3) explosion; and (4) fire.

#### **M.3.1 Accidents**

Accidents must be handled on a case-by-case basis. Minor cuts, bruises, muscle pulls, and the like will still allow the injured person to undergo reasonably normal decontamination procedures before receiving direct first aid. More serious injuries may not permit complete decontamination procedures to be undertaken, particularly if the nature of the injury is such that the victim should not be moved. In these cases, arrangements will be made with the medical facility and transporter to allow them to take proper precautions. The nature and degree of surface contamination at a site is generally low enough that emergency vehicles could reach the victim onsite without undue hazard. However, if onsite access is limited, accident victims may be transported by ABB-ES personnel trained for this response to a point accessible by an ambulance.

#### **M.3.2 Contact and/or Ingestion of Hazardous Materials**

Properly prescribed and maintained protective clothing and adherence to established safety procedures are designed to minimize this hazard. However, it is still possible that contact or ingestion of materials may occur. For example, puncture of a buried drum of liquid during drilling operations might cause the drum contents to contact personnel. Standard first-aid procedures should be

followed. The drilling rig will have a tank of water that may be useful in some circumstances, particularly to flush contaminants from any exposed skin areas. Eye-wash bottles will also be maintained at the site for emergencies. In cases of ingestion or anything other than minor contact with known substances, the local Poison Control Center and hospital should be notified and the victim taken there immediately for further treatment and observation.

### **M.3.3 Explosion**

The drilling crew should be keenly aware of combustible gas meter readings and should withdraw at any indication of imminently hazardous conditions (i.e., greater than 20 percent LEL). The detection of such conditions will be reported to local agencies for potential execution of the evacuation plan, if the situation is assessed to warrant such response.

### **M.3.4 Fire**

The combustible gas meter also warns of imminent fire hazards at borings. The greatest fire hazard at the site should be recognized as handling the fluids (e.g., methanol and acetone) used for certain decontamination procedures. No smoking or open flames are allowed onsite. Carbon dioxide fire extinguishers will be kept at the drilling rig and in the decontamination area/field office. The fire department, previously informed of site activities, will be called as needed.

## **M.4 EVACUATION RESPONSE LEVELS**

Evacuation responses will occur at three levels: (1) withdrawal from immediate work area (100 feet or more upwind), (2) site evacuation, and (3) evacuation of surrounding area. Anticipated conditions that require these responses are described in the following subsections.

### **M.4.1 Withdrawal Upwind (100 Feet or More)**

Withdrawing upwind (100 feet or more) will be required when (1) ambient air conditions contain greater contaminant concentrations than guidelines allow for the type of respiratory protection being worn (the work crew may return after donning greater respiratory protection and/or assessing the situation as transient and past); (2) a breach in protective clothing or minor accident occurs (the work crew may return when the tear or other malfunction is repaired and first aid or decontamination has been administered); or (3) the respirator malfunctions requiring replacement.

### **M.4.2 Site Evacuation**

Evacuation of the site will be required when (1) ambient air conditions contain explosive and persistent levels of combustible gas or excessive levels of toxic gases; (2) a fire or major accident occurs; or (3) explosion is imminent or has occurred.

### **M.4.3 Surrounding Area Evacuation**

The area surrounding the site will be evacuated when persistent, unsuppressible toxic or explosive vapors from test pits or borings (e.g., pressure release from punctured drum) are released, or air quality monitored at several points downwind assess danger to the surrounding area.

## **M.5 EVACUATION PROCEDURES**

### **M.5.1 Withdrawal Upwind**

The work crew will continually observe general wind directions while onsite. (A simple wind sock may be set up near the work site for visual determinations.) Upon observing conditions that warrant moving away from the work site, the crew will relocate upwind a distance of approximately 100 feet or farther, as indicated by the site monitoring instruments. Donning SCBA and a safety harness and line, the HSO and a member of the crew may return to the work site to determine whether the conditions noted were transient or persistent. If persistent, an alarm should be raised to notify onsite personnel of the situation and the need to leave the site or don SCBA. An attempt should be made to decrease emissions only if greater respiratory protection is donned. The HSM, HSS, and client will be notified of conditions. When access to the site is restricted and escape is thereby hindered, the crew may be instructed to evacuate the site rather than move upwind, especially if withdrawal upwind moves the crew away from escape routes.

### **M.5.2 Site Evacuation**

After determining that site evacuation is warranted, the work crew will proceed upwind of the work site and notify the security force, HSO, and field office of site conditions. If the decontamination area is upwind and more than 500 feet from the work site, the crew will pass quickly through decontamination to remove contaminated outer suits. If the hazard is toxic gas, respirators will be retained. The crew will proceed to the field office to assess the situation, where the respirators may be removed (if instrumentation indicates an acceptable condition). As more facts are determined from the field crew, they will be relayed to the appropriate agencies. The advisability and type of further response action will be coordinated and implemented by the HSO.

### **M.5.3 Evacuation of Surrounding Area**

When the HSO determines that conditions warrant evacuation of downwind residences and commercial operations, the local agencies will be notified and assistance requested. Designated onsite personnel will initiate evacuation of the immediate offsite area without delay.

**APPENDIX N HEALTH AND SAFETY FORMS AND DATA SHEETS**

APPENDIX N HEALTH AND SAFETY FORMS AND DATA SHEETS

N.1 HEALTH AND SAFETY AUDIT

Site Name: \_\_\_\_\_ Date: \_\_\_\_\_

Auditor: \_\_\_\_\_

SEND A COPY OF COMPLETED FORM TO THE HEALTH AND SAFETY MANAGER.

<u>GENERAL</u>	<u>YES</u>	<u>NO</u>	<u>COMMENTS</u>
HASP onsite?	_____	_____	_____
HASP completely signed off and approved?	_____	_____	_____
OSHA poster posted in trailer?	_____	_____	_____
Emergency telephone numbers posted in trailer?	_____	_____	_____
Emergency eyewash onsite?	_____	_____	_____
Emergency shower onsite?	_____	_____	_____
Stretcher onsite?	_____	_____	_____
First-aid kit onsite?	_____	_____	_____
Adequately stocked?	_____	_____	_____
Proper sanitation facilities?	_____	_____	_____
<u>DOCUMENTATION AND RECORDKEEPING</u>			
Only personnel listed and approved in HASP onsite?	_____	_____	_____
All personnel properly trained?	_____	_____	_____
All personnel in health monitoring program?	_____	_____	_____
Daily field records kept by the Site Manager?	_____	_____	_____
Levels of PPE recorded?	_____	_____	_____
Contaminant levels recorded?	_____	_____	_____
Site surveillance records kept by HSO?	_____	_____	_____

	<u>YES</u>	<u>NO</u>	<u>COMMENTS</u>
Calibration records maintained?	_____	_____	_____
Accident/incident forms onsite?	_____	_____	_____
Field team review sheets signed?	_____	_____	_____
Medical data sheets completed?	_____	_____	_____
Spare hospital directions available?	_____	_____	_____
Visitors logbook completed?	_____	_____	_____
MSDSs for chemicals onsite?	_____	_____	_____
HASP revisions recorded?	_____	_____	_____
First-aid kit inspected weekly?	_____	_____	_____
Are daily safety meetings held?	_____	_____	_____
Emergency procedures discussed during safety meetings?	_____	_____	_____

EMERGENCY RESPONSES

	<u>YES</u>	<u>NO</u>	<u>COMMENTS</u>
Vehicle available onsite for transportation to the hospital?	_____	_____	_____
Fire extinguishers onsite?	_____	_____	_____
At least two persons trained in CPR and first-aid onsite at all times?	_____	_____	_____
All personnel know who is trained?	_____	_____	_____

PERSONNEL PROTECTIVE EQUIPMENT

Proper PPE being worn as specified in the HASP?	_____	_____	_____
Level of PPE being worn:	_____	_____	_____
PPE adequate for work conditions?	_____	_____	_____
If not, give reason:	_____	_____	_____
Upgrade/downgrade to PPE level:	_____	_____	_____
Has facial hair that would interfere with fit of respirators been removed?	_____	_____	_____

	<u>YES</u>	<u>NO</u>	<u>COMMENTS</u>
If not, willing to shave if necessary?	_____	_____	_____
Fit-tested within the last year?	_____	_____	_____
If Level B, back-up/emergency person suited up (except for air)?	_____	_____	_____
HSO periodically inspects PPE and equipment?	_____	_____	_____
PPE not in use properly stored?	_____	_____	_____
<u>MONITORING EQUIPMENT</u>			
All equipment listed in HASP onsite?	_____	_____	_____
Properly calibrated?	_____	_____	_____
In good condition?	_____	_____	_____
Used properly?	_____	_____	_____
Other equipment needed?	_____	_____	_____
List:	_____		
Monitoring equipment covered with plastic to minimize contamination?	_____	_____	_____
<u>DECONTAMINATION</u>			
Decon line set up properly?	_____	_____	_____
Proper cleaning fluid used for known or suspected contaminants?	_____	_____	_____
Proper decon procedures used?	_____	_____	_____
Decon personnel wearing proper PPE?	_____	_____	_____
Equipment decontaminated?	_____	_____	_____
Samples decontaminated?	_____	_____	_____
Disposable items changed twice a day or more often if needed?	_____	_____	_____

WORK PRACTICES

YES

NO

COMMENTS

Proper collection and disposal of contaminated PPE?

\_\_\_\_\_

Proper collection and disposal of decon fluid?

\_\_\_\_\_

Water available for decon?

\_\_\_\_\_

Buddy system used?

\_\_\_\_\_

Equipment kept off drums and ground?

\_\_\_\_\_

Kneeling or sitting on drums or ground not allowed?

\_\_\_\_\_

Personnel avoid standing or walking through puddles or stained soil?

\_\_\_\_\_

Zones established?

\_\_\_\_\_

If night work to be conducted, adequate illumination?

\_\_\_\_\_

Smoking, eating, or drinking in the Exclusion Zone or CRZ not allowed?

\_\_\_\_\_

To the extent feasible, contaminated materials handled remotely?

\_\_\_\_\_

Contact lenses not allowed onsite?

\_\_\_\_\_

Entry into excavations not allowed unless properly shored or sloped?

\_\_\_\_\_

All unusual situations onsite listed in HASP?

\_\_\_\_\_

    If not, what?

\_\_\_\_\_

    Action taken?

\_\_\_\_\_

    HASP revised?

\_\_\_\_\_

CONFINED SPACE ENTRY

All confined spaces identified?

\_\_\_\_\_

    If not, list:

\_\_\_\_\_

All appropriate equipment available and in good working order?

\_\_\_\_\_

	<u>YES</u>	<u>NO</u>	<u>COMMENTS</u>
Equipment properly calibrated?	_____	_____	_____
Confined Space Checklists used?	_____	_____	_____
Checklists completely and correctly filled out?	_____	_____	_____

**ABB ENVIRONMENTAL SERVICES INC.**  
**ACCIDENT REPORT**

**SITE INFORMATION:**

Site: \_\_\_\_\_ Job Number: \_\_\_\_\_  
Location: \_\_\_\_\_  
Location of Accident (if different from above): \_\_\_\_\_  
Did injury involve ABB-ES employee?: \_\_\_\_\_ Subcontractor?: \_\_\_\_\_ Other?: \_\_\_\_\_

**PERSONAL INFORMATION:**

Name of Injured Person: \_\_\_\_\_  
Address of Injured Person: \_\_\_\_\_  
SSN: \_\_\_\_\_ DOB: \_\_\_\_\_ Marital Status: \_\_\_\_\_  
Department: \_\_\_\_\_ Date of Hire: \_\_\_\_\_

**ACCIDENT INFORMATION:**

Date of Accident: \_\_\_\_\_ Time of Accident: \_\_\_\_\_ Weather Conditions: \_\_\_\_\_  
Name of Witness: \_\_\_\_\_ Telephone No.: \_\_\_\_\_  
Address: \_\_\_\_\_

Accident Category:  Chemical Exposure  Physical Injury  Motor Vehicle  Fire  
 Property Damage (list): \_\_\_\_\_  Other: \_\_\_\_\_

Severity:  Medical Treatment  Non-disabling  Disabling  Fatality  
 Estimated Amount of Property Damage: \_\_\_\_\_

Classification of Injury:  Heat Burns  Allergic Reaction  Lacerations  Fracture  
 Chemical Burns  Bites  Punctures  Dislocations  
 Radiation Burns  Poison Ivy  Abrasions  Nausea  
 Toxic-Respiratory  Heat Stroke  Sprains  Headache  
 Toxic-Dermal  Cold Exposure  Bruises  Faint/Dizzy  
 Toxic-Ingestion  Blisters  Concussion  
 Other: \_\_\_\_\_

If chemical exposure, list all possible contaminants of concern: \_\_\_\_\_

Part(s) of Body Affected: \_\_\_\_\_ Degree of Disability: \_\_\_\_\_  
Date Medical Care Received: \_\_\_\_\_ Emergency Service: \_\_\_\_\_ Follow-up Examination Needed: \_\_\_\_\_  
Name and Address of Medical Facility: \_\_\_\_\_

Name of Attending Physician: \_\_\_\_\_ Telephone Number: \_\_\_\_\_  
Date/Time Employee went back to work: \_\_\_\_\_ Employee on Restricted Duty? \_\_\_\_\_  
Estimated Number of Days Away From Work: \_\_\_\_\_

**CAUSE OF INJURY/ACCIDENT:**

Causitive agent(s) most directly related to accident (e.g., object, substance, material, machinery, equipment, or weather): \_\_\_\_\_

Were there unsafe mechanical/physical/environmental condition(s) at the time of the accident?: \_\_\_\_\_

Did an unsafe act contribute to the accident? If yes, specify: \_\_\_\_\_

Did personal factors contribute to the accident (e.g., improper attitude, lack of knowledge or skill, slow reaction, fatigue, inattention, or horseplay.): \_\_\_\_\_

**ACCIDENT PREVENTION:**

Level of Personal Protective Equipment required in the HASP: \_\_\_\_\_  
Was injured using required equipment?: \_\_\_\_\_. If not, how did actual equipment differ from what was required in the HASP. Describe: \_\_\_\_\_

Was personal protective equipment required in the HASP adequate for site conditions? \_\_\_\_\_  
If no, what additional equipment was needed?: \_\_\_\_\_

What can be done to prevent a re-occurrence of this type of accident? (e.g., ventilation, machine modification/guarding, modification of work practices, or additional training.): \_\_\_\_\_

**NARRATIVE:**

Provide a detailed description of how and why the accident occurred. Include objects, equipment, tools, circumstances of assigned duties, weather, etc. Be specific.: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Signature of Preparer: \_\_\_\_\_ Date: \_\_\_\_\_  
Signature of Site Manager: \_\_\_\_\_ Date: \_\_\_\_\_

## N.3 HSO CHECKLIST FOR FIELD OPERATIONS

The following is a list of the minimum equipment and materials needed to fulfill the requirements for health and safety at a site. This list does not include monitoring equipment, decontamination equipment, or personal health and safety equipment (e.g., respirators, tyveks, and boots).

Need	Posted?	Paperwork
<input type="checkbox"/>		Health and Safety Plan
<input type="checkbox"/>		Health and Safety Plan Appendix
<input type="checkbox"/>		Field Team Review Sheets
<input type="checkbox"/>		Medical Data Sheets
<input type="checkbox"/>	<input type="checkbox"/>	OSHA Job Safety & Health Protection Poster
<input type="checkbox"/>	<input type="checkbox"/>	Emergency Information Sheet
<input type="checkbox"/>	<input type="checkbox"/>	Spare Hospital Directions
<input type="checkbox"/>		Blank Accident Report Forms
<input type="checkbox"/>		Visitors Logbook
<input type="checkbox"/>		H & S Audit Form
<input type="checkbox"/>		Confined Space Entry Forms
<input type="checkbox"/>		Site-specific HASP Attachments
<input type="checkbox"/>		MSDSs for Chemicals Taken On-site (other than those in HASP Appendix)
<input type="checkbox"/>		1. <input style="width: 150px; height: 15px;" type="text"/>
<input type="checkbox"/>		2. <input style="width: 150px; height: 15px;" type="text"/>

Need	Quantity	Equipment
<input type="checkbox"/>	<input type="checkbox"/>	First Aid Kit
<input type="checkbox"/>	<input type="checkbox"/>	Emergency Eye Wash Station
<input type="checkbox"/>	<input type="checkbox"/>	Fire Extinguisher
<input type="checkbox"/>	<input type="checkbox"/>	Emergency Horn
<input type="checkbox"/>	<input type="checkbox"/>	Emergency Stretcher/Backboard



NER CODE A-III

MONSANTO PRODUCT NAME  
**TRISODIUM PHOSPHATE  
CRYSTALLINE**

MONSANTO COMPANY  
800 N. LINDBERGH BLVD.  
ST. LOUIS, MO 63167

Emergency Phone No.  
(Call Collect)  
314-694-1000

**PRODUCT IDENTIFICATION**

**Synonyms:** TSP/C; Trisodium orthophosphate; Sodium phosphate, tribasic; Phosphoric acid, trisodium salt; Trisodium phosphate dodecahydrate

**Chemical Formula:**  $Na_3PO_4 \cdot 12H_2O - 1/4 NaOH$  (approximately)

**CAS No.:** 10101-89-0

**DOT Proper Shipping Name:** Sodium Phosphate, Tribasic (see NOTE below)

**DOT Hazard Class/ I.D. No.:** ORM-E/NA9148

**DOT Label(s):** Not Applicable

**Hazardous Substance(s)/ RQ(s):** Yes/5,000 lbs.

**U.S. Surface Freight Classification:** Trisodium Phosphate

**Note:** Bagged material is not regulated.

\*Since hydrated materials could not be reported on the TSCA initial inventory list, Trisodium Phosphate Crystalline was reported as anhydrous with the CAS No. 7601-54-9.

**WARNING STATEMENTS**

DANGER!  
CAUSES EYE BURNS  
CAUSES SKIN IRRITATION

**PRECAUTIONARY MEASURES**

Do not get in eyes, on skin, on clothing.  
Avoid breathing dust.  
Keep container closed.  
Use with adequate ventilation.  
Wash thoroughly after handling.

**EMERGENCY AND FIRST AID PROCEDURES**

**FIRST AID:** IF IN EYES, immediately flush with plenty of water for at least 15 minutes.  
Call a physician.

IF ON SKIN, immediately flush with plenty of water. Remove contaminated clothing.  
Wash clothing before reuse.

# JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Requirements of the Act include the following:

## EMPLOYERS

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm or employees. Employers must comply with occupational safety and health standards issued under the Act.

## EMPLOYEES

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

## INSPECTION

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

## COMPLAINT

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides the employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discriminatory action.

## CITATION

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

## PROPOSED PENALTY

The Act provides for mandatory civil penalties against employers of up to \$7,000 for each serious violation and for optional penalties of up to \$7,000 for each nonserious violation. Penalties of up to \$7,000 per day may be proposed for failure to correct violations within the proposed time period and for each day the violation continues beyond the prescribed abatement date. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to \$70,000 for each such violation. A violation of posting requirements can bring a penalty of up to \$7,000.

There are also provisions for criminal penalties. Any willful violation resulting in the death of any employee, upon conviction, is punishable by a fine of up to \$250,000 (or \$500,000 if the employer is a corporation), or by imprisonment for up to six months, or both. A second conviction of an employer doubles the possible term of imprisonment. Falsifying records, reports, or applications is punishable by a fine of \$10,000 or up to six months in jail or both.

## VOLUNTARY ACTIVITY

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

OSHA has published Safety and Health Program Management Guidelines to assist employers in establishing or perfecting programs to prevent or control employee exposure to workplace hazards. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for health such as training.

## VOLUNTARY ACTIVITY

Free assistance in identifying and correcting hazards and in improving safety and health management is available to employers, without citation or penalty, through OSHA-supported programs in each State. These programs are usually administered by the State labor or Health department or a State university.

## POSTING INSTRUCTIONS

Employees in States operating OSHA approved State Plans should obtain and post the State's equivalent poster.

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or facsimile) in a conspicuous place where notices to employees are customarily posted.

## More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta, Georgia  
Boston, Massachusetts  
Chicago, Illinois  
Dallas, Texas  
Denver, Colorado  
Kansas City, Missouri  
New York, New York  
Philadelphia, Pennsylvania  
San Francisco, California  
Seattle, Washington

(404) 347-3573  
(617) 565-7164  
(312) 353-2220  
(214) 767-4731  
(303) 844-3061  
(816) 426-5861  
(212) 337-2378  
(215) 596-1201  
(415) 744-6670  
(206) 442-5930

Washington, D.C.  
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OSHA 2203

Lynn Martin, Secretary of Labor  
**U.S. Department of Labor**  
Occupational Safety and Health Administration

To report suspected fire hazards, imminent danger safety and health hazards in the workplace, or other job safety and health emergencies, such as toxic waste in the workplace, call OSHA's 24-hour hotline: 1-800-321-OSHA.

## N.6 DAILY HEALTH AND SAFETY AUDIT

Site Name: \_\_\_\_\_ Date: \_\_\_\_\_

Auditor: \_\_\_\_\_

**SEND A COPY OF COMPLETED FORM TO THE HEALTH AND SAFETY MANAGER**

	YES	NO	N/A	COMMENTS
--	-----	----	-----	----------

(Use back of form if more space is needed)

- |   |  |  |  |  |
|---|--|--|--|--|
| 1. Safety meeting held today?   |  |  |  |  |
| 2. Emergency procedures discussed during safety meeting?  |  |  |  |  |
| 3. Vehicle available on-site for transportation to the hospital?  |  |  |  |  |
| 4. At least two persons trained in CPR and first-aid on-site?   |  |  |  |  |
| 5. Proper PPE being worn as specified in the HASP?<br>Level of PPE being worn: _____                                    |  |  |  |  |
| 6. PPE adequate for work conditions?<br>If not, give reason: _____<br>Upgrade/downgrade to PPE level: _____             |  |  |  |  |
| 7. If Level B, back-up/emergency person suited up (except for air)?   |  |  |  |  |
| 8. Monitoring equipment calibrated?   |  |  |  |  |
| 9. Monitoring equipment in good condition?  |  |  |  |  |
| 10. Monitoring equipment used properly?   |  |  |  |  |
| 11. Other monitoring equipment needed?<br>List: _____   |  |  |  |  |
| 12. Monitoring equipment covered with plastic to minimize contamination?  |  |  |  |  |
| 13. Decon line set up properly?   |  |  |  |  |
| 14. Proper cleaning fluid used for known or suspected contaminants?   |  |  |  |  |
| 15. Proper decon procedures used?   |  |  |  |  |
| 16. Decon personnel wearing proper PPE?   |  |  |  |  |
| 17. Equipment decontaminated?   |  |  |  |  |
| 18. Samples decontaminated?   |  |  |  |  |
| 19. Disposable items changed twice a day or more often if needed?   |  |  |  |  |
| 20. Proper collection and disposal of contaminated PPE?   |  |  |  |  |
| 21. Proper collection and disposal of decon fluid?  |  |  |  |  |
| 22. Buddy system used?  |  |  |  |  |
| 23. Equipment kept off drums and ground?  |  |  |  |  |
| 24. Kneeling or sitting on drums or ground not allowed?   |  |  |  |  |
| 25. Personnel avoid standing or walking through puddles or stained soil?  |  |  |  |  |
| 26. Zones established?  |  |  |  |  |
| 27. If night work to be conducted, adequate illumination?   |  |  |  |  |
| 28. Smoking, eating, or drinking in the Exclusion Zone or CRZ not allowed?  |  |  |  |  |
| 29. To the extent feasible, contaminated materials handled remotely?  |  |  |  |  |
| 30. Entry into excavations not allowed unless properly shored or sloped?  |  |  |  |  |
| 31. All unusual situations on-site listed in HASP?<br>If not, what? _____<br>Action taken? _____<br>HASP revised? _____ |  |  |  |  |
| 32. All confined spaces identified?<br>If not, list: _____  |  |  |  |  |
| 33. Confined Space Checklists used?   |  |  |  |  |
| 34. Confined Space Checklists completely and correctly filled out?  |  |  |  |  |

**ALL DEFICIENCIES MUST BE CORRECTED IMMEDIATELY!**

**APPENDIX O RESPIRATORY PROTECTION PROGRAM**

## APPENDIX O RESPIRATORY PROTECTION PROGRAM

### 0.1 INTRODUCTION

This program was developed to govern the selection and use of respiratory protective devices by ABB-ES personnel. The program is intended to comply with OSHA requirements as set forth in 29 CFR 1910.134(b). The scope of this program is limited to activities related to field investigations of potentially hazardous waste disposal sites.

### 0.2 PERSONNEL REQUIREMENTS

All personnel assigned to field activities at hazardous or potentially hazardous locations are currently required by ABB-ES's health and safety policies to be enrolled in the corporate health monitoring program. Part of this program involves spirometry, a measure of the respiratory system status. No personnel may be assigned to the use of or may withdraw from stock any respiratory protective device without a physician's certification that use of the device will not be injurious to health. Psychological limitations (e.g., claustrophobia) are also considered in personnel assignments. Training in the use of the selected device and fit testing, as described herein, are also required.

Personnel will not be assigned duties that require a respirator when facial hair, skullcaps, or eyeglasses will interfere with a proper fit. Contact lenses may not be worn with any respiratory protective device. Eyeglass frames that fit inside the respirator facepiece are provided as necessary.

### 0.3 APPLICABLE EQUIPMENT

ABB-ES maintains the following respiratory protective equipment:

- full-face chemical/mechanical air-purifying respirators
- SCBA
- full-face airline-supplied breathing apparatus
- 5-minute escape air supply

This equipment is intended for use on an as-needed basis, to be determined by an evaluation of onsite conditions. Respiratory protective equipment should not be used arbitrarily by any ABB-ES personnel. Selection criteria are presented separately; training is required in the use of each type of equipment before drawing from stock.

### 0.4 PERSONNEL TRAINING

Training of personnel in the proper use and care of respiratory protective equipment is considered essential to the success of the program. Training encompasses the following topics:

- respiratory protection principles
- selection of appropriate equipment
- use of equipment
- maintenance of equipment
- fit testing

Information regarding each topic is presented as standard respiratory protection procedures in the corporate health and safety program manual.

#### 0.5 PROGRAM ADMINISTRATION AND DOCUMENTATION

Administration of the ABB-ES Respiratory Protection Program is the responsibility of the HSM, and includes the following:

- respirator selection
- personnel training
- fit testing
- respirator maintenance
- documentation
- program evaluation and improvements
- personnel pulmonary testing and certification

Fit testing and respirator maintenance is performed by the equipment manager of ABB-ES's Sample Control and Staging Center in Portland, Maine, and designated, trained employees at the other offices. All fit-testing and respirator maintenance is conducted under the administration of the HSM. Major maintenance is performed by manufacturer-certified technicians only. Personnel training in respiratory protection is one aspect of the HSM's ongoing personnel training programs. Program evaluation is a dynamic process, occurring each time a project HASP is prepared.

Medical supervision of personnel occurs as part of the ABB-ES health monitoring program, also administered by the HSM. Medical surveillance is required for all personnel assigned to hazardous or potentially hazardous site activities.

Documentation of the various elements of the ABB-ES respiratory protection program is achieved through several media, as follows:

- Documentation of respirator selection is included in the hazard assessment of each site's HASP.
- Documentation of personnel training is maintained in both hardcopy and computerized files.

- Documentation of medical surveillance is achieved indirectly by maintaining a list of enrolled employees in the health monitoring program, and directly through physician certification of personnel allowed to be assigned respiratory protective devices.
- Using the appropriate form, documentation of fit-testing is maintained on file with the equipment manager of the Sample Control and Staging Center and with the HSM or designee.
- Documentation of site surveillance is required both by this program and by the HASP for each site. Records of site surveillance are created by the HSO and maintained in project files.
- Respirator inspection and maintenance records are created and maintained by the equipment manager for each respirator, SCBA, and escape respirator.

Inspection and documentation occurs either before each unit is removed from stock and when it is returned, or monthly.

## 0.6 INSPECTION, MAINTENANCE, AND STORAGE

### 0.6.1 Introduction

Respirator maintenance is an integral part of the overall respirator program. Wearing a poorly maintained or malfunctioning respirator, in one sense, is more dangerous than not wearing a respirator at all. Personnel wearing defective devices think they are protected when, in reality, they are not. Emergency escape and rescue devices are particularly vulnerable to poor maintenance because they generally are used infrequently, and then in the most hazardous and demanding circumstances. Serious injury or death can result from wearing a defective device during an emergency escape or rescue. The respirator program includes the following components:

- inspection for defects (including a leak check)
- cleaning and disinfecting
- repair as required
- proper and sanitary storage of equipment

### 0.6.2 Inspection for Defects

The most important part of a respirator maintenance program is continual inspection of the devices. If properly performed, inspections will identify damaged or malfunctioning respirators before they can be used. Two types of inspections will be performed: (1) while the respirator is in use, and (2) while it is being cleaned. Because the use and cleaning will be performed primarily by the same personnel, these inspections may become concurrent.

### 0.6.3 Frequency of Inspection

OSHA requires that "All respirators be inspected before and after each use," and that those not used routinely (i.e., emergency escape and rescue devices) "shall be inspected after each use and at least monthly...." Obviously, emergency escape and rescue devices do not require inspection before each use.

### 0.6.4 Inspection Procedures

Respirator inspection will include checking of the following:

- tightness of the connections
- facepiece
- valves
- connecting tubes
- canisters, filters, or cartridges

In addition, the regulator and warning devices on a SCBA will be checked for proper functions.

### 0.6.5 Field Inspection of Air-purifying Respirators

Routinely used air-purifying respirators will be checked as follows before and after each use:

1. Examine the facepiece for:
  - excessive dirt
  - cracks, tears, holes, or physical distortion of shape from improper storage
  - inflexibility of rubber facepiece (stretch and knead to restore flexibility)
  - cracked or badly scratched lenses in full facepieces
  - incorrectly mounted full facepiece lenses, or broken or missing mounting clips
  - cracked or broken air-purifying element holder(s), badly worn threads, or missing gasket(s)
2. Examine the head straps or head harness for:
  - breaks
  - loss of elasticity
  - broken or malfunctioning buckles and attachments
  - excessively worn serrations on head harness, which might permit slippage (full facepieces only)

3. Examine the exhalation valve for the following after removing the cover:
  - foreign material (e.g., detergent residue, dust particles, or human hair under valve seat)
  - cracks, tears, or distortion in the valve material
  - improper insertion of the valve body in the facepiece
  - cracks, breaks, or chips in the valve body, particularly the sealing surface
  - missing or defective valve cover
  - improper installation of the valve in the valve body
4. Examine the air-purifying element(s) for:
  - incorrect cartridge, canister, or filter for the hazard
  - incorrect installation, loose connections, missing or worn gasket, or cross-threading in the holder
  - expired shelf-life date on the cartridge or canister
  - cracks or dents in the outside case of the filter, cartridge, or canister indicated by the absence of sealing material, tape, or foil over the inlet
  - identical cartridges if more than one are used

#### 0.6.6 Care and Cleaning of Self-contained Breathing Apparatus

The proper care of SCBAs involves the following:

- inspection for defects
- cleaning and disinfecting
- repair
- storage

The following checklist is to be used by personnel whenever they check out a SCBA. (Note: Any discrepancy found should be cause to set the unit aside until it can be repaired by a certified repairperson.)

1. Preliminary Inspection. Check to ensure that:
  - high-pressure hose connector is tight on cylinder fitting
  - bypass valve is closed

- mainline valve is closed
  - there is no cover or obstruction on regulator outlet
  - pressure in the tank is at least 1,800 psi
2. Backpack and Harness Assembly.
- Straps
    - visually inspect for complete set
    - visually inspect for frayed or damaged straps that may break during use
  - Buckles
    - visually inspect for mating ends
    - check locking function
  - Backplate and Cylinder Lock
    - visually inspect backplate for cracks and for missing rivets or screws
    - visually inspect cylinder hold-down strap and physically check strap tightener and lock to ensure that it is fully engaged
3. Cylinder and Cylinder Valve Assembly.
- Cylinder
    - physically check cylinder to ensure that it is tightly fastened to backplate
    - check hydrostatic test date to ensure that it is current
    - visually inspect cylinder for large dents or gouges in metal
  - Head and Valve Assembly
    - visually inspect cylinder for presence of valve lock
    - visually inspect cylinder gauge for condition of face, needle, and lens
    - open cylinder valve and listen or feel for leakage around packing (if leakage is noted, do not use until repaired); note function of valve lock
4. Regulator and High-pressure Hose.
- High-pressure Hose and Connector. Listen or feel for leakage in hose or at hose-to-cylinder connector. (Bubble in outer hose covering may be caused by seepage of air through hose when stored under pressure. This does not necessarily mean a faulty hose.)

- Regulator and Low-pressure Alarm

- Cover outlet of regulator with palm of hand. Open mainline valve and read regulator gauge (must read at least 1,800 psi and not more than rated cylinder pressure).
- Close cylinder valve and slowly move hand from regulator outlet to allow slow flow of air. Gauge should begin to show immediate loss of pressure as air flows. Low-pressure alarm should sound between 650 and 550 psi. Remove hand completely from outlet and close mainline valve.
- Place mouth onto or over regulator outlet and blow. A positive pressure should be created and maintained for 5 to 10 seconds without any loss of air. Next, establish a slight negative pressure in regulator and hold for 5 to 10 seconds. Vacuum should remain constant. This tests the integrity of the diaphragm. Any loss of pressure or vacuum during this test indicates a leak in the apparatus.
- Open cylinder valve.
- Place hand over regulator outlet and open mainline valve. Remove hand from outlet and replace in rapid movement. Repeat twice. Air should escape when hand is removed each time, indicating a positive pressure in chamber. Close mainline valve and remove hand from outlet.
- Ascertain that no obstruction is in or over the regulator outlet. Open and close the bypass valve momentarily to ensure flow of air through bypass system.

5. Facepiece and Corrugated Breathing Tube.

- Facepiece

- Visually inspect head harness for damaged serrations and deteriorated rubber. Visually inspect rubber facepiece body for signs of deterioration or extreme distortion.
- Retaining clamp properly in place, visually inspect lens for proper seal in rubber facepiece, and for cracks or large scratches.
- Visually inspect exhalation valve for visible deterioration or foreign materials buildup.

- Breathing Tube and Connector

- Stretch breathing tube and visually inspect for deterioration and holes.
- Visually inspect connector to ensure good condition of threads and for presence and proper condition of "O" ring or rubber gasket seal.
- Perform a negative pressure test on facepiece.

a. Don backpack and facepiece.

- b. With facepiece held tightly to face or facepiece properly donned, stretch breathing tube to open corrugations and place thumb or hand over end of connector.
- c. Inhale. Negative pressure should be created inside mask, causing it to pull tightly to face. This negative pressure should be maintained for 5 to 10 seconds. If negative pressure leaks down, the facepiece assembly is not adequate and should not be worn.

6. Storage of Units. Check that:

- cylinder is refilled as necessary and unit is cleaned and inspected
- cylinder valve is closed
- high-pressure hose connector is tight on cylinder
- pressure is bled off high-pressure hose and regulator
- bypass valve is closed
- mainline valve is closed
- all straps are completely loosened and laid straight
- facepiece is properly stored to protect against dust, sunlight, heat, extreme cold, excess moisture, and damaging chemicals

#### 0.6.7 Cleaning and Sanitizing

Any good detergent may be used, followed by a disinfecting rinse or a combination disinfectant-detergent for a one-step operation. Reliable, effective disinfectants can be made from readily available household solutions, including the following:

- Hypochlorite solution (50 ppm of chlorine) can be made by adding approximately 2 milliliters of bleach (e.g., Clorox) to 1 liter of water, or 2 tablespoons of bleach per gallon of water. A 2-minute immersion disinfects the respirators.
- Aqueous solution of iodine (50 ppm of iodine) can be made by adding approximately 0.8 milliliter of tincture of iodine per liter of water, or 1 teaspoon of tincture of iodine per gallon of water. A 2-minute immersion is sufficient to disinfect the respirators.

To prevent damaging the rubber and plastic in the respirator facepieces, the cleaning water should not exceed 140°F; however, to ensure adequate cleaning, it should not be less than 120°F.

#### 0.6.8 Rinsing

The cleaned and disinfected respirators should be rinsed thoroughly in water (140°F maximum) to remove all traces of detergent and disinfectant. This is important for preventing dermatitis.

#### 0.6.9 Drying

The respirators may be allowed to dry in room air on a clean surface. They may also be hung from a horizontal wire, like drying clothes; however, care must be taken not to damage or distort the facepieces.

#### 0.6.10 Reassembly and Inspection

To avoid contamination, the clean, dry respirator facepieces should be reassembled and inspected in an area separate from the disassembly area. The inspection procedures were discussed previously; special emphasis should be given to inspecting the respirators for detergent or soap residue left by inadequate rinsing. This appears most often under the seat of the exhalation valve, and can cause valve leakage or sticking. The respirator should be thoroughly inspected and all defects corrected. New or retested cartridges and canisters should be installed, and the completely reassembled respirator should be tested for leaks. For SCBA devices, the facepiece should be combined with the tested regulator and the fully charged cylinder, and an operational check should be performed.

#### 0.6.11 Maintenance and Repair

Replacement or repair should be done only by trained, experienced persons using parts designed for the respirator. Besides being contrary to OSHA requirements, substitution of parts from a different brand or type of respirator invalidates approval of the device. This restriction applies particularly to maintenance of the more complicated devices, especially SCBA, and more specifically, regulator valves and low-pressure warning devices. These devices should be returned to the manufacturer or to a trained technician for adjustment or repair. No problems are anticipated in repairing and maintaining most simple respirators, particularly the commonly used air-purifying type.

#### 0.6.12 Respirator Storage

Respirators must be stored properly to protect against the following:

- dust
- sunlight
- heat
- extreme cold
- excessive moisture
- damaging chemicals
- mechanical damage

Damage and contamination of respirators may occur if they are stored on a workbench; in a tool cabinet or toolbox among heavy tools, greases, and dirt; or in a vehicle.

APPENDIX P OTHER

## APPENDIX P OTHER

### P.1 ILLUMINATION

Site operations will not be permitted without adequate lighting. Therefore, unless provisions are made for artificial light, downrange operations must halt in time to permit personnel and equipment to exit the Exclusion Zone and proceed through decontamination before dusk. Conversely, operations will not be permitted to begin until lighting is adequate.

### P.2 SANITATION

Provisions must be made for sanitation facilities for the site work force. At a minimum, the provision of toilet facilities must meet the requirements of 29 CFR 1910.120(n), which includes one facility for less than 20 employees, or one toilet and one urinal for every 40 employees, up to 200; then one of each for every 50 employees. If it is a mobile crew and they have transport readily available, the requirements do not apply.

### P.3 HEALTH AND SAFETY AUDIT PROCEDURES

Regular health and safety audits will be conducted to ensure compliance with health and safety policy and procedures. The HSO will perform periodic audits, with the goal of one audit per shift, using the health and safety audit form (see Appendix N). Auditing may be performed on any ABB-ES site by the HSS or the HSM, and will include health and safety evaluations of all work activities. The audits will be an unannounced evaluation of sites selected at the discretion of the HSM or HSS, with the goal of 10 percent of active sites being subject to audits each quarter.

Results of each site health and safety audit will be summarized in an audit report provided to the site HSO, the Project Manager, and the Operational Group Manager charged with responsibility for the project. Where the audit report identifies deficiencies, it will be the Project Manager's responsibility to promptly implement corrective action. The corrective action undertaken will be outlined in a written report submitted to the HSS and the HSM. The HSM or the HSS will retain the original audit report that has been signed by the Project Manager and the HSO to acknowledge receipt of the audit's findings. Any mitigating comments submitted to the HSM or the HSS will be appended to the original report.

APPENDIX Q STANDARD OPERATING PROCEDURES

## APPENDIX Q STANDARD OPERATING PROCEDURES

### Q.1 STANDARD OPERATING PROCEDURES FOR THE USE OF EXPLOSIVES IN SEISMIC REFRACTION SURVEYS

#### Q.1.1 Introduction

This appendix lists some of the more important aspects of the purchase, transport, storage, handling, and use of explosives. It is intended as a general guide for ABB-ES personnel who may be involved in conducting seismic surveys or who may be overseeing or auditing such surveys. It is not intended as a stand-alone reference replacing appropriate federal and/or state regulations, which can be very specific about certain aspects regarding explosives.

Many recent advances in computer software and hardware and hardware technology have revolutionized data processing and interpreting in the seismic industry. Likewise, the recent development of sophisticated (and very expensive) truck-mounted energy sources that can scan a large range of frequencies for optimum response from deep reflecting horizons has made possible reflection surveys for hydrocarbon deposits to depths of up to 20 kilometers. However, for shallow (i.e., the upper several hundred feet) seismic refraction surveys, the best and most economical energy source continues to be small explosive charges detonated with electric blasting caps.

A small explosive charge, as defined herein, consists of the equivalent of from 1/8 to 1 pound of dynamite which is primed for detonation with one or more electric blasting caps. The "dynamite" that ABB-ES generally uses is KINESTIK 1/3, which consists of a powder and liquid, mixed onsite to form an explosive similar in performance to dynamite. Each stick (86 to a case) is equivalent to 1/3 pound of dynamite. Before mixing, the two parts are not considered by the DOT to be explosive; therefore, they can be shipped, transported, and stored with no special precautions. In practice, ABB-ES personnel should take every precaution to ensure that the powder and liquid are separated while being stored for any length of time to prevent unauthorized access to potentially explosive materials.

Electric blasting caps come in two configurations acceptable for seismographic work. The "seismograph" variety is best because of its repeatability with regard to delay time (i.e., the time that elapses between when the "fire" button on the blaster is depressed and when the blasting cap actually detonates). The other type is known as "instantaneous," and it has acceptable delay time characteristics. Blasting caps are graded by the federal government (and all states) as a Class A explosive and must be handled and stored accordingly. Requirements for Class A explosive are discussed in the following subsection.

#### Q.1.2 Purchase, Transport, and Storage

The federal government has specific guidelines regarding the purchase, transport, and storage of explosives, particularly regarding interstate commerce. In addition, each state has developed regulations that supersede federal regulations if they are more restrictive. Therefore, the user must become familiar with federal as well as state regulations. In practice, it is unlikely that ABB-ES would ever become involved in interstate activities regarding explosives. In fact, it has been ABB-ES's practice to subcontract out-of-state blasting

activities to a local blaster to minimize expenses that would otherwise be incurred in obtaining necessary permits, and to eliminate time expended to purchase, transport, and store explosives. The following subsections pertain to State of Maine requirements. Other states can be and are different from Maine, and requirements vary widely.

**Q.1.2.1 Purchase.** In the State of Maine, a blasting license for an individual is not required. Such a license is required in Massachusetts (a competency license) and New York (an explosives license). However, the State of Maine does require a written permit, issued by the Commissioner of Public Safety, for the transport of explosives in intrastate commerce in quantities larger than 200 pounds of dynamite, or more than 500 electric blasting caps. Although ABB-ES never transport quantities exceeding these amounts, it has been company policy to obtain the State Permit to Transport Explosives, because it provides additional credibility to explosives vendors and local officials.

Before purchasing explosives in Maine, the user must obtain a permit from the fire marshal or appropriate local official in the town in which the explosives are to be used and/or stored. The local official must first establish the identity of the applicant, verify that he or she is older than 21 years of age and is a U.S. citizen, and inquire about the intended use of the explosives. Permitting thorough local officials can be as easy as a courtesy telephone call from the official notifying the local fire department or police chief (every town or city handles explosives permitting a little differently).

Before selling explosives, the state requires the vendor to verify that a valid permit has been issued to the buyer by the appropriate local town official. In addition, the vendor should ascertain whether the buyer can comply with the rules and regulations relative to the transport of explosives.

**Q.1.2.2 Transport.** Before issuing the State Permit to Transport Explosives, officials from the Department of Public Safety in Augusta, Maine, inspect the vehicle driven by the applicant to ensure that it is roadworthy. They also inspect the explosives magazine in which the explosives will be locked while in transit. State regulations require that the magazine be constructed of 1-and-1/2-inch-thick planking with no exposed metal on the inside (to eliminate sparks) and sheathed with NO. 24-gauge galvanized sheet steel. The magazine should have a strong hasp and padlock and be locked at all times when explosives are being transported. The magazine should also be chained and locked within the vehicle to prevent removal or shifting while under way. In addition, the vehicle should be equipped front and rear with two 1-quart (minimum) fire extinguishers suitable to extinguish electrical fires, and four diamond-shaped Class "A" explosives signs mounted on the front and rear and both sides of the vehicle. ABB-ES owns a "day" magazine and other equipment that meets these requirements.

**Q.1.2.3 Storage.** Regulations are very specific regarding storage. All that ABB-ES personnel need to remember is Class "A" explosives must be returned for storage to a permanent or temporary magazine before sunset on each day of usage. The ABB-ES day magazine is not a permanent or temporary magazine. A permanent magazine is a substantial structure located well away from dwellings and buildings where people work or congregate. It has walls 4 to 8 inches thick (depending on method of construction), strong doors with interior hinges, and double-shielded locks specially designed for storage magazines. The roof is constructed to be bullet-proof, and foundation requirements are also specified.

A temporary magazine is usually a rather massive steel box (i.e., 350 to 500 pounds or more) on casters, lined with thick wood planking, with double-shielded locks. It should be securely fastened to the ground.

### Q.1.3 Handling and Use

Safety should be the foremost consideration whenever explosives are being used. Seismic surveys routinely expend 20 to 30 sticks of dynamite (and an equal number of electric blasting caps) during a single field day. To mix the KINESTIK, mix one "tube" of the KINESTICK liquid (a clear red liquid composed of nitromethane) with one "stick" of white powder (ammonium nitrate), and allow to stand until the powder is thoroughly saturated with the liquid (it becomes pink); this takes 5 to 10 minutes. If the upper 4 feet of overburden are wet or saturated, it is a good idea to seal the stick (equipped with a screw cap) with tape to prevent contamination by groundwater. If groundwater enters the stick, it can cause the KINESTIK to misfire.

While the KINESTIK is being mixed, a series of shotholes (usually five) are prepared by driving a pointed 1-3/4-inch steel bar to the desired depth (from 2 to 4 or 5 feet) with a sledgehammer. The shothole depth depends on soil conditions and the anticipated size of the charge. Only when the explosives are ready to be placed at the bottom of a shothole, a blasting cap is placed in a molded cavity at the base of each stick. The blasting cap has two lead wires, usually 8 or 12 feet long, which are grounded together with a removable metal shield that should be left in place until the primed shot is ready to be fired. This prevents the induction of electric charge, which could accidentally fire the cap. The lead wires are used to connect the blasting cap to a double conductor (i.e., "shot") wire leading to the blaster. The cap is secured to the KINESTIK by two or more half-hitches with the two cap lead wires.

The explosive is not "primed" for detonation. After the primed shot is placed at the bottom of the shothole, a small amount of native soil (preferably sand) is placed in the hole and gently tamped with a tamping stick into the base of the hole over the primed explosive charge. A proper tamping stick is wooden (non-sparking), about 6 feet long and 1 to 1-1/4 inches in diameter (Note: dowel stock works well). The tamping procedure continues until a uniform column of native soil completely fills the shothole. One should be careful not to damage the cap lead wires during the tamping process.

The removal metal shield grounding the two cap lead wires together is removed only when the shot is ready to fire. Prior to making the connection between the cap lead wire and the shot wire leading to the blaster, the person making the connection should ascertain that the shot wire has been sorted out as the blaster by the party chief (operating the blaster) so that inadvertent detonation is not possible). While making the connection, the lead wires should be extended as far from the shothole as possible. The person making the connection should turn his or her back to the shothole, remove the metal grounding shield, and attach the shot wire leads (no polarity) to the cap wire leads.

As each shot is detonated, one person (usually the one making the connection) should be assigned to verify that no one is near the shot. The party chief should then call out, "Are you clear (of the shot)?" The response, "all clear" indicates that everything is ready and no one is close enough to be in any danger when the shot is detonated. A "safe" distance varies with soil conditions and

the depth of the shot; 75 to 100 feet is generally adequate. The party chief then calls out to everyone in the area, "Fire in the hole," and the charge is detonated.

If a misfire occurs (extremely rare), it is the responsibility of the party chief to remove the undetonated charge from the ground with a nonsparking shovel of wood or brass. The party chief is responsible for maintaining an explosives log that documents all explosives purchased, expended, stored, and destroyed. This log is subject to inspection at any time by local, state, and federal officials. It provides a record detailing the disposition of every cap and stick of dynamite (or KINESTIK) that comes under the control of ABB-ES personnel.

The amount of explosives that can be loaded into a shothole depends on the nature of the surface materials and the depth of the water table. Some general rules follow:

- use as few explosives as necessary to produce good quality data
- the more granular the soils, the more explosives will be required (to produce good data); the finer the soils, the fewer will be required
- the deeper the water table, the more explosives required, and vice versa
- the deeper the bedrock, the more explosives will be required, and vice versa

When ascertaining the proper explosive charge to produce good data at a new site, it is good practice to start with a single shothole well away from any buildings and power lines, and perform a test shot to determine local soil (an energy transmission) characteristics. Start with a small charge (e.g., half a stock of KINESTIK, obtained by mixing half the liquid from one tube with half the powder from one stick) buried to moderate depth (e.g., 3 feet) and increase (or decrease) the amount of the charge (and the depth of the shothole) as necessary.

#### Q.1.4 Use of Explosives at NAS Cecil Field

If seismic refraction surveys utilizing explosives are conducted at NAS Cecil Field, the purchase, storage, transportation, and handling of explosives will be subcontracted to a Florida licensed professional blaster. The blaster will be responsible for the safe handling, storage, and use of explosives in accordance with federal, state, and local regulations.

**APPENDIX R RADIATION PROTECTION PROGRAM**

## APPENDIX R RADIATION PROTECTION PROGRAM

### R.1 INTRODUCTION

The Radiation Protection Program addresses the work practices which personnel must follow in order to be protected from exposure to radiological hazards. Work practices must provide the protection necessary to keep the exposure levels as low as reasonably achievable (ALARA). Appendix I, Radiation Protection program includes the following items: types of radiation, general work practices, general area and personnel monitoring, bioassay program, environmental monitoring, sample collection and transportation, health and safety plan, training requirements, safety equipment and clothing, respiratory protection, and instrumentation.

The Radiation Protection program sets out procedures to protect workers from radiological hazards. The extent of the Radiation Protection program depends on the amount of contamination present above natural background radiation. At sites, where information cannot rule out the presence of radioactive material, monitoring with direct reading instruments for hazardous levels of ionizing radiation is necessary. Radiation monitoring is required using a Radiation Monitor 4 to measure radiation levels and dosimeter badges for personnel exposure. However, if a site has known contamination, a health physicist must give expertise in establishing the Radiation Protection program. The next section gives an overview of radiation hazards followed by a description of general work practices at potentially contaminated radioactive material sites.

### R.2 TYPES OF RADIATION AND ASSOCIATED HAZARDS

There are five types of radiation. At hazardous waste sites, the following three types and their hazards may be encountered:

- (1) An alpha particle is emitted from the nucleus of heavy atoms. It has a mass of 4 atomic mass units (amu): 2 protons and 2 neutrons. The slow moving alpha particles carry a positive charge. They cannot penetrate a piece of paper or skin but are very dangerous when substances emitting them are ingested or inhaled. Alpha particles present an internal hazard. An internal hazard causes damage inside the body and can occur through injection, inhalation, or absorption. Any particles inhaled will ionize living tissue.
- (2) A beta particle is a charged particle emitted from the nucleus of the atom. It has a low mass and a (+) or (-) charge. It travels at one-tenth the speed of light, traveling faster than an alpha particle. Beta particles can penetrate paper or several millimeters of skin. Because of its smaller size and charge, beta particles have a lower probability of interaction with electrons, and therefore a greater ability to penetrate living tissue. Beta particles present both an internal and external hazard, although mostly an internal hazard. An external hazard causes damage inside the body from an outside source of radiation. Beta particles absorbed through the skin act in a similar manner as alpha particles. The lenses of the eye are also susceptible. A 1/4 to

1/2-inch shield of plexiglass or lead will shield most beta particles.

- (3) Gamma radiation is electromagnetic radiation emitted from the nucleus of an atom. An unstable nucleus can remain unsettled, even after emitting an alpha or beta particle. It will rid itself of the electromagnetic radiation by emitting a gamma ray. A gamma ray is considered a photon with no mass or charge. It travels at the speed of light. Because the gamma ray does not have any charge or mass, there is little interaction with electrons. Therefore, gamma rays will penetrate through material very readily. Because gamma is a penetrating type of radiation, it presents an external hazard. This radiation also presents an internal hazard because gamma rays pass easily into the human body, damaging tissue in the process. An ionizing event occurs inside the body from a source outside the body.

### **R.3 GENERAL WORK PRACTICES**

Before working in a potentially radioactive-contaminated work area, employees must have a thorough knowledge of the work practices in the site-specific HASP. The Health and Safety Officer (HSO) must consider all the possible hazards when developing the HASP.

#### **R.3.1 General Area and Personal Monitoring**

Personnel and general area monitoring strategies have been devised to ensure the identification of areas and work activities for which engineering controls or respiratory protection are required. Monitoring shall be conducted to confirm that the levels of protection provided by engineering controls and by the respiratory protection program are adequate to protect the worker.

**R.3.1.1 General Area Monitoring.** General area monitoring assesses airborne contaminants in work areas and at the site boundary. Swipe and grab samples are collected to identify contamination on surfaces and equipment. Equipment that is adequate for monitoring needs shall be available, properly calibrated, and controlled. Depending on the operation, surveys shall be performed to determine the following: external radiation exposure levels, airborne concentrations of radioactive material, personnel contamination, surface contamination in work areas, contamination of personal protective equipment, and suitability for release of equipment and material to an unrestricted area.

**R.3.1.2 Personal Monitoring.** Personnel monitoring methods measure external and internal exposure to radioactive material. The type of personnel monitoring depends on the type of radiation, the type of work to be performed, and the condition of the work site.

The purpose of internal exposure monitoring is to determine whether and to what extent radionuclides have entered the body. Monitoring of radiation workers for internal contamination is necessary only in work situations where radioactive materials may become airborne, have the potential for ingestion, or could be absorbed through the skin. The most effective internal monitoring techniques are bioassay surveillance and air sampling.

**R.3.1.2.1 Bioassay Program.** Bioassay includes the measurement of radioactive material in the body to evaluate the radiation dose. The type and frequency of bioassay surveillance required for workers on site must be delineated based on the air sampling results, quantity and chemical form of radioactive material, half-life, and detection sensitivity of the instruments.

A bioassay program will only be used when contamination levels are high enough and are readily dispersed into the air causing the radioactive material to be absorbed through the skin, inhaled, or ingested. The amount of contaminant that can be deposited in the body is based on the maximum permissible concentration hours (MPC-H). The MPC-H depends upon the concentration limits for each individual radionuclide listed in 10 CFR 20, Appendix B.

Any time an ABB-ES employee enters a site where there is a potential for radioactive contamination or an unknown hazardous waste site, he or she must be monitored for external radiation exposure by means of personal dosimeters. These personal dosimeters or badges monitor any exposure to penetrating radiation (beta and gamma) and are changed quarterly. Exposure records are kept for total lifetime doses.

Radiation workers may request a copy of their exposure records. Former employees may request a written summary of their exposures or request that the information be forwarded to a subsequent employer.

Respiratory protection is used only if engineering controls and work practices do not adequately protect workers.

### **R.3.2 Environmental Monitoring**

Contaminants of concern may be present in soil; in air as a result of suspension from soil, groundwater, or transient surface water; or bound to existing surfaces.

All work sites will be surveyed for any surface contamination above background levels. As work is being conducted in an area, radiation survey meters will be used to scan personnel and equipment before leaving the work area. Various instruments will be used (i.e., portable radiation survey instruments), typically ratemeters with scintillation detectors, proportional counters, or Geiger-Mueller counters.

Soil and water samples will be screened in more detail to determine the type and amount of radioactive material in the samples. The characterization of the contaminant depends on the capabilities of the instrumentation. A scaler/counter is used for a specified time period to determine the amount of radioactive material in each sample. With unknown contaminants, further analysis is necessary.

### **R.3.3 Sample Collection and Transportation**

When necessary, all samples will be analyzed for any presence of radioactive material before shipment to an environmental laboratory. Any sample over a certain limit of radioactivity is to be considered radioactive material. Federal regulations require that the owner of the material (licensee) is responsible for the shipment of the material. The shipment must be made under the licensee's

name. Any facility contracted to perform the analysis of the samples must have a specific state or federal license to receive radioactive material. The facility must be licensed to handle the radionuclide and the quantity that is in the sample.

#### R.4 HEALTH AND SAFETY PLAN

The Health and Safety Plan (HASP) has been developed to provide the practical health and safety framework for all field operations. The HASP complies with regulations under the Occupational Safety and Health Act, 1910.120.

The HASP for the site shall address radiological hazards and present the guidelines to be followed for all field activities.

The HASP must address the following situations: training, environmental and personal monitoring, equipment collection and transportation of samples, and work practices.

#### R.5 TRAINING REQUIREMENTS

All site workers shall be trained to work in accordance with 29 CFR 1910.120. If there is radioactive contamination, then site-specific training will include radiological hazards.

Items that may be covered depending on the severity of contamination are as follows:

- (1) Introduction
- (2) Radiation fundamentals
- (3) Types of radiation and their characteristics
- (4) Units of measure of radiation.
- (5) Radiation exposures from natural, and man-made sources
- (6) Biological effects
- (7) Radiation effects and risks
- (8) Radiation protection fundamentals - time, distance, shielding
- (9) Exposure and contamination limits
- (10) Monitoring equipment
- (11) Radiation protection plans and procedures

## R.6 SAFETY EQUIPMENT AND CLOTHING

The safety equipment and clothing used for chemical hazards is capable of safeguarding against radiological hazards.

### R.6.1 Respiratory Protection

The level of respiratory protection will be determined from the results of the air monitoring.

## R.7 INSTRUMENTATION

There is only one way to detect and measure radiation and that it is through instrumentation. Instruments used in detecting radiation serve various purposes. Therefore, there is a wide variety of instrument types.

Choosing an instrument depends on portability; mechanical ruggedness; ease of use, reading, servicing; ease of decontamination; reliability; and hazardous waste site work conditions and work practices. Choice also depends on the ability to respond to the radiation being measured, measurement sensitivity at the desired level, response time, and energy dependence. Factors that effect radiation instrument readings are counting geometry, dead time, and the type and energy of radiation.

The instrumentation is calibrated in accordance with manufacturer's specifications.

Some instruments that may be used in the field are **radiation survey meters** and **counters**; both have a specific detector for the desired radiation. Detectors are classified in the following categories: gas-filled detectors including ionization chambers, proportional counters, and Geiger-Mueller counters; and scintillation detectors including inorganic crystals, liquid phosphors, and semiconductor devices.

**Radiation survey meters** are used to detect environmental, personnel, and equipment contamination. **Counters** are used for scanning environmental samples and wipes to determine the presence of any radioactive material in the samples or on surfaces where the wipe was taken. An evaluation of radiological hazards found at the site must be made by a Health Physicist.

APPENDIX S BLOODBORNE PATHOGEN EXPOSURE CONTROL PLAN

## APPENDIX S BLOODBORNE PATHOGEN EXPOSURE CONTROL PLAN

### S.1 INTRODUCTION

On December 6, 1991, the Occupational Safety and Health Administration (OSHA) issued a final standard on Occupational Exposure to Bloodborne Pathogens. This standard is intended to protect all workers who may reasonably anticipate being occupationally exposed to blood and other potentially infectious materials. Occupational exposure means a "reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of the workers duties."

ABB-ES has developed this EXPOSURE CONTROL PLAN (ECP) to help protect its associates from being inadvertently exposed to the hepatitis B virus (HBV) or human immunodeficiency virus (HIV). This ECP applies to all associates bearing current first aid or cardiopulmonary resuscitation (CPR) certification or who will work at a hazardous waste site containing medical wastes. The ECP supplemented by training will help associates become aware of the hazards to which they may be exposed and how to reduce exposure incidents. This plan will be reviewed and updated at least annually, or whenever necessary, to reflect new or modified tasks and procedures affecting occupational exposure. In addition, site-specific procedures must be addressed in the Health and Safety Plan HASP for all sites potentially containing medical wastes.

### S.2.0 EXPOSURE DETERMINATION

During the normal course of their work, ABB-ES associates would not routinely become exposed to bloodborne pathogens (e.g., viruses). Circumstances where exposure may occur would be when providing first aid/CPR treatment (see Personnel Master Training List for associates currently certified) or when working at a hazardous waste site containing medical wastes. (Note: Project Assistants who are in health monitoring and have received Project Assistant training and who will be handling samples potentially contaminated with bloodborne pathogens will also be covered by the standard.)

#### S.2.1 Routes of Exposure

The infectious process can best be compared to a chain with six interrelated links, all of which must be present for an infection to take place.

**S.2.1.1 Infectious Agent.** The first link is the etiologic agent itself. This would include any bacterium, fungus, virus, or other microorganism. Not only must the organism be present, it must also be pathogenic and present in sufficient quantity to provide an infective dose. Seldom, if ever, has the transmission of disease resulted from the transfer of a single microorganism. It usually requires thousands to millions of such agents before infection can take place. The actual number required depends on the pathogen in question.

**S.2.1.2 Reservoir.** The second major link is the presence of a reservoir or source that allows for microbial survival and, perhaps, even multiplication of a potential pathogen. Common reservoirs would include not only humans, but also

the equipment used in medical treatment. While HIV cannot survive long outside the body, HBV becomes dormant and can survive for years.

**S.2.1.3 Portal of Exit.** The third link is the presence of a source from which the pathogen can emerge, a portal of exit. Obvious portals of exit include the respiratory tract, vascular system, skin and mucous membranes, as well as the gastrointestinal tract and genitourinary tracts. Each of these portals of exit is particular to a given disease. For example, tuberculosis and influenza would involve only the respiratory tract, and typhoid fever the gastrointestinal tract.

**S.2.1.4 Mode of Transmission.** The fourth link, a mode of transmission, is one over which there is a great deal of control. This link is, by far, the easiest to break. Transmission can occur in one of four ways: contact; airborne; vehicular; and vector (vector transmission involves the transmission of pathogens via insect, animal, or plant vectors) modes of spread.

The transfer of infectious agents through vehicular means (e.g., food or water borne) is not a common event. Nonetheless, it can and does occur.

The airborne route transmits many diseases (e.g., tuberculosis, measles, mumps, and chicken pox). Controlling the airborne spread of disease usually involves good ventilatory patterns and caution when coming into close proximity with infected individuals (e.g., when providing first aid or CPR).

The major mode of disease transfer is contact transmission. This takes place either through direct or indirect contact, or through droplet spread involving contact with exhaled respiratory secretions. Direct contact, person-to-person transmission, is primarily person-to-person spread through actual physical contact. Indirect contact transmission can be the result of contact with a contaminated, intermediate object such as medical wastes in a landfill. Droplet spread can occur as the result of contact with respiratory secretions through means such as sneezing or coughing.

**S.2.1.5 Portal of Entry.** The fifth link in the chain is a suitable portal of entry. As with chemical exposures, these portals are inhalation, ingestion, dermal, and injection. Most infectious diseases and infectious conditions require very specific portals of entry.

**S.2.1.6 Susceptible Host.** The last major link involves the necessity for a susceptible host, someone who lacks effective resistance to a given pathogenic agent. A variety of host factors must be met before infection can occur. Very few organisms can gain entrance through normal intact skin. Most require some breach in skin integrity. Other less obvious lines of defense include tears, gastric acid, and cilia of the nose and upper respiratory tract. One's ability to mount a local inflammatory response provides yet another non-specific host defense mechanism.

There are, however, several biologic factors that decrease, rather than increase, a resistance to infection. Extremes in age, either the very young or very old, are associated with decreased resistance. Other factors such as major surgery and the presence of chronic diseases -diabetes, neoplasia, blood disorders - alter host resistance.

Malnutrition, anemia, and chronic alcoholism also have pronounced effects on the ability to combat disease.

### **S.2.2 Bloodborne Pathogens of Concern**

**S.2.2.1 Hepatitis B Virus.** The term "hepatitis" simply means an inflammation of the liver. This condition can be caused by a wide variety of agents, including medication, alcohol, toxic or poisonous substances, and infectious agents such as viruses. Hepatitis B, formerly known as "serum" hepatitis, is the only form of viral hepatitis that poses a significant occupational threat.

Nationwide, there are approximately 300,000 new cases of hepatitis B infection each year and about 5,000 deaths caused by this disease. Approximately 5 percent of the entire U.S. population, more than 12 million people, have been infected. The carrier rate is approximately 10 percent. It is estimated that, in the United States alone, there are approximately 750,000 to 1,000,000 asymptomatic carriers of the virus. The hepatitis B virus has been found in blood, semen, vaginal secretions, breast milk, saliva, and serous fluid. In occupational settings, the major route into the body is from blood or blood-contaminated bodily fluids splashed into the eyes, mucous membranes, or mouth.

There is a direct relationship between the likelihood of occupational hepatitis B infection and the frequency of blood contact. It is the frequency of blood contact that establishes the level of risk of being infected with HBV.

**S.2.2.2 Human Immunodeficiency Virus.** Acquired immunodeficiency syndrome or AIDS is a severe viral disease. AIDS severely affects the immune system and is characterized by a multitude of opportunistic infections. The AIDS or HIV virus is typical of most viruses in that it cannot survive for any appreciable amount of time outside its human host. Its presence in the general environment is extremely unlikely and occupationally would be limited to body secretions, primarily blood. Being an unstable virus, HIV is very susceptible to a large number of common household disinfectants.

Over the past decade, approximately 210,000 cases of AIDS have been reported in the United States. In addition, an estimated 1 million individuals have been infected with the virus but have not yet developed the disease. It is important to remember that these individuals are generally without symptoms, yet they are carriers of the virus and thus potentially infectious.

### **S.3 METHODS OF CONTROL**

As a result of increased epidemiologic knowledge concerning HIV and HBV transmissions, the Centers for Disease Control recommended that all blood or bodily fluids be considered potentially infectious. This approach has come to be known as "Universal Precautions." The concept of Universal Precautions recognizes that medical histories and examinations cannot reliably identify all patients infected with HIV or other bloodborne pathogens nor can you recognize those individuals on site, thereby dictating certain precautionary measures when providing first aid or CPR to any worker.

Wherever feasible, engineering and work practice controls will be used to eliminate or minimize employee exposure. Where occupational exposure remains

after institution of these controls, personal protective equipment will also be used.

### **S.3.1 Engineering Controls**

If engineering controls are utilized (e.g., remote handling of contaminated materials), they will be examined and maintained or replaced on a regular schedule to confirm their effectiveness.

### **S.3.2 Work Practices**

Work practices that will be used at sites with include:

1. Handwashing facilities with soap and running water. If a site does not have access to running water, an antiseptic hand cleanser in conjunction with clean cloth/paper towels or antiseptic towelettes will be provided. When antiseptic hand cleansers or towelettes are used, hands shall be washed with soap and running water as soon as feasible.
2. No eating, drinking, smoking, applying lip balm or cosmetics, and handling contact lenses are allowed in the Exclusion Zone or immediately after providing first aid or CPR.
3. Associates are to wash their hands, or any other exposed skin, with soap and water as soon as feasible after any exposure to any potentially infectious material and before eating, drinking, smoking, applying lip balm or cosmetics, and before handling contact lenses. Flush mucous membranes with water immediately or as soon as feasible following body contact with blood or any other potentially infectious material.
4. Equipment that is contaminated with blood or other potentially infectious material will be decontaminated prior to exiting the Exclusion Zone or as soon as feasible after providing first aid treatment. Equipment that cannot be decontaminated immediately will be labeled as a biohazard until such a time as decontamination can take place.
5. All procedures involving blood or other potentially infectious materials will be performed in such a manner as to minimize splashing, spraying, spattering, and generating droplets of these substances.
6. Samples containing potentially infectious material shall be placed in a container that prevents leakage during collection, handling, processing, storage, transport, or shipping. If outside contamination of the primary container occurs, the primary container shall be placed within a second container that also prevents leakage.

### **S.3.3 Personal Protective Equipment**

Modified Level D (Level C - dermal) is the minimum level of personal protection to be used at a hazardous waste site suspected to contain medical wastes. When

providing first aid treatment, gloves, safety goggles/glasses, and coveralls/tyveks will be worn at a minimum. Level C or B can be used if face shields are unavailable.

Personal protective equipment (PPE), is only considered appropriate if it does not permit blood or other potentially infectious materials to pass through or to reach an associate's work clothes, street clothes, undergarments, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time the protective equipment is used. First aid kits will be stocked with safety glasses, gloves, and disposable mouthpieces (with one-way valves) for use when providing CPR.

All PPE will be removed before leaving the Exclusion Zone or immediately after first aid treatment has concluded. All disposable PPE will be collected and labeled as a biohazard and disposed of properly. ABB-ES will collect, bag, and label (red bags or bags with biohazard label), launder, and decontaminate all non-disposable PPE. Should blood or other potentially infectious materials penetrate the garment, the worker will remove it immediately or as soon as feasible.

**S.3.3.1 Gloves.** Gloves shall be worn when it can reasonably be anticipated that the associate may have hand contact with blood, other potentially infectious materials, mucous membranes, and non-intact skin; or when handling or touching contaminated items or surfaces. The gloves typically used at hazardous waste sites are acceptable.

**S.3.3.2 Eye Protection and Face Shields.** Eye protection devices, such as goggles or glasses with solid side shields, or chin-length face shields, shall be worn whenever splashes, spray, spatter, or droplets of blood or other potentially infectious materials may be generated.

**S.3.3.3 Protective Clothing.** Clothing such as, but not limited to, tyveks, polycoated tyveks, aprons, and coveralls, or similar outer garments shall be worn when providing first aid or working on a site where medical wastes are suspected or known to be. The type of clothing selected will be based on the task, degree of exposure anticipated, and other hazards (e.g., chemicals) present at the site.

## **S.4 DECONTAMINATION AND DISPOSAL**

### **S.4.1 Decontamination**

All equipment and work surfaces shall be cleaned and decontaminated after contact with blood or other potentially infectious materials. Contaminated work surfaces shall be decontaminated with an appropriate disinfectant (such as chlorine bleach) after completion of procedures; immediately or as soon as feasible when surfaces are overtly contaminated or after any spill of blood or other potentially infectious materials; and at the end of the work shift. Protective coverings, such as plastic wrap, aluminum foil, or imperviously-backed absorbent paper used to cover equipment and environmental surfaces, shall be removed and replaced as soon as feasible when they become overtly contaminated or at the end of the day.

All bins, pails, cans, coolers, etc., intended for reuse that have a reasonable likelihood for becoming contaminated with blood or other potentially infectious materials shall be inspected, decontaminated, and disinfected (with chlorine bleach) immediately or as soon as feasible.

Broken glassware or other sharp objects that may be contaminated shall not be picked up directly with hands. These shall be cleaned using mechanical means, such as a brush and dust pan, tongs, shovel, etc.

#### S.4.2 Disposal

Contaminated sharps (e.g., broken sample bottles) shall be discarded immediately or as soon as feasible in containers that are: (1) closable; (2) puncture-resistant; (3) leakproof on sides and bottom; and (4) labeled or color-coded.

Other regulated wastes (e.g., gloves, tyveks) shall be placed in containers that are: (1) closable; (2) constructed to contain all contents and prevent leakage of fluids during handling, storage, transport, or shipping; (3) labeled or color-coded; and (4) closed prior to removal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping. If outside contamination of the regulated waste container occurs, it shall be placed in a second container that meets the qualifications of the primary container.

Disposal of all regulated wastes shall be in accordance with applicable regulations.

#### S.4.3 Laundry

Disposable items shall be used whenever possible. In the event that coveralls or street clothing becomes contaminated with potentially infectious materials, it shall be laundered by a facility capable of handling potentially infectious materials.

Contaminated laundry shall be handled as little as possible with a minimum of agitation. All contaminated laundry shall be bagged or containerized without being sorted or rinsed at the location where it was used. Contaminated laundry shall be placed and transported in bags or containers labeled or color-coded. Whenever contaminated laundry is wet and presents a reasonable likelihood of soak-through or leakage from the bag or container, the laundry shall be placed and transported in bags or containers that prevent soak-through and/or leakage of fluids to the exterior. All associates who have contact with the laundry shall wear protective gloves and other appropriate PPE.

### S.5 LABELS

Signs and labels used to indicate potentially infectious materials must include the following legend:

These labels shall be fluorescent orange or orange-red or predominantly so, with lettering or symbols in contrasting color and affixed as close as feasible to the container by string, wire, adhesive, or other methods that prevents their loss or unintentional removal.

Warning labels containing the above symbol must be affixed to containers of regulated waste, coolers, laundry bags, or other containers used to store, transport, or ship blood or other potentially infectious materials. A substitute for labels is the use of red bags or containers. These can be used to differentiate between infectious and non-infectious materials as long as all associates at the site are aware of its meaning.

Labels required for contaminated equipment will contain the biohazard symbol and shall also state which portions of the equipment remain contaminated.

#### **S.6.0 TRAINING**

All associates maintaining current certification in first aid and/or CPR as well as associates who are assigned to a site potentially contaminated with medical wastes will be trained in the contents of this ECP. This training will include:

1. The hazards involved from being exposed to potentially contaminated blood and other bodily fluids, including a general explanation of the epidemiology and symptoms of bloodborne diseases and an explanation of the modes of transmission of bloodborne pathogens.
2. The hepatitis B vaccine.
3. Appropriate work practices and engineering controls.
4. Proper personal protective equipment.
5. Proper housekeeping, transportation, and disposal of contaminated wastes and proper disposal or laundering of personal protective equipment.
6. Actions to take if worker comes in contact with blood or other potentially infectious material.
7. An explanation of the signs, labels, and/or color-coding required.

Training will be done at the time of initial employment and annually thereafter during refresher training courses. Additional training will be conducted when working at sites suspected of containing medical wastes or when otherwise needed.

#### **S.7 EXPOSURE INCIDENT**

##### **S.7.1 Vaccination**

All associates working at hazardous waste sites where medical wastes are a potential contaminant and who will be working in the Exclusion Zone, handling samples, or who otherwise may come in contact with potentially contaminated materials, must be offered a Hepatitis B vaccination series 10 days prior to working at the site. In addition, all associates who, during the course of providing first aid or CPR, come in contact with blood or other potentially infectious bodily fluids, are to be offered a hepatitis vaccine within 24 hours of exposure regardless of whether PPE was worn.

### S.7.2 Exposure Notification

Should an occupational exposure to blood or other potentially infectious bodily fluids occur, the Health and Safety Manager (HSM) will be notified immediately. Should the exposure occur after normal hours or over the weekend, the Health and Safety Officer (HSO) will contact our health monitoring provider, Environmental Medicine Resources (EMR) at 1-800-229-3672 to arrange for the hepatitis B vaccine at a nearby clinic or hospital. Exceptions to this policy are only for associates who have already received the complete vaccine series and antibody testing has revealed that they are immune, or if the vaccine is inadvisable for medical reasons.

If the associate declines the hepatitis B vaccination, the associate must sign the "Hepatitis B Vaccine Declination" statement (Figure J-2) before being allowed to work at the site or within 24 hours of exposure after providing first aid or CPR.

Any associate who initially declines the vaccine is still eligible to take it at a later date. The vaccine will be available at no charge to the associate.

### S.7.3 Post-Exposure Evaluation and Follow-up

Hepatitis B vaccinations are available, at no charge, to all ABB-ES associates who have current certification in first aid or CPR and have had an occupational exposure to blood or other potentially infectious bodily fluids or who work at sites where there is a potential for an exposure to medical wastes.

After the occurrence of an occupational exposure, a post-exposure follow-up examination will occur. All medical evaluations and procedures are performed under the supervision of EMR and will be conducted at the health monitoring clinic normally used by ABB-ES associates or a clinic or hospital near the site. All evaluations, procedures, vaccinations, and post-exposure management will be conducted according to current standard recommendations of U.S. Public Health Service.

Following a report of an exposure incident, each associate will immediately receive a confidential medical evaluation and follow-up. Included in this examination will be the following elements:

1. Documentation of the route(s) of exposure, and the circumstances under which the exposure incident occurred.
2. Identification and documentation of the source individual, unless ABB-ES can establish that identification is infeasible or prohibited by state or local law.
3. Testing the source individual's blood as soon as possible for HBV. Testing for HIV is performed only after consent is obtained. If consent is not obtained, document that legally required consent cannot be obtained as needed. When the source individual is already known to be infected with HBV or HIV, this testing does not need to be repeated.

4. Results of the source individual's testing will be made available to the exposed associate, and the associate will be informed of applicable laws and regulations concerning disclosure of the identity and the infectious status of the source individual.
5. The exposed associate's blood will be collected and tested after consent is obtained. If the associate consents to baseline blood collection but does not give consent at that time for HIV serologic testing, the sample is preserved for at least 90 days. If within 90 days of the exposure incident, the associate elects to have the baseline sample tested, the testing is done as soon as feasible.
6. High-risk exposure involves blood or body fluids introduced through intact skin or splashed onto mucous membranes or broken or abraded skin of the associate. Any associate sustaining a high-risk exposure should notify the HSM immediately.
7. Follow-up of the exposed associate includes any or all of the following: (a) antibody or antigen testing; (b) counseling; (c) illness reporting; and (d) safe and effective post-exposure measures to prevent the spread of disease.
8. EMR already has or will be provided the following information:
  - a. A copy of the Bloodborne Pathogen Standard and its appendices (29 CFR 1910.1030).
  - b. A description of the affected associates's duties as they relate to the exposure.
  - c. Documentation of the route(s) of exposure and circumstances under which exposure occurred.
  - d. Results of the source individual's tests if available.
  - e. All medical records relevant to the appropriate treatment of the associate including vaccination status.
9. A physician's written opinion will be sent to the associate with a copy to the HSM within 15 days of the completion of the evaluation. The written opinion to the HSM will be limited to:
  - a. the physician's recommended limitations on the associate's ability to receive hepatitis B vaccination;
  - b. a statement that the associate has been informed of the results of the medical evaluation; and
  - c. a statement that the associate has been told about any medical conditions resulting from exposure to blood or other potentially infectious materials that require further evaluation or treatment.

All other findings and diagnoses will remain confidential and will not be included in the HSM's copy of the written report.

## S.8 DEFINITIONS AND ACRONYMS

ABB-ES - ABB Environmental Services, Inc.

AIDS - Acquired Immunodeficiency Syndrome

BLOOD - Human blood, human blood components, and products made from human blood.

BLOODBORNE PATHOGENS - Pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

CONTAMINATED - The presence or reasonably anticipated presence of blood or other potentially infectious materials on an item or surface.

CONTAMINATED LAUNDRY - Laundry which has been soiled with blood or other potentially infectious materials may contain sharps.

CONTAMINATED SHARPS - Any contaminated object that can penetrate the skin, including, but not limited to, needles, scalpels, broken glass, broken capillary tubes, and exposed ends of dental wire.

CPR - Cardiopulmonary resuscitation

DECONTAMINATION - The use of physical or chemical means to remove, inactivate, or destroy bloodborne pathogens on a surface or item to the point where they are no longer capable of transmitting infectious particles and the surface or items is rendered safe for handling, use, or disposal.

ECP - Exposure Control Plan

EMR - Environmental Medicine Resources, Inc.

ENGINEERING CONTROLS - Controls that isolate or remove the bloodborne pathogens from the workplace.

EXPOSURE INCIDENT - A specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that results from the performance of an employee's duties.

HANDWASHING FACILITIES - Facility providing an adequate supply of running potable water, soap, and single-use towels or hot-air drying machines.

HASP - Health and Safety Plan

HBV - Hepatitis B virus.

HIV - Human immunodeficiency virus.

HSM - Health and Safety Manager

HSO - Health and Safety Officer

OCCUPATIONAL EXPOSURE - Reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from performance of an associate's duties.

OSHA - Occupational Safety and Health Administration

OTHER POTENTIALLY INFECTIOUS MATERIALS - are defined as:

1. The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, and any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids.
2. Any unfixed tissue or organ (other than intact skin) from a human (living or dead).

PARENTERAL - Piercing mucous membranes or the skin barrier through such events as needlesticks, human bites, cuts, and abrasions.

PERSONAL PROTECTIVE EQUIPMENT (PPE)- Specialized clothing or equipment worn by an associate for protection against a hazard. General work clothes (e.g., uniforms, pants, shirts, or blouses) not intended to function as protection against a hazard are not considered to be personal protection equipment.

REGULATED WASTE - Liquid or semiliquid blood or other potentially infectious materials; contaminated items that would release blood or other potentially infectious materials in a liquid or semiliquid state if compressed; items caked with dried blood or other potentially infectious materials that are capable of releasing these materials during handling; contaminated sharps; and pathological and microbiological wastes.

SOURCE INDIVIDUAL - Any individual, living or dead, whose blood or other potentially infectious materials may be a source of occupational exposure to the employee. Examples include, but are not limited to, hospital and clinic patients, clients in institutions for the developmentally disabled, trauma victims, clients of drug and alcohol treatment facilities, residents of hospices and nursing homes, human remains, and individuals who donate or sell blood or blood components.

STERILIZE - Use of physical or chemical procedures to destroy all microbial life, including highly resistant bacterial endospores.

UNIVERSAL PRECAUTIONS - An approach to infection control. According to the concept of Universal Precautions, all human blood and certain human body fluids are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.

WORK PRACTICE CONTROLS - Controls that reduce the likelihood of exposure by altering the manner in which a task is performed (e.g., by prohibiting recapping of needles, using a two-handed technique).



Figure S-1: Biohazard Symbol

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## **ABB ENVIRONMENTAL SERVICES, INC.**

### **DECLINATION FORM FOR HEPATITIS B VACCINE**

I understand that due to my occupational exposure to blood and other potentially infectious materials I may be at risk of acquiring hepatitis B virus (HBV) infection. I have been given the opportunity to be vaccinated with hepatitis B vaccine at no charge to me. However, I decline hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring hepatitis B, a serious disease. If in the future I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with hepatitis B vaccine, I can receive the vaccination series at no charge to me.

Employee Signature: \_\_\_\_\_

Social Security Number: \_\_\_\_\_

Date: \_\_\_\_\_

Signature of Witness: \_\_\_\_\_

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**Figure S-2: Declination Form For Hepatitis B Vaccine**

APPENDIX T UNEXPLODED ORDNANCE (UXO)

## APPENDIX T UNEXPLODED ORDNANCE (UXO)

### T.1 INTRODUCTION

There are a variety of Safety precautions, both general and specific, which relate to Ordnance Explosive Waste Hazardous/Non-hazardous (OEW) operations. These related safety precautions should be consulted and complied with, as appropriate to the operation or situation. By their nature, OEW operations are hazardous and certain calculated risks must be taken such as, ingenuity, judgement, common sense and, above all the mastery of Explosive Ordnance Disposal (EOD) techniques and observance of EOD principles will determine success or failure. The below listed safety precautions are general in nature and are applicable to EOD/OEW operations involving ordnance of all nations.

### T.2 GENERAL SAFETY PRECAUTIONS

The following general safety precautions are applicable to OEW related operations.

- During EOD/OEW operations only the minimum number of personnel essential to the operation should be present in the vicinity. EOD/OEW operations will normally be conducted by a minimum of two EOD technicians.
- Do not allow unauthorized or unnecessary personnel to be present in the vicinity of possible hazardous explosive ordnance or when EOD/OEW operations are pending or in progress.
- Personnel working with explosives and explosive ordnance shall comply with the following:
  - Do not carry fire or spark-producing devices on site.
  - Do not smoke, except in authorized areas.
  - Do not have fires for heating or cooking, except in authorized areas.
  - Do not conduct operations without approved Standard Operating procedures (SOP) and proper supervision.
  - Do not become careless by reason of familiarity with ammunition.
  - Do not conduct explosive operations during electrical, sand, dust, or snow storms.
  - Do not conduct explosive operations between sunset and dawn.
- A records search should indicate the possibility of encountering foreign Unexploded Ordnance (UXO), ordnance containing toxic chemicals, or experimental ordnance on the work site. Remember that some foreign UXO has been returned to the United States for exploitation, test firing, and disposal. If the records search indicates that UXO containing military toxic chemical agents may be on the site, a decontamination plan shall be approved prior to entry onto the site. If a chemical UXO is encountered, the 2-man concept is immediately implemented and notification shall be made through

proper channels. EOD personnel shall immediately establish and maintain security of the UXO and the immediate vicinity until military authorities arrive and assume custody.

- In dealing with an unknown type of ordnance, past experience, conditions of delivery, and probable or obvious targets will usually provide a clue as to the type of ordnance. However, considerations should include:
  - The most hazardous type it could be.
  - The most hazardous feature it could contain.
  - The most hazardous condition it could be in.
- Make every effort to identify the ordnance before performing any procedures. However, do not move the item to inspect it unless absolutely necessary and then move it using remote means. Remotely conduct any initial movement or jarring of a possibly hazardous munition or item.
- Care must be observed in probing for, moving, and handling UXO. Do not depress plungers, turn vanes, or rotate spindles, levers, setting rings, or other fittings on the ordnance.
- Do not disassemble or subject any UXO to unnecessary movement, except in response to a valid requirement.
- Personnel preparing to work on possible live ordnance that could contain electrical elements shall momentarily ground themselves before touching the ordnance.
- The site shall be surveyed for electromagnetic radiation (EMR) radio frequency transmitters and appropriate action taken. Safe distances have been established for specific transmitter power and transmitters. These distances shall be made available to the contractor by the Huntsville Division of the Corps of Engineers.
- Do not take magnetic tools or equipment near and unidentified object until it can be absolutely determined that the object is not magnetically functioned.
- Do not wear outer or undergarments made of wool, silk, or synthetic textiles such as rayon and nylon while working on UXO. These materials can generate sufficient static charge to ignite fuels or initiate explosives. Any person coming in contact with an UXO shall ground himself prior to touching Electroexplosive Device (EED). This must be done to discharge any electrostatic charge accumulation from the body.
- Consider explosive ordnance which has been exposed to fire as extremely hazardous. Chemical and physical changes may have occurred to the contents, which render it much more sensitive.
- Avoid inhaling and skin contact with smoke, fumes, and vapors of explosives and related hazardous materials. Do not get in the smoke

of burning explosives, including solid propellants. The smoke will penetrate ordinary clothing. Severe dermatitis, as well as eye and respiratory irritation, can result. If the smoke cannot be avoided, wear protective clothing and a self contained breathing apparatus. Wear gloves and wash thoroughly with soap and water as soon as possible after handling known/unknown explosives and propellants.

- Do not ingest any explosive material; most are poisonous if taken internally. Do not inhale the gaseous products of high explosive detonations (certain types of gases produced are poisonous).
- Do not subject any explosive-loaded item of ordnance to shock or rough handling.
- Protect explosive-loaded ordnance and explosive-loaded components from extremes of heat, including the direct rays of the sun.
- Do not carry explosives or explosive components in pockets or elsewhere on the body, unless in special containers designed and approved for this purpose.
- Do not permit smoking, matches, or other sources of fire or flame within 100 feet of an area in which explosives or explosive-loaded ordnance is being handled.
- Exercise extreme caution in dealing with old, damaged, and possibly deteriorated explosive-loaded ordnance. Certain explosives, notably picric acid and ammonium picrate, may react with metals, other explosives, air, or chemicals in the earth to produce extremely sensitive explosive compounds.
- Do not rely on the color coding of UXO for positive identification of contents. Munitions having none, incomplete, or improper color coding have been encountered.
- Assume a practice UXO contains a live charge it can be determined otherwise.
- Avoid the area forward of the nose of a munition until it can be determined that the item is not a shaped charge, High Explosive Anti-Tank (HEAT) UXO. The explosive jet can be fatal to great distances forward of the longitudinal axis of the item.
- Assume any shaped charge munition to contain a piezoelectric (PZ) graze sensitive fuzing system until the fuzing is otherwise identified. A PZ graze sensitive fuse is extremely sensitive. It can fire at the slightest physical change, and may remain hazardous for an indefinite period of time.
- Anticipate a detonation when burning any explosive. Certain low explosives, such as black powder, casting powders, and solid propellants having a nitrogen content can react under certain conditions with a violence approaching a high order detonation.

- Civil War projectiles shall be treated as any other UXO, especially projectiles with uncut Bormann time fuses and projectiles with percussion fuses, brass in particular. These have generally provided a watertight seal, even if they have been in the ground over one-hundred years. No projectile should be exposed to excess heat. The ignition point of black powder, used as a bursting charge in all Civil War projectiles, is 457 degrees Fahrenheit. Under no circumstances should an attempt be made to drill a hole in a projectile, either through the fuse or the body of the projectile.

### T.3 EXCAVATION OF UNEXPLODED ORDNANCE

- The usual method for uncovering buried UXO is to excavate by hand. Hand excavation is the most reliable method for uncovering UXO, but unless the UXO is very near the surface, hand excavation exposes more people to the hazard of detonation for a longer period of time than any other method.
- Earth moving machinery (EMM) may be used to excavate for buried UXO, if the UXO is estimated to be deeper than 12 inches. EMM shall not be used to excavate within 12 inches of an UXO. When excavation gets within 12 inches of an UXO, hand excavation shall be used to uncover the UXO.
- Excavation shall comply with the provisions of 29 CFR 1926 subpart P.
- Perform initial movement of an embedded projectile remotely. First movement of an embedded projectile may cause fuse functioning. During this remote operation, precautions shall be taken for a high-order detonation.
- UXO which penetrates the earth to a depth where the force of the explosion is not enough to rupture the earth's surface forms an underground cavity called a camouflet. Camouflets will be filled with the end product of the explosion, carbon monoxide gas. Camouflet detection and precautions must be considered if records search indicates the site was used as an impact area.

### T.4 SAFETY PRECAUTIONS FOR FUSES

- Before any movement of an UXO, the fuse condition must be ascertained. If the condition is questionable, consider the fuse armed. The fuse is considered the most hazardous component of UXO, regardless of type or condition.
- Observe magnetic and acoustic precautions when approaching and unidentified fuse.
- Avoid any unnecessary movement of an armed fuse. Perform any initial movement of an armed fuse remotely and avoid any unnecessary movement of an armed fuse.

- Do not disturb a piezoelectric firing crystal in any way.
- When transporting a possible armed fuse, position the fuse in the most neutral orientation possible.
- Do not subject a mechanical time fuse to any unnecessary movement.
- Do not attempt to reset an adjustable clockwork fuse.
- Do not turn off or on any source of radio frequency or any rapidly alternating electric current in the vicinity of a known or suspected proximity variable time (VT) fuse.
- Do not approach a proximity VT fuse until the prescribed waiting period has elapsed, and then approach from the rear.
- Keep a fuse which has been removed from ordnance, separated from other explosive ordnance.

#### **T.5 PRECAUTIONS FOR PYROTECHNICS AND INCENDIARY MUNITIONS**

- Protect the eyes by number 6 shade welders goggles, or equivalent, if visual exposure to burning pyrotechnic material is probable.
- Use sand to smother incendiary fires. Water may induce a violent reaction or be completely ineffective.
- Bury the incendiary-loaded munitions in sand when transporting. This will smother any fire which may start until other corrective actions can be taken.
- Anticipate a high-order detonation when burning pyrotechnic or incendiary loaded ordnance.
- Do not approach a pyrotechnic or incendiary ordnance burn for 30 minutes after cessation of burning.
- Do not attempt to dispose of photoflash munitions by burning.
- Do not look directly at photoflash munitions during disposal operations.
- Photoflash powder is extremely sensitive, as it contains black powder and aluminum.
- Use oil or WD-40 to desensitize spilled photoflash powder.
- Do not manually remove fuses from munitions containing photoflash powder.
- Photoflash powder generates hydrogen gas when exposed to moisture.

- Expended pyrotechnic/practice devices may contain red/white phosphorus residue. Due to incomplete combustion, red and white phosphorus may be present and re-ignite spontaneously if subjected to friction, or if the crust is broken.
- Extra care shall be taken when uncovering a buried UXO if a records search indicated white phosphorus (WP) munitions were fired or destroyed in the area. A buried WP munition may be damaged and when exposed to air, may start burning and detonate. An ample supply of water and mud shall be immediately available if excavation reveals a WP UXO. Appropriate protective equipment and first aid shall also be immediately available.
- Do not approach a smoking WP UXO. Burning WP may detonate the burster or dispersal explosive charge at any time.
- Do not transport a WP munition, unless it is immersed in water, mud or wet sand.
- WP UXO shall not be detonated into the ground. The UXO shall be counter-charged on the bottom-center-line.

#### T.6 SAFETY PRECAUTIONS FOR AIRCRAFT - HAZARDS AND ASSOCIATED MUNITIONS

- Turn off aircraft power prior to working on any munition or hazard still attached to the aircraft.
- Ensure that the aircraft and all personnel are properly grounded before operations on any ordnance attached to the aircraft.
- Always consider a dispenser to be loaded. The presence or absence of a payload may not be obvious from an external examination.
- Do not remove munitions from a dispenser unless absolutely necessary. Many of the contained munitions are designed to arm as soon as they leave the dispenser.
- Approach and work on unfired rocket and missile motors from the side. Do not expose electrically fired rocket motors within 150 feet of any exposed electronic transmitting equipment or exposed antenna leads.
- When approaching an unidentified guided missile, observe liquid fuel and liquid oxidizer precautions until monitoring has been verified that the missile does not contain these hazards.
- Do not disconnect or cut any electrical cable unless it is specifically prescribed in the EOD procedure.
- Be aware of high voltage, thermal batteries, wet cell battery acid and high pressure lines.

- Always approach an aircraft involved in an accident at a 45 degree angle from the rear.
- Some practice bombs do not contain any positive safety features. Positively identify and review all safety precautions prior to handling practice bombs.

#### T.7 SAFETY PRECAUTIONS FOR GROUND LAUNCHED AND EMPLOYED MUNITIONS

- All munitions that have been fired, launched, thrown, placed, etc., will be considered armed.
- Permit only one man at a time to work on a mine.
- Consider an emplaced landmine armed until proven otherwise. Many training mines contain firing indicator charges capable of inflicting serious injury.
- Exercise care with wooden mines that have been buried for a long time. Because of soil conditions, the wood deteriorates and the slightest inadvertent pressure on top may initiate the fuse.
- Probe and examine carefully the ground around a mine before starting to work on it.
- Be constantly on the lookout for boobytraps.
- Before lifting a mine, neutralize all fuses and remove the mine remotely.
- Always assume a mine to be protected by other mines, anti-lift devices and other boobytraps.
- Do not cut or pull a taut wire, never pull a slack one; look at both ends of a wire before you touch it.

#### T.8 RENDER SAFE PROCEDURES AND DISPOSAL OF UNEXPLODED ORDNANCE

- The preferred and safest method for disposal of UXO is to destroy it in its original position by detonation. This method should be used whenever considerations and circumstances permit.
- No UXO shall be destroyed until it has been positively identified. Make every effort to identify the UXO. Carefully examine the item for markings and other identifying features such as shape, size, and external markings. However, do not remove the item to inspect it. If an unknown UXO is encountered, photographs shall be taken and express-mailed to CEHND-ED SY (or other governing agency), which has access to the Army Technical Manual (TM) 60 Series publications.
- If the situation dictates, protective measures to reduce shock blast, and fragmentation damage shall be taken. TM 5-855-1,

Fundamentals of Protective Design for Conventional Weapons and associated software program "CONWEP" contains data on blast effects, groundshock, cratering, ejecta, and fragmentation.

- Consideration shall be given to tamping the UXO to control fragments, if the situation warrants.
- Coordination with the appropriate airspace representative shall be conducted and the appropriate notification procedures arranged.
- A post-search of the detonation site shall be conducted to assure a complete disposal was accomplished.
- Do not pack a bomb fuse well with explosives, unless it can be positively confirmed that the fuse does not contain any fuse components.
- If a UXO must be transported off site for disposal, the provisions of 49 CFR 100-199, state and local laws shall be followed.
- If base-ejection type projectiles must be transported to a disposal area or collection point, the base shall be oriented in the rear of the vehicle and the projectile secured, in the event the ejection charge functions in route.
- If an UXO with exposed hazardous filler (HE, etc.) has to be moved to a disposal area, the item shall be placed in a heavy duty plastic bag to prevent migration of the hazardous filler. Padding should also be added to protect the exposed filler from heat, shock, and friction.
- Do not undertake the handling or disposal of liquid propellant fuels or oxidizers if not familiar with the characteristics of the material.
- Inert ordnance will not be disposed of or sold for scrap until the internal fillers have been exposed. Heat generated during reclamation operation can cause the inert filler, moisture and air to expand and burst sealed casings. Venting or exposure may be accomplished in any way necessary to preclude rupture due to confined pressure.

APPENDIX U USE OF EXPLOSIVES FOR SEISMIC REFRACTION SURVEYS

## APPENDIX U USE OF EXPLOSIVES FOR SEISMIC REFRACTION SURVEYS

### U.1 INTRODUCTION

This appendix lists some of the more important aspects of the purchase, transport, storage, handling, and use of explosives. It is intended as a general guide for ABB-ES personnel who may be involved in conducting seismic surveys or who may be overseeing or auditing such surveys. It is not intended as a stand-alone reference replacing appropriate federal and/or state regulations, which can be very specific about certain aspects regarding explosives.

Many recent advances in computer software and hardware and hardware technology have revolutionized data processing and interpreting in the seismic industry. Likewise, the recent development of sophisticated (and very expensive) truck-mounted energy sources that can scan a large range of frequencies for optimum response from deep reflecting horizons has made possible reflection surveys for hydrocarbon deposits to depths of up to 20 kilometers. However, for shallow (i.e., the upper several hundred feet) seismic refraction surveys, the best and most economical energy source continues to be small explosive charges detonated with electric blasting caps.

A small explosive charge, as defined herein, consists of the equivalent of from 1/8 to 1 pound of dynamite which is primed for detonation with one or more electric blasting caps. The "dynamite" that ABB-ES generally uses is KINESTIK 1/3, which consists of a powder and liquid, mixed onsite to form an explosive similar in performance to dynamite. Each stick (86 to a case) is equivalent to 1/3 pound of dynamite. Before mixing, the two parts are not considered by the DOT to be explosive; therefore, they can be shipped, transported, and stored with no special precautions. In practice, ABB-ES personnel shall take every precaution to ensure that the powder and liquid are separated while being stored for any length of time to prevent unauthorized access to potentially explosive materials.

Electric blasting caps come in two configurations acceptable for seismographic work. The "seismograph" variety is best because of its repeatability with regard to delay time (i.e., the time that elapses between when the "fire" button on the blaster is depressed and when the blasting cap actually detonates). The other type is known as "instantaneous," and it has acceptable delay time characteristics. Blasting caps are graded by the federal government (and all states) a Class A explosive and must be handled and stored accordingly. Requirements for Class A explosive are discussed in the following subsection.

### U.2 PURCHASE, TRANSPORT, AND STORAGE

The federal government has specific guidelines regarding the purchase, transport, and storage of explosives, particularly regarding interstate commerce. In addition, each state has developed regulations that supersede federal regulations if they are more restrictive. Therefore, the user must become familiar with federal as well as state regulations. In practice, it is unlikely that ABB-ES would ever become involved in interstate activities regarding explosives. In fact, it has been ABB-ES's practice to subcontract out-of-state blasting activities to a local blaster to minimize expenses that would otherwise be

incurred in obtaining necessary permits, and to eliminate time expended to purchase, transport, and store explosives. The following subsections pertain to State of Maine requirements. Other states can be and are different from Maine, and requirements vary widely.

### U.2.1 Purchase

In the State of Maine, a blasting license for an individual is not required. Such a license is required in Massachusetts (a competency license) and New York (an explosives license). However, the State of Maine does require a written permit, issued by the Commissioner of Public Safety, for the transport of explosives in intrastate commerce in quantities larger than 200 pounds of dynamite, or more than 500 electric blasting caps. Although ABB-ES never transports quantities exceeding these amounts, it has been company policy to obtain the State Permit to Transport Explosives, because it provides additional credibility to explosives vendors and local officials.

Before purchasing explosives in Maine, the user must obtain a permit from the fire marshal or appropriate local official in the town in which the explosives are to be used and/or stored. The local official must first establish the identity of the applicant, verify that he or she is older than 21 years of age and is a U.S. citizen, and inquire about the intended use of the explosives. Permitting thorough local officials can be as easy as a courtesy telephone call from the official notifying the local fire department or police chief (every town or city handles explosives permitting a little differently).

Before selling explosives, the state requires the vendor to verify that a valid permit has been issued to the buyer by the appropriate local town official. In addition, the vendor should ascertain whether the buyer can comply with the rules and regulations relative to the transport of explosives.

### U.2.2 Transport

Before issuing the State Permit to Transport Explosives, officials from the Department of Public Safety in Augusta, Maine, inspect the vehicle driven by the applicant to ensure that it is roadworthy. They also inspect the explosives magazine in which the explosives will be locked while in transit. State regulations require that the magazine be constructed of 1-1/2-inch-thick planking with no exposed metal on the inside (to eliminate sparks) and sheathed with NO. 24-gauge galvanized sheet steel. The magazine should have a strong hasp and padlock and be locked at all times when explosives are being transported. The magazine should also be chained and locked within the vehicle to prevent removal or shifting while under way. In addition, the vehicle should be equipped front and rear with two 1-quart (minimum) fire extinguishers suitable to extinguish electrical fires, and four diamond-shaped Class "A" explosives signs mounted on the front and rear and both sides of the vehicle. ABB-ES owns a "day" magazine and other equipment that meets these requirements.

### U.2.3 Storage

Regulations are very specific regarding storage. All that ABB-ES personnel need to remember is Class "A" explosives must be returned for storage to a permanent or temporary magazine before sunset on each day of usage. The ABB-ES day magazine is not a permanent or temporary magazine. A permanent magazine is a

substantial structure located well away from dwellings and buildings where people work or congregate. It has walls 4 to 8 inches thick (depending on method of construction), strong doors with interior hinges, and double-shielded locks specially designed for storage magazines. The roof is constructed to be bullet-proof, and foundation requirements are also specified. A temporary magazine is usually a rather massive steel box (i.e., 350 to 500 pounds or more) on casters, lined with thick wood planking, with double-shielded locks. It should be securely fastened to the ground.

### U.3 HANDLING AND USE

Safety shall be the foremost consideration whenever explosives are being used. Seismic surveys routinely expend 20 to 30 sticks of dynamite (and an equal number of electric blasting caps) during a single field day. To mix the KINESTIK, mix one "tube" of the KINESTICK liquid (a clear red liquid composed of nitromethane) with one "stick" of white powder (ammonium nitrate), and allow to stand until the powder is thoroughly saturated with the liquid (it becomes pink); this takes 5 to 10 minutes. If the upper 4 feet of overburden are wet or saturated, it is a good idea to seal the stick (equipped with a screw cap) with tape to prevent contamination by groundwater. If groundwater enters the stick, it can cause the KINESTIK to misfire.

While the KINESTIK is being mixed, a series of shotholes (usually five) are prepared by driving a pointed 1-and-3/4-inch steel bar to the desired depth (from 2 to 4 or 5 feet) with a sledgehammer. The shothole depth depends on soil conditions and the anticipated size of the charge. Only when the explosives are ready to be placed at the bottom of a shothole, a blasting cap is placed in a molded cavity at the base of each stick. The blasting cap has two lead wires, usually 8 or 12 feet long, which are grounded together with a removable metal shield that should be left in place until the primed shot is ready to be fired. This prevents the induction of electric charge, which could accidentally fire the cap. The lead wires are used to connect the blasting cap to a double conductor (i.e., "shot") wire leading to the blaster. The cap is secured to the KINESTIK by two or more half-hitches with the two cap lead wires.

The explosive is not "primed" for detonation. After the primed shot is placed at the bottom of the shothole, a small amount of native soil (preferably sand) is placed in the hole and gently tamped with a tamping stick into the base of the hole over the primed explosive charge. A proper tamping stick is wooden (non-sparking), about 6 feet long and 1 to 1-1/4 inches in diameter (Note: dowel stock works well). The tamping procedure continues until a uniform column of native soil completely fills the shothole. One should be careful not to damage the cap lead wires during the tamping process.

The removal metal shield grounding the two cap lead wires together is removed only when the shot is ready to fire. Prior to making the connection between the cap lead wire and the shot wire leading to the blaster, the person making the connection should ascertain that the shot wire has been sorted out as the blaster by the party chief (operating the blaster) so that inadvertent detonation is not possible). While making the connection, the lead wires should be extended as far from the shothole as possible. The person making the connection shall turn his or her back to the shothole, remove the metal grounding shield, and attach the shot wire leads (no polarity) to the cap wire leads.

As each shot is detonated, one person (usually the one making the connection) will be assigned to verify that no one is near the shot. The party chief shall then call out, "Are you clear (of the shot)?" The response, "all clear" indicates that everything is ready and no one is close enough to be in any danger when the shot is detonated. A "safe" distance varies with soil conditions and the depth of the shot; 75 to 100 feet is generally adequate. The party chief then calls out to everyone in the area, "Fire in the hole," and the charge is detonated.

If a misfire occurs (extremely rare), it is the responsibility of the party chief to remove the undetonated charge from the ground with a nonsparking shovel of wood or brass. The party chief is responsible for maintaining an explosives log that documents all explosives purchased, expended, stored, and destroyed. This log is subject to inspection at any time by local, state, and federal officials. It provides a record detailing the disposition of every cap and stick of dynamite (or KINESTIK) that comes under the control of ABB-ES personnel.

The amount of explosives that can be loaded into a shothole depends on the nature of the surface materials and the depth of the water table. Some general rules follow:

- use as few explosives as necessary to produce good quality data
- the more granular the soils, the more explosives will be required (to produce good data); the finer the soils, the fewer will be required
- the deeper the water table, the more explosives required, and vice versa
- the deeper the bedrock, the more explosives will be required, and vice versa

When ascertaining the proper explosive charge to produce good data at a new site, it is good practice to start with a single shothole well away from any buildings and power lines, and perform a test shot to determine local soil (an energy transmission) characteristics. Start with a small charge (e.g., half a stock of KINESTIK, obtained by mixing half the liquid from one tube with half the powder from one stick) buried to moderate depth (e.g., 3 feet) and increase (or decrease) the amount of the charge (and the depth of the shothole) as necessary.

#### U.4 EXPLOSIVE USE AT NAS CECIL FIELD

If seismic refraction surveys utilizing explosives are conducted at NAS Cecil Field, the purchase, storage, transportation, and handling of explosives will be subcontracted to a Florida licensed professional blaster. The blaster will be responsible for the safe handling, storage, and use of explosives in accordance with federal, state, and local regulations.

# PUBLIC HEALTH FACT SHEET

# LYME DISEASE

Acknowledgements: Portions of this text are reproduced from Fact Sheets published by the Massachusetts and Maryland Departments of Public Health.

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## What is Lyme Disease?

Lyme Disease is an illness caused by bacteria that are transmitted to humans, dogs, horses and other animals by the bite of an infected deer tick (*Ixodes dammini*). While rarely life-threatening it is an important illness because of its potential to cause problems in the joints, nervous system, and heart.

## Where is Lyme Disease Found?

Transmission of Lyme Disease has been documented in many parts of the world. It occurs over wide areas of the United States, but particularly along the east coast. It was first recognized in the U.S. in 1975 as the result of an investigation of a group of children with arthritis in Lyme, Connecticut.

## How is Lyme Disease Transmitted?

The bacteria that cause Lyme Disease are acquired by juvenile deer ticks (larvae) through feeding on an infected animal, usually a mouse. At a subsequent stage in development (nymph), the ticks cling to vegetation in brushy, wooded, or grassy areas and transfer by direct contact to the skin of passing animals and humans. The bite of the infected tick can then transmit the bacteria to the new host. This transmission of the infectious organism appears to require that the tick be attached for at least 24 hours.

The immature deer tick is very small, and when attached to the skin may not be immediately noticeable. The approximate size of the tick at various stages of development is illustrated below:

	Larva	Nymph	Adult	Engorged adult
Actual size				
	August September	June July	April, May September - December	

During its complex two-year life cycle the tick can infect a variety of hosts including white-footed mice, deer, and other wild and domestic animals as well as humans. Lyme Disease is most commonly acquired in the summer months, less often in early spring or late fall, and only rarely during the winter.

It is important to note that not all ticks carry Lyme disease. The common dog tick for example does not transmit the infection. Even a deer tick bite does not necessarily mean that disease will follow, because not all members of the species are infected. Prompt removal of a tick will greatly decrease the risk of disease transmission.

## What are the symptoms of Lyme Disease?

### Early Symptoms:

The first symptom of Lyme Disease is usually-but not always- a skin rash called Erythema Migrans (EM). While the tick may have gone undetected, the rash occurs at the site of the bite. It begins as a small red area 3 to 32 days after the bite, then gradually enlarges, often with partial clearing at the center, so that it resembles a doughnut. The rash may be accompanied by flu-like symptoms such as fever, headache, stiff neck, sore and aching muscles and joints, fatigue, sore throat, and swollen glands. There may be multiple rashes in other areas of the body that develop after the rash that occurs at the site of the bite. These symptoms may disappear on their own over a period of weeks. However, the rash may recur in about 50% of untreated people and more serious problems may develop later. Treatment with appropriate antibiotics clears up the rash within days and may prevent complications.

### Late Symptoms:

Three major organ systems-the joints, nervous system, and heart-can be affected weeks-months after the initial tick bite, although symptoms usually appear within four to six weeks. A small

number of people with Lyme Disease may develop symptoms during later stages without having had the early skin rash.

Arthritis in the large joints (primarily the knee, elbow, and wrist) occurs in more than one-half of untreated persons. The arthritis may move from joint to joint and can become chronic.

Nervous system complications occur in 10% - 20% of infected persons. These complications may take many forms, some quite serious. Treatment with intravenous antibiotics can be helpful.

Heart symptoms occur in 6% - 10% of infected persons. Electrical conduction in the heart may be affected and the heart muscle may become inflamed.

#### How is Lyme Disease Diagnosed?

Diagnosis is based primarily on recognition of the typical symptoms of Lyme Disease, especially the characteristic early rash and on the history of possible tick exposure, such as outdoor activity in a high-risk area. Atypical cases or cases with only later stage complications can be difficult to diagnose. Laboratory tests are helpful in some circumstances, but require very careful interpretation by a physician. In general, the lab tests are more useful in aiding the diagnosis of disease in later stages than in diagnosing early Lyme Disease.

#### What is the Treatment for Lyme Disease?

Oral antibiotic treatment is beneficial early in illness. Two commonly used medications in this settings are Tetracycline and Amoxicillin, although other antibiotics may be substituted. Prompt treatment of early Lyme Disease may prevent later and more serious complications. Treatment of joint and nervous system complications is often accomplished with antibiotics given intravenously or by injection.

#### How Can Lyme Disease be Prevented?

The only known way to get Lyme Disease is from the bite of an infected tick. Knowing where these ticks are found, avoiding such areas, and promptly removing the tick are the primary preventive measures. Persons living in or visiting high-risk areas should take the following precautions:

- Don't walk barelegged in woods, brush, or tall grass where ticks may be found.
- If you do walk in such areas, wear a long-sleeved shirt, long pants, high socks (with pants tucked into socks), and closed shoes or boots. Light colors will help you spot ticks on clothing.
- Apply a commercial tick repellent on clothing, shoes, and socks after reading label instructions carefully. Avoid applying high concentration products to the skin, particularly of children.
- Conduct daily "tick checks" on yourself, your children, companions and on pets when you get in from the field. Shower, if possible. The ticks are often found on the thigh, flank, arms, underarms, and legs, and may be very small. Prompt removal of the tick will prevent infection.
- To remove an embedded tick, use tweezers to grip its body as close to the skin as possible and pull gently but firmly until the tick lets go. If tweezers are unavailable, grasp the tick with piece of tissue. Do not handle the tick with bare hands.
- Know the symptoms of Lyme Disease. If you have been in an area where ticks are found, and you develop such symptoms, particularly the skin rash and/or "flu" symptoms, see a physician promptly for evaluation and treatment.



ATTACHMENT B

SITE 11 HASP ADDENDUM

# **NAS CECIL FIELD**

## **HEALTH AND SAFETY PLAN ADDENDUM 1**

### **SITE 11 - GOLF COURSE PESTICIDE DISPOSAL AREA**

This is an addendum to the Cecil Field Health and Safety Plan for site 11 where an insecticide 1,2-dibromo-3-chloropropane (Nemagon), as well as other pesticides and herbicides were reportedly buried near a golf course.

#### **1.1 SCOPE OF WORK**

In an effort to expedite the remediation action process at NAS Cecil Field, the Navy has begun to identify sites that are candidates for the removal action process. The Golf Course Pesticide Disposal Area, Site 11 (OU6), has been identified as an appropriate site for removal action.

Work anticipated at the site include clearing brush, etc. from the area, a magnetometer survey to identify anomalies, and test pitting to confirm location of buried drums.

#### **1.2 SITE HISTORY AND LAYOUT**

Site 11 is located approximately 600 feet northwest of building 398, between fairways 11 and 17. Based on the information provided in the IAS report, the site covers an area approximately 40 feet by 40 feet, encompassing approximately 0.1 acre.

The site was used as a disposal area for pesticide, fungicide, and herbicides containers from the early 1970s to 1978. Typically, waste containers were collected from the golf course maintenance building and transported to the site by hand or truck for disposal.

Approximately two to four empty five-gallon cans were disposed per month at the site. The cans were not rinsed prior to being taken to the site. The cans were allowed to accumulate for a number of months before they were crushed by a front-end loader and buried approximately three feet deep. It is estimated that between 200 and 450 empty 5-gallon cans were disposed at the site during the time it was used.

After completion of a new pesticide facility (building 397) in 1978, two to three 30-gallon drums of unused pesticide, of which at least one was reportedly Nemagon, and approximately 10-15 full 5-gallon containers of pesticides, herbicides and fungicides were discarded and buried at the site. Many of these containers were beginning to rust, or lacked identification labels, and were considered unusable for the new facility. Once the move was made to the new maintenance facility, use of Site 11 for disposal purposes was discontinued. Potential wastes disposed at the site are listed in Table 1.

Table 1

TYPICAL INVENTORIES OF PEST CONTROL MATERIALS  
MAINTAINED AT THE GOLF COURSE FACILITY\*

NAS CECIL FIELD  
JACKSONVILLE, FLORIDA

PEST CONTROL MATERIAL	TYPE	NORMAL INVENTORY LEVEL
Carbaryl, 80% wettable powder (WP)	Insecticide	150 pounds
Dursban, 23.5% emulsifiable concentrate (EC)	Insecticide	20 gallons
Malathion, 57% EC	Insecticide	10 gallons
Propoxur (Baygon), 70% WP	Insecticide	50 pounds
Nemagon	Insecticide	300 pounds
Buctril (Bromoxyril) 33.8% EC	Herbicide	4 gallons
Monosodium acid methane arsonate, 48% EC	Herbicide	90 gallons
Round-up (glyphosate), 41% EC	Herbicide	5 gallons
Trimec, 30% EC	Herbicide	10 gallons
Trimec, 43% EC	Herbicide	5 gallons
2,4-D, 47.4% Amine	Herbicide	40 gallons
Dithane (Manzate), 80% WP	Fungicide	200 pounds
Maneb (Tersan LSR), 80% WP	Fungicide	30 pounds
Maneb (Tersan), 75% WP	Fungicide	70 pounds
Form-A-Turf (formaldehyde), 31% EC	Fungicide	10 gallons
Daconil	Fungicide	10 gallons

\*Based on interviews with pest control personnel and the 1979 Pest Management Plan.

### **1.3 TRAINING**

In addition to the training requirements of the Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) (See HASP Appendix A, Section 4), training in compliance with the OSHA standard for 1,2-dibromo-3-chloropropane (Nemagon) (29 CFR 1910.1044) will be required for all personnel who work on site 11. This training will include:

1. A review of Appendix A of the OSHA Standard (Substance Safety Data Sheet for Nemagon)
2. Information on the quantity, location, manner of use, release, or storage of Nemagon as well as all necessary protective steps to use.
3. A review of the purpose, proper use, and limitations of respirators.
4. The purpose and description of the medical surveillance program required by the standard.
5. A review of the standard, including appendices.

Maintenance personnel, golfers, as well as base personnel will be informed of the work being conducted and instructed to keep away.

### **1.4 MEDICAL SURVEILLANCE**

In addition to the medical surveillance requirements of the Hazardous Waste Operations and Emergency Response Standard (29 CFR 1910.120) (See HASP Appendix A, Section 3), all workers entering or potentially entering the exclusion zone on Site 11 who could potentially come in contact with Nemagon, will be required to receive additional medical surveillance in compliance with the OSHA standard for 1,2-dibromo-3-chloropropane (Nemagon) (29 CFR 1910.1044).

The testing required of 1910.1044 (m) include:

1. A medical and occupational history including reproductive history.
2. A physical examination, including examination of the genito-urinary tract, testicle size, and body habitus including a determination of sperm count.
3. A serum specimen and following determinations made by radioimmunoassay techniques utilizing National Institutes of Health (NIH) specific antigen or one of equivalent sensitivity for a) Serum follicle stimulating hormone (FSH); b) Serum luteinizing hormone (LH); and c) Serum total estrogen (females only).
4. Any other tests deemed appropriate by the examining physician.

See 1910.1044 Appendix C - Medical Surveillance Guidelines for DBCP (Nemagon) for further information on required procedures.

## **1.5 HEALTH HAZARDS**

Table 1 lists the pesticides, herbicides, and fungicides of the typical inventories used at the site. The material safety data sheets (MSDS) for all listed materials are attached. Refer to the MSDSs for further information on these materials.

The pesticide Nemagon is the contaminant of concern at Site 11. This compound has an OSHA PEL of 1 ppb, cannot be detected adequately by any real-time monitoring instrumentation, is absorbed through all routes of entry into the body (inhalation, ingesting, dermal, and eye), can cause breakthrough in impermeable work clothing, and causes cancer, atrophy of the testicles (men), changes in the estrous cycle (women), liver disease, kidney disease, skin disease, as well as causing blood disorders.

## **1.6 SAFETY HAZARDS**

Safety hazards include those hazards that personnel may be exposed to that are unrelated to hazardous wastes. These include hazards such as heat stress, operation and presence around heavy equipment, lifting of heavy objects, vehicle traffic, Noise from the take-off and landing of Jets, and snake bites.

Extreme caution should be exhibited by all personnel while conducting work around drill rigs, backhoes, and other heavy equipment. During hot days, personnel should take time to drink fluids and cool off to avoid overheating and symptoms related to heat stress. Ice vests will be worn by all workers wearing Level B PPE. (See Chapter 12 for further information on heat stress.) Lifting of heavy objects should be done with caution. Personnel should assist one another with moving heavy objects or use the appropriate equipment to accomplish these tasks. Mechanical aids should always be used when available. Hearing protection will be worn when working around the runways or in noisy areas. During all site activities, personnel should be aware of the possibility of an encounter with poisonous snakes, particularly rattlesnakes, water moccasins, and pygmy diamondbacks.

## **1.7 CONCLUSIONS/RISK ASSESSMENT**

The risk to the workers doing the clearing and magnetometer survey is expected to be low. It is not anticipated that these individuals will come in contact with potentially contaminated drums or soil. Workers doing test-pitting have a potential to come in contact with high concentrations of contaminants from full and unrinsed drums.

## **1.8 PROTECTIVE MEASURES**

### **1.8.1 ENGINEERING CONTROLS/WORK PRACTICES**

An attempt is being made to obtain a track-hoe with an enclosed cab to be used when test pitting. All workers will stay clear of the exclusion zone until absolutely necessary to enter to perform assigned task. All workers entering the exclusion zone should avoid unnecessary contact with contaminated soil, containers, and equipment. All unessential personnel will be prohibited from the site.

### **1.8.2 LEVELS OF PROTECTION**

All invasive activities will be done in Level B PPE. Non-invasive or work with no potential for accidental contact (clearing, magnetometer survey) will be done at Level D.

Level B PPE will include the following:

- SCBA (pressure demand) or supplied air respirator (pressure demand with escape SCBA)
- Hooded chemical resistant clothing made from Dupont Barricade fabric.
- Outer Glove - SilverShield
- Inner Glove - Nitrile
- Boots - Steel Toe, ANSI approved
- Boot covers - 4-H (Ansel Edmont)
- Hard Hat
- Ice vest

### **1.8.3 AIR MONITORING**

Real time monitoring will be conducted with a respirable dust monitor, LEL/Oxygen meter and PID. (Note: Due to Nemagon having a PEL of 1 ppb, real time monitoring for volatiles in the breathing zone is impractical).

The perimeter of the exclusion zone will be monitored with a respirable dust monitor and PID. If dust level exceed  $5 \mu\text{g}/\text{m}^3$ , work will halt and dust control measures instigated. If PID readings exceed background, work will halt and all non-exclusion zone workers will backoff to a safe area. The workers in the exclusion zone will attempt to determine the source. Work will continue only if the source has been determined not to be Nemagon, the source has been contained, or when the exclusion zone has been enlarged sufficiently so that PID readings at the perimeter are at background. If a contamination reduction zone, large enough to prevent any

possibility of exposures to golfers, cannot be established, all work will halt and a determination made to either discontinue operations or close the golf course.

LEL will be measured at the source (e.g., test pit). The following action limits will be used:

LEL  $\geq$  10% Work will continue only if proper precautions are taken (spark arresters, non-sparking tools/spikes on track-hoe [bronze], intrinsically safe equipment)

LEL  $\geq$  20% Work will halt until levels are reduced to below 20%.

#### **1.8.4 PERSONAL MONITORING**

Personal monitoring will be conducted once test pitting operations begin for all workers in the exclusion zone. A Gillian high flow pump with a low flow attachment will be used to collect samples on petroleum based charcoal absorption tubes for analysis of the breathing zone levels. Two 4-hour samples, set at a flow rate of 50 ml/min, to collect a total volume of 10 liters will be taken each of the 3 days test pitting is conducted to determine the workers time weighted average.

The names of all the personnel who will work or potentially work in the exclusion zone, their social security numbers, and their Company Names and Addresses will be documented. In addition, environmental conditions (e.g., weather conditions, wind speed, topography, etc.) will be noted. All personnel for whom the samples represent will be notified of the results within 5 working days of their receipt.

#### **1.9 ZONATION**

As work will be conducted near the fairways of an active golf course, extra precautions will be taken to ensure the protection of the public.

The exclusion zone will be established approximately 30 feet around the anticipated test pit area. The boundary will be marked with flagging or some other similar means. Near the entry into the Exclusion zone, a sign stating:

**DANGER**  
**1,2-DIBROMO-3-CHLOROPROPANE (NEMAGON)**  
**CANCER HAZARD**  
**AUTHORIZED PERSONNEL ONLY**  
**RESPIRATOR REQUIRED**

The contamination reduction zone (CRZ) will be established at a sufficient distance from the exclusion zone to ensure the public is kept well clear of the hazardous area. The perimeter of the CRZ will be monitored, and all who approach the area will be instructed to kept out.

Any golf balls that enter the CRZ may be returned to their owner if there is no potential of contamination. Any golf balls that enter the exclusion zone will be kept and disposed of as hazardous waste.

#### **1.10 DECONTAMINATION/DISPOSAL**

The decontamination station will be positioned up wind from the test pitting activities.

If workers protective clothing becomes contaminated with Nemagon, it must be removed and disposed of immediately.

All workers must wash their hands thoroughly with soap or a mild detergent before eating, smoking, or using the toilet facilities. All workers must shower at the end of the work day.

A level B decontamination station will be established for the decontamination of all personnel who enter the exclusion zone. All decontamination fluids will be collected and placed in 55 gallon drums for later disposal. All contaminated clothing will be bagged and placed in 55 gallon drums for disposal. All contaminated soil will be placed back into the test pit and covered with clean soil. Refer to Section 8.0 of the HASP for further information.

#### **1.11 EMERGENCY AND CONTINGENCY PLAN**

Prior to the initiation of work activities, the wind direction will be noted and an area of refuge established in the event an evacuation is required.

Should a container accidentally be damaged by the trackhoe, work will halt and workers will back off until a determination using the PID and dust monitor is made that the established zones are adequate to protect the support zone workers and the public. If Levels at the perimeter of the exclusion zone exceed  $5 \mu\text{g}/\text{m}^3$  or if PID readings exceed background, new zones will be established. If safe zones cannot be established, the containers will covered immediately.

Once the adequacy of the zones has been confirmed, an attempt will be made to determine the contents of the container by reading the label. Workers must maintain Level B PPE while in the exclusion zone. The attempt to read the label will be done as remotely as possible.

A shower facility will be located in the CRZ for use in an emergency in the event that Nemagon or Nemagon-contaminated soil comes in contact with a workers skin. The shower will also be used to cool a worker in the event of heat stroke.

In the event that workers own clothing or shoes comes in contact with Nemagon, those clothing will be removed immediately and not worn again until the Nemagon is completely removed.

##### **1.11.1 EMERGENCY AND FIRST AID PROCEDURES**

The following first aid procedures should be followed should workers be exposed to or develop symptoms of exposure to Nemagon:

**Eye Exposure** If Nemagon liquids or dust containing nemagon gets into your eyes, wash immediately with large amounts of water (15-20 minutes), lifting the lower and upper lids occasionally. Get medical attention immediately.

**Skin Exposure** If Nemagon liquids or dusts containing Nemagon get on you skin, immediately wash with soap or mild detergent and water. If Nemagon liquids or dusts containing Nemagon penetrate through your clothing, remove the clothing immediately and wash. If irritation is present after washing, get medical attention.

**Breathing** If you or any person breathe in large amounts of Nemagon, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. DO NOT USE MOUTH-TO MOUTH. Keep the affected person warm and at rest. Get medical attention as soon as possible.

**Swallowing** When Nemagon has been swallowed and the person is conscious, give the person large amounts of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

Approved by:

Cynthia Sudquist, CIH, CSP  
Health and Safety Manager

9/16/93  
Date

**1,2-DIBROMO-3-CHLOROPROPANE (NEMAGON)**  
**29 CFR 1910.1044**

OSHA has a substance specific standard for one of the pesticides, 1,2-Dibromo-3-chloropropane (Nemagon), reportedly buried at Site 11. This standard is one of the most stringent due to the hazardous nature of the chemical. Because of the hazard associated with the compound, OSHA requires all employees who may be exposed to Nemagon to be trained in the following aspects:

- Appendix A - Substance Safety Data Sheet for Nemagon.
- The quantity, location and manner of use, release, or storage of Nemagon and the specific nature of operations which could result in exposure to Nemagon as well as any necessary protective steps.
- The purpose, proper use, and limitations of the respirators;
- The purpose and description of the medical surveillance program required by the standard.
- Review of the standard including appendices. (Note: a copy of the standard and appendices are attached.)

This course will cover the above topics as well as a review of the personal monitoring equipment and procedures.

29 CFR 1910.1044  
1,2-DIBROMO-3-CHLOROPROPANE

(a) Scope and Application

1. Applies to all occupational exposures to Nemagon
2. Does not apply when:
  - a. Applied and used as a pesticide.
  - b. When stored, transported, distributed, or sold in intact containers.

(b) Definitions.

1. Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment which may, or does, result in an unexpected release of Nemagon

(c) Permissible Exposure Limit.

1. 1 ppb, 8-hour TWA
2. The employer shall assure that no employee is exposed to eye or skin contact with Nemagon.

(d) Notification of use.

1. Within ten days following the introduction of Nemagon into the workplace, every employer who has a workplace where Nemagon is present, shall report it to the nearest OSHA Area Office.

(e) Regulated area.

1. Employer must establish regulated areas where the levels of Nemagon are in excess of the OSHA PEL. The exclusion zone will be considered the regulated area.

(f) Exposure Monitoring.

1. Personal sampling is required for all workers entering the exclusion zone that will be representative of a workers 8-hour time weighted average.
2. Personal sampling is required in each workplace (e.g., site).

3. Repeat testing is required monthly if levels are above the PEL and quarterly if below.
4. Additional testing is required whenever there is a change in process, production, control, or personnel which may result in new or additional exposures to Nemagon
5. Workers will be notified within five working days after the receipt of the results.
  - a. If levels are above the PEL, a notice of correction action will be included.
6. Accuracy of measurement will be  $\pm 25\%$ , to the 95 percent confidence limit.

(g) Methods of Compliance.

1. Where feasible, engineering controls and work practices will be used to reduce Nemagon levels to below the PEL or to the lowest levels achievable. If levels cannot be reduced to below the PEL, respiratory protection (level B) must be used.
2. Employer must establish a written program to reduce employee exposure to Nemagon to below the PEL solely by means of engineering controls.
  - a. Must include schedule for development of the engineering and work practice controls.
  - b. Employer must institute and maintain controls.

(h) Respirators.

1. Respirators must be used:
  - a. during the period required to reduce levels to below the PEL.
  - b. During maintenance and repair activities in which engineering controls and work practice controls are not feasible. (Including decontamination)
  - c. When engineering controls and work practice controls are not yet sufficient to reduce exposure to below the PEL.
  - d. During emergencies.

2. Respirator Selection:

- a. Respirators must be provided and maintained by employer.
- b. Respirators NIOSH approved.
- c. Must have a respiratory protection program.
- d. Must allow workers to clean respirators and face periodically to avoid skin irritation.
- e. Only Pressure-demand SCBA or Pressure-demand (or continuous flow) Airline respirator with escape bottle will be allowed.

(i) Emergency Situations

1. Must have written plan.
2. Must wear Level B PPE as identified in HASP addendum.
3. Employees not engaged in correcting the emergency must be evacuated and not allowed back until emergency is abated.
4. If possibility of employee exposure to Nemagon due to the occurrence of an emergency, a general alarm shall be installed and maintained to alert employees.
5. Employer must provide medical surveillance to any employee exposed to Nemagon in an emergency situation.
6. Must conduct exposure monitoring following an emergency.

(j) Protective Clothing and Equipment.

1. *Provision and Use.* Where there is any possibility of eye or dermal contact with liquid or solid Nemagon, the employer must provide and ensure employees wear impermeable protective clothing and equipment to protect the area of the body which may come in contact with Nemagon.
2. *Removal and Storage.*
  - a. Workers must remove Nemagon contaminated clothing only in change rooms (Decontamination station in Contamination Reduction Zone).
  - b. Workers must promptly remove any protective clothing and/or equipment that becomes contaminated with Nemagon. The clothing cannot be reworn or the equipment reused until decontaminated.

- c. All contaminated clothing must remain in the decon area until disposed of or is being removed for cleaning, maintenance, or disposal.
- d. Nemagon-contaminated protective clothing and work clothing shall be placed and stored in closed container with prevent dispersion of the Nemagon outside the container.
- e. Containers of Nemagon contaminated protective devices or work clothing which are to be taken out of the decontamination station for cleaning, maintenance, or disposal must bear the label:

DANGER  
1,2-Dibromo-3-chloropropane  
CANCER HAZARD

3. *Cleaning and Replacement*

- a. Employer must clean, launder, repair, or replace protective clothing and equipment to maintain effectiveness. Clean protective clothing and equipment must be provided at least daily.
- b. Must notify person who launders or cleans Nemagon-contaminated protective clothing or equipment of hazards.
- c. Cannot remove contamination by blowing or shaking clothing or equipment.

(k) *Housekeeping*

- 1. All surfaces must be maintained free of visible contamination.
  - a. Cannot use dry sweeping or blowing of air for cleaning. (must use vacuuming method)
  - b. Cleaning of floors and other contaminated surfaces shall not be performed by washing down with a hose unless a fine spray has first been laid down.
- 2. Containers of Nemagon must be kept tightly closed to the maximum extent possible.
- 3. Nemagon scrap waste, debris, containers, or equipment shall be disposed of in sealed bags or other closed containers which prevent dispersion.

(l) *Hygiene Facilities and Practices.*

1. Must provide change rooms and place for separate storage of street clothes and protective clothing.
2. Must provide showers.
  - a. Workers must shower an end of shift.
  - b. Workers must shower or wash immediately if skin becomes contaminated with Nemagon
  - c. Employer must provide shower facility.
3. Lunchrooms - temperature controlled, positive pressure, filtered air supply.
  - a. Must wash hands and face before eating.
4. Lavatories - Must be provided.
5. No smoking, eating, drinking, or the applying cosmetics in the exclusion zone. Must wash hands and face before using.

(m) Medical Surveillance

1. Must provide for employees working in the exclusion zone or exposed during emergency situation.
2. Must be under supervision of licensed physician, no cost to employee.
3. Initial assignment and annually thereafter.
4. Physical must include:
  - a. Medical and occupational history (including reproductive history).
  - b. Physical examination, including examination of the genito-urinary tract, testicle size, and body habitus including a determination of sperm count.
  - c. A serum specimen shall be obtained and the following determinations made by radioimmunoassay techniques utilizing National Institutes of Health (NIH) specific antigen or one of equivalent sensitivity.
    - 1) Serum follicle stimulating hormone (FHS)
    - 2) Serum luteinizing hormone (LH)
    - 3) Serum total estrogen (females)
  - d. Any other tests deemed necessary by the physician.

5. Certain information must be provided to the Physician.
  - a. The regulation
  - b. Duties of employees
  - c. Anticipated level of exposure to Nemagon
  - d. PPE to be used.
6. Physician must provide written opinion on the results of the tests, any detected medical conditions that could place employee at an increased risk, any limitations in the exposure to Nemagon or the use of PPE. (Note: Physician cannot reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.)
7. If employee exposed in an emergency situation, employer must provide sperm count test as soon as practicable (or the hormone tests if person has been vasectomized or is unable to produce a semen specimen) and an additional test three months later.

(n) Employee Training and Information.

1. Appendix A - Substance Safety Data Sheet for Nemagon.
2. The quantity, location and manner of use, release, or storage of Nemagon and the specific nature of operations which could result in exposure to Nemagon as well as any necessary protective steps.
3. The purpose, proper use, and limitations of the respirators;
4. The purpose and description of the medical surveillance program required by the standard.
5. Review of the standard including appendices. (Note: a copy of the standard is attached.)

(o) Signs and Labels

1. Must post sign to identify regulated area:

**DANGER**  
**1,2-Dibromo-3-chloropropane**  
**Nemagon**  
**CANCER HAZARD**  
**AUTHORIZED PERSONNEL ONLY**  
**RESPIRATOR REQUIRED**

2. Must label all containers of Nemagon or products containing Nemagon:

DANGER  
1,2-Dibromo-3-chloropropane  
CANCER HAZARD

(p) Recordkeeping

1. Exposure monitoring records to include:
  - a. Dates, number, duration, and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure.
  - b. A description of the sampling and analytical methods used.
  - c. Type of respiratory protective devices worn, if any.
  - d. Name, social security number, and job classification of the employee monitored and all other employees whose exposure the measurement is intended to represent.
2. Medical surveillance records shall include:
  - a. Name and social security number of the employee
  - b. A copy of the physicians written opinion.
  - c. Employee medical complaints related to exposure to Nemagon.
  - d. A copy of the information provided to the physician.
  - e. A copy of the employee's medical and work history.
3. Records maintained for duration of employment plus 20 years or at least 40 years, whichever is longer.
4. Records are available to OSHA and employees or their representative for review.
5. If employer ceases to do business, successor employer required to maintain records.
6. If employer ceases to do business and there is no successor employer, records are to be mailed to the Director of NIOSH.

7. At the expiration of the retention period for the records, the employer shall transmit these records to the Director of NIOSH.

(q) Observation of Monitoring

1. Employees have the right to observe all steps in the monitoring of employees exposed to Nemagon and receive an explanation of the measurement procedures.

## 29 CFR SECTION 1910.1044—1,2-DIBROMO-3-CHLOROPROPANE

## §1910.1044 1,2-dibromo-3-chloropropane.

(a) Scope and application.

(1) This section applies to occupational exposure to 1,2-dibromo-3-chloropropane (DBCP).

(2) This section does not apply to:

(i) Exposure to DBCP which results solely from the application and use of DBCP as a pesticide; or

(ii) The storage, transportation, distribution or sale of DBCP in intact containers sealed in such a manner as to prevent exposure to DBCP vapors or liquid, except for the requirements of paragraphs (i), (n) and (o) of this section.

(b) Definitions. Authorized person means any person required by his duties to be present in regulated areas and authorized to do so by his employer, by this section, or by the Act. "Authorized person" also includes any person entering such areas as a designated representative of employees exercising an opportunity to observe employee exposure monitoring.

DBCP means 1,2-dibromo-3-chloropropane, Chemical Abstracts Service Registry Number 96-12-8, and includes all forms of DBCP.

Director means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education and Welfare, or designee.

Emergency means any occurrence such as, but not limited to equipment failure, rupture of containers, or failure of control equipment which may, or does, result in an unexpected release of DBCP.

OSHA Area Office means the Area Office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the affected workplace is located.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

(c) Permissible exposure limit.—

(1) Inhalation. The employer shall assure that no employee is exposed to an airborne concentration of DBCP in excess of 1 part DBCP per billion parts of air (ppb) as an 8-hour time-weighted average.

(2) Dermal and eye exposure. The employer shall assure that no employee is exposed to eye or skin contact with DBCP.

(d) Notification of use. Within ten (10) days following the introduction of DBCP into the workplace, every employer who has a workplace where DBCP is present, shall report the following information to the nearest OSHA Area Office for each such workplace;

(1) The address and location of the workplace;

(2) A brief description of each process or operation which may result in employee exposure to DBCP;

(3) The number of employees engaged in each process or operation who may be exposed to DBCP and an estimate of the frequency and degree of exposure that occurs; and

(4) A brief description of the employer's safety and health program as it relates to limitation of employee exposure to DBCP.

(e) Regulated areas.

(1) The employer shall establish, within each place of employment, regulated areas wherever DBCP concentrations are in excess of the permissible exposure limit.

(2) The employer shall limit access to regulated areas to authorized persons.

(f) Exposure monitoring.—(1) General.

(i) Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to DBCP over an 8-hour period.

(ii) For the purposes of this paragraph, employee exposure is that exposure which would occur if the employee were not using a respirator.

(2) Initial. Each employer who has a place of employment in which DBCP is present, shall monitor each workplace and work operation to accurately determine the airborne concentrations of DBCP to which employees may be exposed.

(3) Frequency.

(i) If the monitoring required by this section reveals employee exposure to be below the permissible exposure limit, the employer shall repeat these measurements at least quarterly.

(ii) If the monitoring required by this section reveals employee exposures to be in excess of the permissible exposure limit, the employer shall repeat these measurements for each such employee at least monthly. The employer shall continue monthly monitoring until at least two consecutive measurements, taken at least seven (7) days apart, are below the permissible exposure limit. Thereafter the employer shall monitor at least quarterly.

(4) Additional. Whenever there has been a production, process, control, or personnel change which may result in any new or additional exposure to DBCP, or whenever the employer has any reason to suspect new or additional exposures to DBCP, the employer shall monitor the employees potentially affected by such change for the purpose of redetermining their exposure.

(5) Employee notification.

(i) Within five (5) working days after the receipt of monitoring results, the employer shall notify each employee in writing of the measurements which represent the employee's exposure.

(ii) Whenever the results indicate that employee exposure exceeds the permissible exposure limit, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action being taken to reduce exposure to or below the permissible exposure limit.

(6) Accuracy of measurement. The employer shall use a method of measurement which has an accuracy, to a confidence level of 95 percent, of not less than plus or minus 25 percent for concentrations of DBCP at or above the permissible exposure limit.

(g) Methods of compliance.—(1) Priority of compliance methods.

The employer shall institute engineering and work practice controls to reduce and maintain employee exposure to DBCP at or below the permissible exposure limit, except to the extent that the employer establishes that such controls are not feasible. Where feasible engineering and work practice controls are not sufficient to reduce employee exposures to within the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls, and shall supplement them by use of respiratory protection.

(2) Compliance program. The employer shall establish and implement a written program to reduce employee exposure to DBCP to or below the permissible exposure limit solely by means of engineering and work practice controls as required by paragraph (g)(1) of this section.

(ii) The written program shall include a detailed schedule for development and implementation of the engineering and work practice controls. These plans shall be revised at least every six months to reflect the current status of the program.

(iii) Written plans for these compliance programs shall be submitted upon request to the Assistant Secretary and the Director and shall be available at the worksite for examination and copying by the Assistant Secretary, the Director, and any affected employee or designated representative of employees.

(iv) The employer shall institute and maintain at least the controls described in his most recent written compliance program.

(h) Respirators.—

(1) General. Where respiratory protection is required under this section, the employer shall select, provide and assure the proper use of respirators. Respirators

[Sec. 1910.1044(h)(1)]

shall be used in the following circumstances:

(i) During the period necessary to install or implement feasible engineering and work practice controls; or

(ii) During maintenance and repair activities in which engineering and work practice controls are not feasible; or

(iii) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limit; or

(iv) In emergencies.

(2) *Respirator selection.*

(i) Where respirators are required under this section, the employer shall select and provide, at no cost to the employee, the appropriate respirator from Table 1 below and shall assure that the employee uses the respirator provided.

(ii) The employer shall select respirators from among those approved by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

Table 1.—Respiratory Protection for DBCP

Airborne concentration of DBCP or condition of use	Respirator type
(a) Less than or equal to 10 ppb.	(1) Any supplied-air respirator; or (2) any self-contained breathing apparatus
(b) Less than or equal to 50 ppb.	(1) Any supplied-air respirator with full facepiece, helmet, or hood; or (2) any self-contained breathing apparatus with full facepiece.
(c) Less than or equal to 1,000 ppb.	(1) A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous flow mode.
(d) Less than or equal to 2,000 ppb.	(1) A Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure mode, or with full facepiece, helmet, or hood operated in continuous flow mode.

Table 1.—Respiratory Protection for DBCP—Contd.

Airborne concentration of DBCP or condition of use	Respirator type
(e) Greater than 2,000 ppb or entry and escape from unknown concentrations.	(1) A combination respirator which includes a Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure or continuous flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or positive pressure mode; or (2) a self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.
(f) Firefighting .....	(1) A self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.

(3) *Respirator program.*

(i) The employer shall institute a respiratory protection program in accordance with 29 CFR 1910.134 (b), (d), (e), and (f).

(ii) Employees who wear respirators shall be allowed to wash their faces and respirator facepieces as needed to prevent potential skin irritation associated with respirator use.

(i) Emergency situations—

(1) Written plans.

(i) A written plan for emergency situations shall be developed for each workplace in which DBCP is present.

(ii) Appropriate portions of the plan shall be implemented in the event of an emergency.

(2) Employees engaged in correcting emergency conditions shall be equipped as required in paragraphs (h) and (j) of this section until the emergency is abated.

(3) *Evacuation.* Employees not engaged in correcting the emergency shall be removed and restricted from the area and normal operations in the affected area shall not be resumed until the emergency is abated.

(4) *Alerting employees.* Where there is a possibility of employee exposure to DBCP due to the occurrence of an emergency, a general alarm shall be installed and maintained to promptly alert employees of such occurrences.

(5) *Medical surveillance.* For any employee exposed to DBCP in an emergency situation, the employer shall provide medical surveillance in accordance with paragraph (m) (6) of this section.

(6) *Exposure monitoring.*

(i) Following an emergency, the employer shall conduct monitoring which complies with paragraph (f) of this section.

(ii) In workplaces not normally subject to periodic monitoring, the employer may terminate monitoring when two consecutive measurements indicate exposures below the permissible exposure limit.

(j) Protective clothing and equipments.—

(1) *Provision and use.* Where there is any possibility of eye or dermal contact with liquid or solid DBCP the employer shall provide, at no cost to the employee, and assure that the employee wears impermeable protective clothing and equipment to protect the area of the body which may come in contact with DBCP. Eye and face protection shall meet the requirements of §1910.133 of this Part.

(2) *Removal and storage.*

(i) The employer shall assure that employees remove DBCP contaminated work clothing only in change rooms provided in accordance with paragraph (l) (1) of this section.

(ii) The employer shall assure that employees promptly remove any protective clothing and equipment which becomes contaminated with DBCP-containing liquids and solids. This clothing shall not be reworn until the DBCP has been removed from the clothing or equipment.

(iii) The employer shall assure that no employee takes DBCP contaminated protective devices and work clothing out of the change room, except those employees authorized to do so for the purpose of laundering, maintenance, or disposal.

(iv) DBCP-contaminated protective devices and work clothing shall be placed and stored in closed containers which prevent dispersion of the DBCP outside the container.

(v) Containers of DBCP contaminated protective devices or work clothing which are to be taken out of change rooms or the workplace for cleaning, maintenance or disposal, shall bear labels in accordance with paragraph (o)(3) of this section.

(3) *Cleaning and replacement.*

(i) The employer shall clean, launder, repair, or replace protective clothing and equipment required by this paragraph to maintain their effectiveness. The employer shall provide clean protective clothing and equipment at least daily to each affected employee.

(ii) The employer shall inform any person who launders or clean DBCP-contaminated protective clothing or equipment of the potentially harmful effects of exposure to DBCP.

(iii) The employer shall prohibit the removal of DBCP from protective clothing and equipment by blowing or shaking.

(k) *Housekeeping.*—

(1) *Surfaces.*

(i) All workplace surfaces shall be maintained free of visible accumulations of DBCP.

(ii) Dry sweeping and the use of compressed air for the cleaning of floors and other surfaces is prohibited where DBCP dusts or liquids are present.

(iii) Where vacuuming methods are selected to clean floors and other surfaces, either portable units or a permanent system may be used.

(a) If a portable unit is selected, the exhaust shall be attached to the general workplace exhaust ventilation system or collected within the vacuum unit, equipped with high efficiency filters or other appropriate means of contaminant removal, so that DBCP is not reintroduced into the workplace air; and

(b) Portable vacuum units used to collect DBCP may not be used for other cleaning purposes and shall be labeled as prescribed by paragraph (o)(3) of this section.

(iv) Cleaning of floors and other surfaces contaminated with DBCP-containing dusts shall not be performed by washing down with a hose, unless a fine spray has first been laid down.

(2) *Liquids.* Where DBCP is present in a liquid form, or as a resultant vapor, all containers or vessels containing DBCP shall be enclosed to the maximum extent feasible and tightly covered when not in use.

(3) *Waste disposal.* DBCP waste scrap, debris, containers or equipment, shall be disposed of in sealed bags or other closed containers which prevent dispersion of DBCP outside the container.

(l) *Hygiene facilities and practices.*—

(1) *Change rooms.* The employer shall provide clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment whenever employees are required to wear protective clothing and equipment in accordance

with paragraphs (h) and (j) of this section.

(2) *Showers.*

(i) The employer shall assure that employees working in the regulated area shower at the end of the work shift.

(ii) The employer shall assure that employees whose skin becomes contaminated with DBCP-containing liquids or solids immediately wash or shower to remove any DBCP from the skin.

(iii) The employer shall provide shower facilities in accordance with 29 CFR 1910.141(d)(3).

(3) *Lunchrooms.* The employer shall provide lunchroom facilities which have a temperature controlled, positive pressure, filtered air supply, and which are readily accessible to employees working in regulated areas.

(4) *Lavatories.*

(i) The employer shall assure that employees working in the regulated area remove protective clothing and wash their hands and face prior to eating.

(ii) The employer shall provide a sufficient number of lavatory facilities which comply with 29 CFR 1910.141(d)(1) and (2).

(5) *Prohibition of activities in regulated areas.* The employer shall assure that, in regulated areas, food or beverages are not present or consumed, smoking products and implements are not present or used, and cosmetics are not present or applied.

(m) *Medical surveillance.*—

(1) *General.*

(i) The employer shall make available a medical surveillance program for employees who work in regulated areas and employees who are subjected to DBCP exposures in an emergency situation.

(ii) All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee.

(2) *Frequency and content.* At the time of initial assignment, and annually thereafter, the employer shall provide a medical examination for employees who work in regulated areas, which includes at least the following:

(i) A medical and occupational history including reproductive history.

(ii) A physical examination, including examination of the genito-urinary tract, testicle size and body habitus including a determination of sperm count.

(iii) A serum specimen shall be obtained and the following determinations made by radioimmunoassay techniques utilizing National Institutes of Health (NIH) specific antigen or one of equivalent sensitivity.

(a) Serum follicle stimulating hormone (FSH);

(b) Serum luteinizing hormone (LH); and

(c) Serum total estrogen (females).

(iv) Any other tests deemed appropriate by the examining physician.

(3) *Additional examinations.* If the employee for any reason develops signs or symptoms commonly associated with exposure to DBCP, the employer shall provide the employee with a medical examination which shall include those elements considered appropriate by the examining physician.

(4) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The level of DBCP to which the employee is exposed; and

(iv) A description of any personal protective equipment used or to be used.

(5) *Physician's written opinion.*

(i) For each examination under this section, the employer shall obtain and provide the employee with a written opinion from the examining physician which shall include:

(a) The results of the medical tests performed;

(b) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at an increased risk of material impairment of health from exposure to DBCP; and

(c) Any recommended limitations upon the employee's exposure to DBCP or upon the use of protective clothing and equipment such as respirators.

(ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.

(6) *Emergency situations.* If the employee is exposed to DBCP in an emergency situation, the employer shall provide the employee with a sperm count test as soon as practicable, or, if the employee has been vasectomized or is unable to produce a semen specimen, the hormone tests contained in paragraph (m)(2)(iii) of this section. The employer shall provide these same tests three months later.

(n) *Employee information and training.*—

(1) *Training program.*

(i) The employer shall institute a training program for all employees who may be exposed to DBCP and shall assure

their participation in such training program.

(ii) The employer shall assure that each employee is informed of the following:

(a) The information contained in Appendix A;

(b) The quantity, location, manner of use, release or storage of DBCP and the specific nature of operations which could result in exposure to DBCP as well as any necessary protective steps;

(c) The purpose, proper use, and limitations of respirators;

(d) The purpose and description of the medical surveillance program required by paragraph (m) of this section; and

(e) A review of this standard, including appendices.

(2) Access to training materials.

(i) The employer shall make a copy of this standard and its appendices readily available to all affected employees.

(ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.

(o) Signs and labels.

(1) General.

(i) The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to or in combination with signs and labels required by this paragraph.

(ii) The employer shall assure that no statement appears on or near any sign or label required by this paragraph which contradicts or detracts from the required sign or label.

(2) Signs.

(i) The employer shall post signs to clearly indicate all regulated areas. These signs shall bear the legend:

**DANGER**

1,2-Dibromo-3-chloropropane

*(Insert appropriate trade or common names)*

**CANCER HAZARD**

**AUTHORIZED PERSONNEL ONLY  
RESPIRATOR REQUIRED**

(3) Labels.

(i) The employer shall assure that precautionary labels are affixed to all containers of DBCP and of products containing DBCP in the workplace, and that the labels remain affixed when the DBCP or products containing DBCP are sold, distributed, or otherwise leave the employer's workplace. Where DBCP or products containing DBCP are sold, distributed or otherwise leave the employer's workplace bearing appropriate labels required by EPA under the regulations in 40 CFR Part 162, the labels required by this paragraph need not be affixed.

(ii) The employer shall assure that the precautionary labels required by this paragraph are readily visible and legible. The labels shall bear the following legend:

**DANGER**

1,2-Dibromo-3-chloropropane

**CANCER HAZARD**

(p) Recordkeeping.

(1) Exposure monitoring.

(i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (f) of this section.

(ii) This record shall include:

(a) The dates, number, duration and results of each of the samples taken; including a description of the sampling procedure used to determine representative employee exposure;

(b) A description of the sampling and analytical methods used;

(c) Type of respiratory protective devices worn, if any; and

(d) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent.

(iii) The employer shall maintain this record for at least 40 years or the duration of employment plus 20 years, whichever is longer.

(2) Medical surveillance.

(i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance required by paragraph (m) of this section.

(ii) This record shall include:

(a) The name and social security number of the employee.

(b) A copy of the physician's written opinion;

(c) Any employee medical complaints related to exposure to DBCP;

(d) A copy of the information provided the physician as required by paragraphs (m)(4)(ii) through (m)(4)(iv) of this section; and

(e) A copy of the employee's medical and work history.

(iii) The employer shall maintain this record for at least 40 years or the duration of employment plus 20 years, whichever is longer.

(3) Availability.

(i) The employer shall assure that all records required to be maintained by this section be made available upon request to the Assistant Secretary and the Director for examination and copying.

(ii) Employee exposure monitoring records and employee medical records required by this paragraph shall be provided upon request to employees, designated representatives; and the Assistant Secre-

tary in accordance with 29 CFR 1910.20 (a)-(e) and (g)-(i).

(4) Transfer of records.

(i) If the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (p) of this section for the prescribed period.

(ii) If the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, the employer shall transmit these records by mail to the Director.

(iii) At the expiration of the retention period for the records required to be maintained under paragraph (p) of this section, the employer shall transmit these records by mail to the Director.

(iv) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.20(h).

(q) Observation of monitoring.

(1) Employee observation. The employer shall provide affected employees, or their designated representatives, with an opportunity to observe any monitoring of employee exposure to DBCP required by this section.

(2) Observation procedures.

(i) Whenever observation of the measuring or monitoring of employee exposure to DBCP requires entry into an area where the use of protective clothing or equipment is required, the employer shall provide the observer with personal protective clothing or equipment required to be worn by employees working in the area, assure the use of such clothing and equipment, and require the observer to comply with all other applicable safety and health procedures.

(ii) Without interfering with the monitoring or measurement, observers shall be entitled to:

(a) Receive an explanation of the measurement procedures;

(b) Observe all steps related to the measurement of airborne concentrations of DBCP performed at the place of exposure; and

(c) Record the results obtained.

(r) Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

Approved by the Office of Management and Budget under control number 1218-0101

**Appendix A—Substance Safety Data Sheet For DBCP**

**I. SUBSTANCE IDENTIFICATION**

A. Synonyms and trade names: DBCP Dibromochloropropane; Fumazone (Dow Chemical Company TM); Nemaflume;

Nemagon (Shell Chemical Co. TM); Nemaset; BBC 12; and OS 1879.

**B. Permissible exposure:**

1. *Airborne.* 1 part DBCP vapor per billion parts of air (1 ppb); time-weighted average (TWA) for an 8-hour workday.

2. *Dermal.* Eye contact and skin contact with DBCP are prohibited.

**C. Appearance and odor:** Technical grades DBCP is a dense yellow or amber liquid with a pungent odor. It may also appear in granular form, or blended in varying concentrations with other liquids.

**D. Uses:** DBCP is used to control nematodes, very small worm-like plant parasites, on crops including cotton, soybeans, fruits, nuts, vegetables and ornamentals.

**II. HEALTH HAZARD DATA**

**A. Routes of entry:** Employees may be exposed:

1. Through inhalation (breathing);
2. Through ingestion (swallowing);
3. Skin contact; and
4. Eye contact.

**B. Effects of exposure:**

1. *Acute exposure.* DBCP may cause drowsiness, irritation of the eyes, nose, throat and skin, nausea and vomiting. In addition, overexposure may cause damage to the lungs, liver or kidneys.

2. *Chronic exposure.* Prolonged or repeated exposure to DBCP has been shown to cause sterility in humans. It also has been shown to produce cancer and sterility in laboratory animals and has been determined to constitute an increased risk of cancer in man.

**C. Reporting Signs and Symptoms.** If you develop any of the above signs or symptoms that you think are caused by exposure to DBCP, you should inform your employer.

**III. EMERGENCY FIRST AID PROCEDURES**

**A. Eye exposure.** If DBCP liquid or dust containing DBCP gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with DBCP.

**B. Skin exposure.** If DBCP liquids or dusts containing DBCP get on your skin, immediately wash using soap or mild detergent and water. If DBCP liquids or dusts containing DBCP penetrate through your clothing, remove the clothing immediately and wash. If irritation is present after washing get medical attention.

**C. Breathing.** If you or any person breathe in large amounts of DBCP, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Do not use mouth-to-mouth. Keep the affected person warm and at rest. Get medical attention as soon as possible.

**D. Swallowing.** When DBCP has been swallowed and the person is conscious, give the person large amounts of water immediately. After the water has been swallowed,

try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

**E. Rescue.** Notify someone. Put into effect the established emergency rescue procedures. Know the locations of the emergency rescue equipment before the need arises.

**IV. RESPIRATORS AND PROTECTIVE CLOTHING**

**A. Respirators.** You may be required to wear a respirator in emergencies and while your employer is in the process of reducing DBCP exposures through engineering controls. If respirators are worn, they must have a National Institute for Occupational Safety and Health (NIOSH) approval label (Older respirators may have a Bureau of Mines Approval label). For effective protection, a respirator must fit your face and head snugly. The respirator should not be loosened or removed in work situations where its use is required. DBCP does not have a detectable odor except at 1,000 times or more above the permissible exposure limit. If you can smell DBCP while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.

**B. Protective clothing.** When working with DBCP you must wear for your protection impermeable work clothing provided by your employer. (Standard rubber and neoprene protective clothing do not offer adequate protection.)

DBCP must never be allowed to remain on the skin. Clothing and shoes must not be allowed to become contaminated with DBCP, and if they do, they must be promptly removed and not worn again until completely free of DBCP. Turn in impermeable clothing that has developed leaks for repair or replacement.

**C. Eye protection.** You must wear splash-proof safety goggles where there is any possibility of DBCP liquid or dust contacting your eyes.

**V. PRECAUTIONS FOR SAFE USE, HANDLING, AND STORAGE**

**A.** DBCP must be stored in tightly closed containers in a cool, well-ventilated area.

**B.** If your work clothing may have become contaminated with DBCP, or liquids or dusts containing DBCP, you must change into uncontaminated clothing before leaving the work premises.

**C.** You must promptly remove any protective clothing that becomes contaminated with DBCP. This clothing must not be reworn until the DBCP is removed from the clothing.

**D.** If your skin becomes contaminated with DBCP, you must immediately and thoroughly wash or shower with soap or mild detergent and water to remove any DBCP from your skin.

**E.** You must not keep food, beverages, cosmetics, or smoking materials, nor eat or smoke, in regulated areas.

**F.** If you work in a regulated area, you must wash your hands thoroughly with soap or mild detergent and water, before eating, smoking or using toilet facilities.

**G.** If you work in a regulated area, you must remove any protective equipment or clothing before leaving the regulated area.

**H.** Ask your supervisor where DBCP is used in your work area and for any additional safety and health rules.

**VI. ACCESS TO INFORMATION**

**A.** Each year, your employer is required to inform you of the information contained in this Substance Safety Data Sheet for DBCP. In addition, your employer must instruct you in the safe use of DBCP, emergency procedures, and the correct use of protective equipment.

**B.** Your employer is required to determine whether you are being exposed to DBCP. You or your representative have the right to observe employee exposure measurements and to record the result obtained. Your employer is required to inform you of your exposure. If your employer determines that you are being overexposed, he is required to inform you of the actions which are being taken to reduce your exposure.

**C.** Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure and medical data for at least 40 years or the duration of your employment plus 20 years, whichever is longer.

**D.** Your employer is required to release exposure and medical records to you, your physician, or other individual designated by you upon your written request.

**Appendix B—Substance Technical Guidelines For DBCP**

**I. PHYSICAL AND CHEMICAL DATA**

**A. Substance Identification**

1. Synonyms: 1,2-dibromo-3-chloropropane; DBCP, Fumazone; Nemafume; Nemagon; Nemaset; BBC 12; OS 1879. DBCP is also included in agricultural pesticides and fumigants which include the phrase "Nema\_\_\_\_\_ " in their name.

2. Formula: C<sub>3</sub>H<sub>5</sub>Br<sub>2</sub>Cl.

3. Molecular Weight: 236.

**B. Physical Data:**

1. Boiling point (760 mm Hg): 195C (383F)

2. Specific gravity (water = 1): 2.093.

3. Vapor density (air = 1 at boiling point of DBCP): Data not available.

4. Melting point: 6C (43F).

5. Vapor pressure at 20C (68F): 0.3 mm Hg

6. Solubility in water: 1000 ppm.

7. Evaporation rate (Butyl Acetate = 1): very much less than 1.

8. Appearance and odor: Dense yellow or amber liquid with a pungent odor at high concentrations. Any detectable odor of DBCP indicates overexposure.

## II. FIRE EXPLOSION AND REACTIVITY HAZARD DATA

### A. Fire

1. Flash point: 170F (77C)
2. Autoignition temperature: Data not available.
3. Flammable limits in air, percent by volume: Data not available.
4. Extinguishing media: Carbon dioxide, dry chemical.
5. Special fire-fighting procedures: Do not use a solid stream of water since a stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.
6. Unusual fire and explosion hazards: None known.

7. For purposes of complying with the requirements of §1910.106, liquid DBCP is classified as a Class III A combustible liquid.

8. For the purpose of complying with §1910.309, the classification of hazardous locations as described in article 500 of the National Electrical Code for DBCP shall be Class I, Group D.

9. For the purpose of compliance with §1910.157, DBCP is classified as a Class B fire hazard.

10. For the purpose of compliance with §1910.178, locations classified as hazardous locations due to the presence of DBCP shall be Class I, Group D.

11. Sources of ignition are prohibited where DBCP presents a fire or explosion hazard.

### B. Reactivity

1. Conditions contributing to instability: None known.

2. Incompatibilities: Reacts with chemically active metals, such as aluminum, magnesium and tin alloys.

3. Hazardous decomposition products: Toxic gases and vapors (such as HBr, HCl and carbon monoxide) may be released in a fire involving DBCP.

4. Special precautions: DBCP will attack some rubber materials and coatings.

## III. SPILL, LEAK AND DISPOSAL PROCEDURES

A. If DBCP is spilled or leaked, the following steps should be taken:

1. The area should be evacuated at once and re-entered only after thorough ventilation.

2. Ventilate area of spill or leak.

3. If in liquid form, collect for reclamation or absorb in paper, vermiculite, dry sand, earth or similar material.

4. If in solid form, collect spilled material in the most convenient and safe manner for reclamation or for disposal.

B. Persons not wearing protective equipment must be restricted from areas of spills or leaks until cleanup has been completed.

### C. Waste Disposal Methods:

1. For small quantities of liquid DBCP, absorb on paper towels, remove to a safe place (such as a fume hood) and burn the paper. Large quantities can be reclaimed or

collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. If liquid DBCP is absorbed in vermiculite, dry sand, earth or similar material and placed in sealed containers it may be disposed of in a State-approved sanitary landfill.

2. If in solid form, for small quantities, place on paper towels, remove to a safe place (such as a fume hood) and burn. Large quantities may be reclaimed. However, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. DBCP in solid form may also be disposed in a state-approved sanitary landfill.

## IV. MONITORING AND MEASUREMENT PROCEDURES

A. Exposure above the permissible exposure limit.

1. *Eight Hour Exposure Evaluation:* Measurements taken for the purpose of determining employee exposure under this section are best taken so that the average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

2. *Monitoring Techniques:* The sampling and analysis under this section may be performed by collecting the DBCP vapor on petroleum based charcoal absorption tubes with subsequent chemical analyses. The method of measurement chosen should determine the concentration of airborne DBCP at the permissible exposure limit to an accuracy of plus or minus 25 percent. If charcoal tubes are used, a total volume of 10 liters should be collected at a flow rate of 50 cc per minute for each tube. Analyze the resultant samples as you would samples of halogenated solvent.

B. Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

## V. PROTECTIVE CLOTHING

Employees should be required to wear appropriate protective clothing to prevent any possibility of skin contact with DBCP. Because DBCP is absorbed through the skin, it is important to prevent skin contact with both liquid and solid forms of DBCP. Protective clothing should include impermeable coveralls or similar fullbody work clothing, gloves, headcoverings, and workshoes or shoe coverings. Standard rubber and neoprene gloves do not offer adequate protection and should not be relied upon to keep DBCP off the skin. DBCP should never be allowed to remain on the skin. Clothing and shoes should not be allowed to become contaminated with the material, and if they do,

they should be promptly removed and not worn again until completely free of the material. Any protective clothing which has developed leaks or is otherwise found to be defective should be repaired or replaced. Employees should also be required to wear splash-proof safety goggles where there is any possibility of DBCP contacting the eyes.

## VI. HOUSEKEEPING AND HYGIENE FACILITIES

1. The workplace must be kept clean, orderly and in a sanitary condition;

2. Dry sweeping and the use of compressed air is unsafe for the cleaning of floors and other surfaces where DBCP dust or liquids are found. To minimize the contamination of air with dust, vacuuming with either portable or permanent systems must be used. If a portable unit is selected, the exhaust must be attached to the general workplace exhaust ventilation system, or collected within the vacuum unit equipped with high efficiency filters or other appropriate means of contamination removal and not used for other purposes. Units used to collect DBCP must be labeled.

3. Adequate washing facilities with hot and cold water must be provided, and maintained in a sanitary condition. Suitable cleansing agents should also be provided to assure the effective removal of DBCP from the skin.

4. Change or dressing rooms with individual clothes storage facilities must be provided to prevent the contamination of street clothes with DBCP. Because of the hazardous nature of DBCP, contaminated protective clothing must be stored in closed containers for cleaning or disposal.

## VII. MISCELLANEOUS PRECAUTIONS

A. Store DBCP in tightly closed containers in a cool, well ventilated area.

B. Use of supplied-air suits or other impervious clothing (such as acid suits) may be necessary to prevent skin contact with DBCP. Supplied-air suits should be selected, used, and maintained under the supervision of persons knowledgeable in the limitations and potential life-endangering characteristics of supplied-air suits.

C. The use of air-conditioned suits may be necessary in warmer climates.

D. Advise employees of all areas and operations where exposure to DBCP could occur.

## VIII. COMMON OPERATIONS

Common operations in which exposure to DBCP is likely to occur are: during its production; and during its formulation into pesticides and fumigants.

## Appendix C—Medical Surveillance Guidelines For DBCP

### I. ROUTE OF ENTRY

Inhalation; skin absorption

### II. TOXICOLOGY

Recent data collected on workers involved in the manufacture and formulation of DBCP has shown that DBCP can cause ste-

rility in animals. Chronic exposure to DBCP resulted in pronounced necrotic action on the parenchymatous organs (i.e., liver, kidney, spleen) and on the testicles of rats at concentrations as low as 5 ppm. Rats that were chronically exposed to DBCP also showed changes in the composition of the blood, showing low RBC, hemoglobin, and WBC, and high reticulocyte levels as well as functional hepatic disturbance, manifesting itself in a long prothrombin time. Reznik et al. noted a single dose of 100 mg produced profound depression of the nervous system of rats. Their condition gradually improved. Acute exposure also resulted in the destruction of the sex gland activity of male rats as well as causing changes in the estrous cycle in female rats. Animal studies have also associated DBCP with an increased incidence of carcinoma. Olson, et al. orally administered DBCP to rats and mice 5 times per week at experimentally predetermined maximally tolerated doses and at half those doses. As early as ten weeks after initiation of treatment, DBCP induced a high incidence of squamous cell carcinomas of the stomach with metastases in both species. DBCP also induced mammary adenocarcinomas in the female rats at both dose levels.

### III. SIGNS AND SYMPTOMS

A. Inhalation: Nausea, eye irritation, conjunctivitis, respiratory irritation, pulmonary congestion or edema, CNS depression with apathy, sluggishness, and ataxia.

B. Dermal: Erythema or inflammation and dermatitis on repeated exposure.

### IV. SPECIAL TESTS

A. Semen analysis: The following information excerpted from the document "Evaluation of Testicular Function", submitted by the Corporate Medical Department of the Shell Oil Company (exhibit 39 -3), may be useful to physicians conducting the medical surveillance program:

In performing semen analyses certain minimal but specific criteria should be met:

1. It is recommended that a minimum of three valid semen analyses be obtained in order to make a determination of an individual's average sperm count.

2. A period of sexual abstinence is necessary prior to the collection of each masturbatory sample. It is recommended that intercourse or masturbation be performed 48 hours before the actual specimen collection. A period of 48 hours of abstinence would follow; then the masturbatory sample would be collected.

3. Each semen specimen should be collected in a clean, widemouthed, glass jar (not necessarily pre-sterilized) in a manner designated by the examining physician. Any part of the seminal fluid exam should be initialed only after liquification is complete, i.e., 30 to 45 minutes after collection.

4. Semen volume should be measured to the nearest 1/10 of a cubic centimeter.

5. Sperm density should be determined using routine techniques involving the use of a white cell pipette and a hemocytometer chamber. The immobilizing fluid most effective and most easily obtained for this process is distilled water.

6. Thin, dry smears of the semen should be made for a morphologic classification of the sperm forms and should be stained with either hematoxylin or the more difficult, yet more precise, Papanicolaou technique. Also of importance to record is obvious sperm agglutination, pyospermia, delayed liquifaction (greater than 30 minutes), and hyperviscosity. In addition, pH, using nitrazine paper, should be determined.

7. A total morphology evaluation should include percentages of the following:

- a. Normal (oval) forms.
- b. Tapered forms.
- c. Amorphous forms (include large and small sperm shapes).
- d. Duplicated (either heads or tails) forms, and
- e. Immature forms.

8. Each sample should be evaluated for sperm *viability* (percent viable sperm moving at the time of examination) as well as sperm *motility* (subjective characterization of "purposeful forward sperm progression" of the majority of those viable sperm analyzed) within two hours after collection, ideally by the same or equally qualified examiner.

B. Serum determinations: The following serum determinations should be performed by radioimmuno-assay techniques using National Institutes of Health (NIH) specific antigen or antigen preparations of equivalent sensitivity:

1. Serum follicle stimulating hormone (FSH);
2. Serum luteinizing hormone (LH); and
3. Serum total estrogen (females only).

### V. TREATMENT

Remove from exposure immediately, give oxygen or artificial resuscitation if indicated. Contaminated clothing and shoes should be removed immediately. Flush eyes and wash contaminated skin. If swallowed and the person is conscious, induce vomiting. Recovery from mild exposures is usually rapid and complete.

### VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

A. Other considerations. DBCP can cause both acute and chronic effects. It is important that the physician become familiar with the operating conditions in which exposure to DBCP occurs. Those with respiratory disorders may not tolerate the wearing of negative pressure respirators.

B. Surveillance and screening. Medical histories and laboratory examinations are required for each employee subject to exposure to DBCP. The employer should screen

employees for history of certain medical conditions (listed below) which might place the employee at increased risk from exposure.

1. Liver disease. The primary site of biotransformation and detoxification of DBCP is the liver. Liver dysfunctions likely to inhibit the conjugation reactions will tend to promote the toxic actions of DBCP. These precautions should be considered before exposing persons with impaired liver function to DBCP.

2. Renal disease. Because DBCP has been associated with injury to the kidney it is important that special consideration be given to those with possible impairment of renal function.

3. Skin disease. DBCP can penetrate the skin and can cause erythema on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of DBCP.

4. Blood dyscrasias. DBCP has been shown to decrease the content of erythrocytes, hemoglobin, and leukocytes in the blood, as well as increase the prothrombin time. Persons with existing blood disorders may be more susceptible to the effects of DBCP.

5. Reproductive disorders. Animal studies have associated DBCP with various effects on the reproductive organs. Among these effects are atrophy of the testicles and changes in the estrous cycle. Persons with pre-existing reproductive disorders may be at increased risk to these effects of DBCP.

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