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HEALTH AND SAFETY PLAN
PHASE II REMEDIAL INVESTIGATION

INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CONNECTICUT

Prepared for:

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
LESTER, PENNSYLVANIA

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COLCHESTER, CONNECTICUT

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1.0 INTRODUCTION

This Health and Safety Plan (HASP) addresses the health and safety practices that will be employed by all site workers participating in the Phase II Remedial Investigation of the Installation Restoration Program at the Naval Submarine Base - New London, Groton, Connecticut (NSB-NLON). Figure 1-1 shows the location of NSB-NLON and Figure 1-2 shows sites included in the Phase II Remedial Investigation covered by this HASP.

This HASP takes into account the specific hazards inherent to the sites investigated and presents detailed procedures to be followed by Atlantic Environmental Services, Inc. (Atlantic) personnel and Atlantic's subcontractors in order to avoid and, if necessary, deal with potential health and/or safety problems. All activities performed under this HASP will comply with OSHA Regulations 29 CFR Part 1910, 1925, and 1926 as amended.

This HASP is applicable to all of the field activities which are discussed in detail in the Field Sampling Plan (FSP). Elements of these investigations include:

- land surveys
- soil gas surveys
- air sampling
- installation, development and sampling of monitoring wells
- test borings and soil sampling
- sediment sampling
- surface water sampling
- biological sampling and bioassays

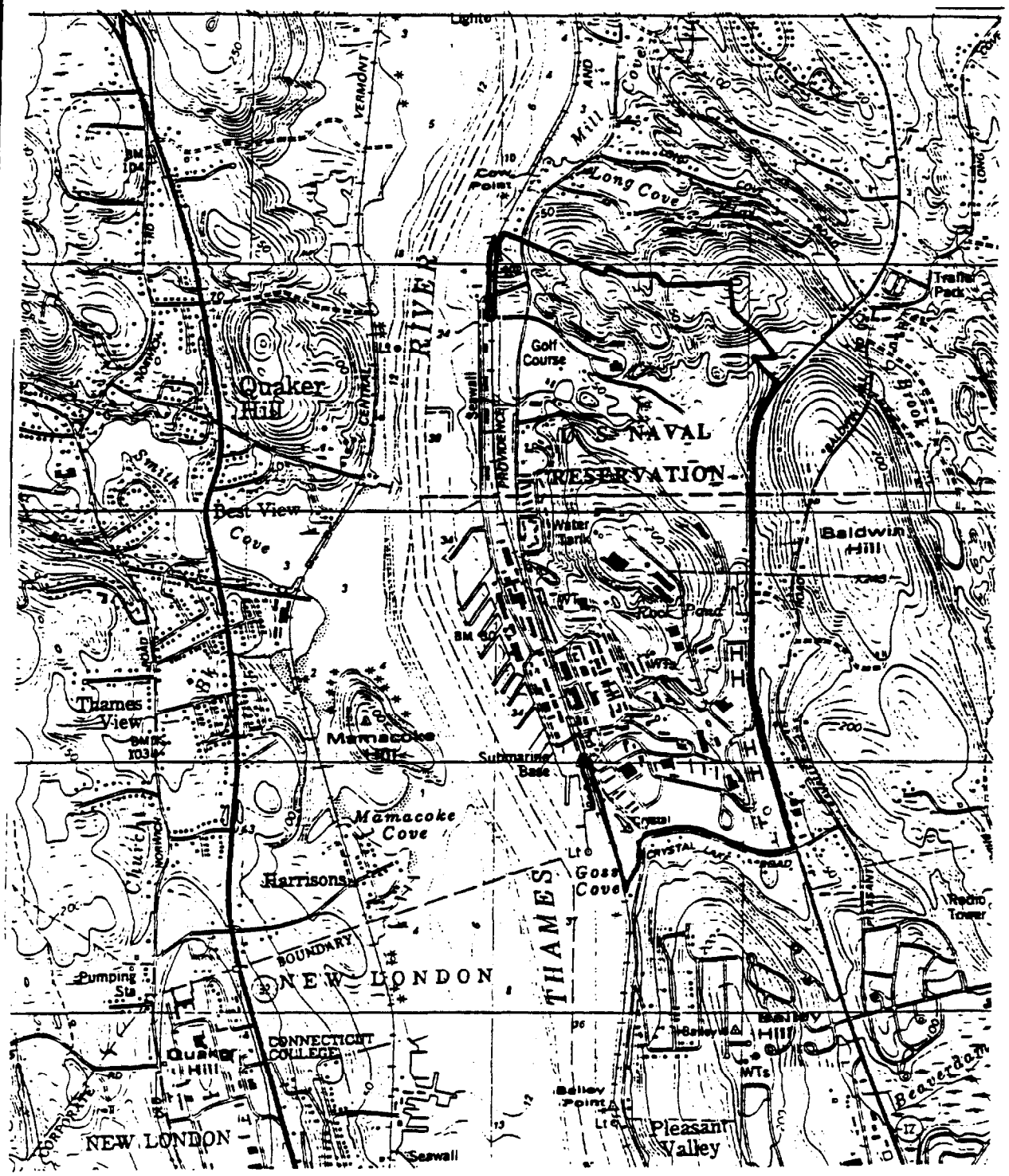
The FSP outlines the investigative measures proposed at each location. Specific health and safety measures applicable to each activity are presented in the following sections of the HASP.

Included in this HASP are four general sections covering the Medical Surveillance Program, Emergency Support and Procedures, Training Programs, and the Site Safety Plan. The Site Safety Plan is written in a format such that it can be separated from this HASP and posted at the site field office for general use.

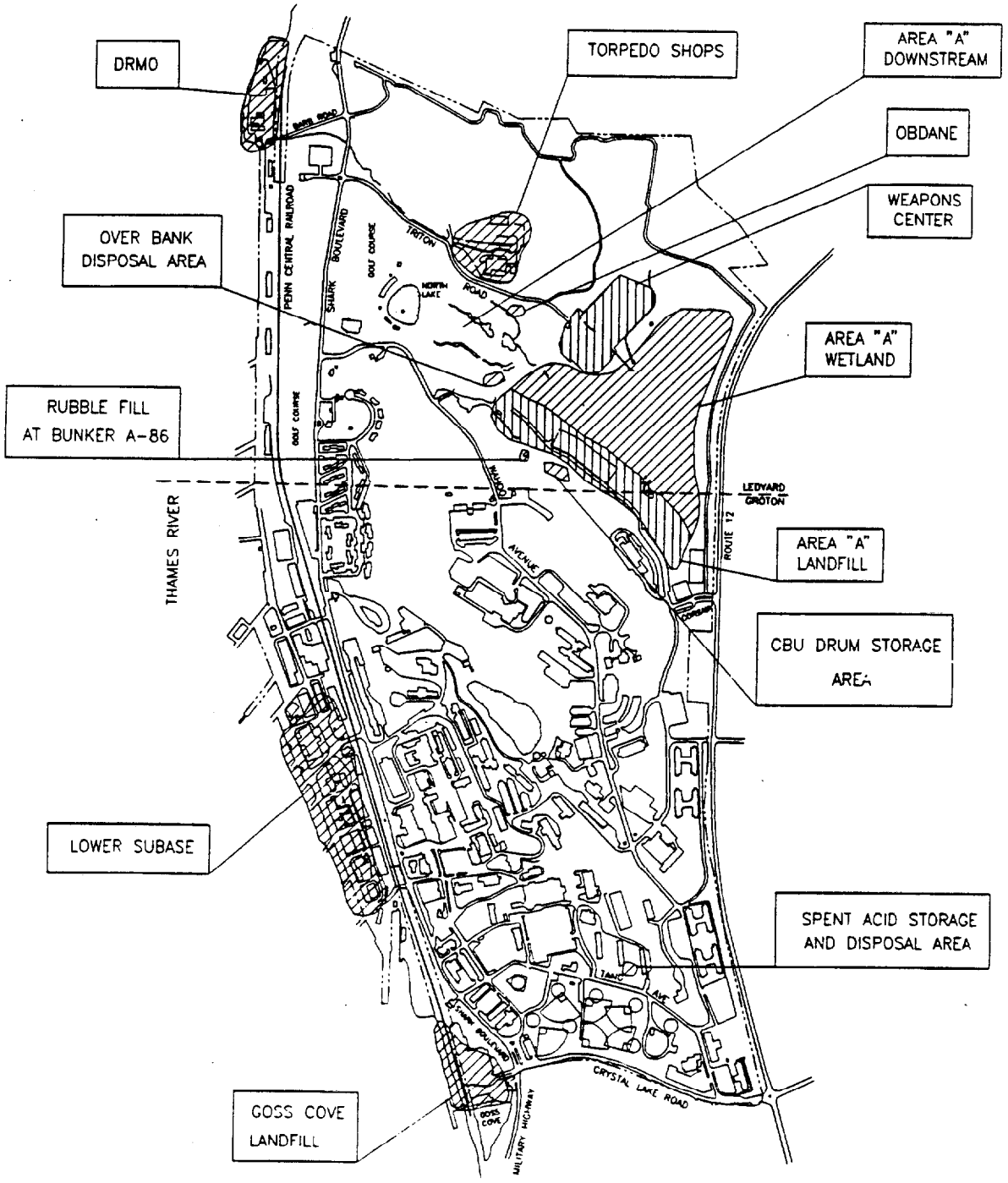
This HASP will be updated as appropriate if additional information is obtained on the chemical nature of materials spilled, used, and their associated health and safety risks, or if a change in planned field operations warrants a HASP update.

Robert Breeding is Atlantic's Corporate Health and Safety Officer and John Bogdanski or Erik Ness is the designated Site Safety Officer for these investigations.

Sites included in this Phase II Remedial Investigation are in three different phases of the Installation Restoration Program. These phases and associated sites are discussed below.



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	SOURCE: Uncasville, CT U.S.G.S. Topographic Map 1984 N	FIGURE 1- 1 SUBASE LOCATION ATLANTIC ENVIRONMENTAL SERVICES, INC.



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE – NEW LONDON GROTON, CT	SOURCE: Naval Submarine Base Existing Conditions April 1985 Loureiro Engineering Associates N 0 600 1200 GRAPHIC SCALE IN FEET	FIGURE 1-2 INSTALLATION RESTORATION STUDY SITES ATLANTIC ENVIRONMENTAL SERVICES, INC.

Supplemental Step I Investigations

Two sites are included in this category. These are sites where initial (i.e., Step I) investigations have been completed.

The Step I Investigations identified low levels of chemicals which were determined to pose minimal risk to human health and the environment. However, in response to comments by the Connecticut Department of Environmental Protection (CTDEP) and the United States Environmental Protection Agency (USEPA), supplemental field investigations are being conducted to confirm that chemicals are not present at levels of concern. The sites included for supplemental Step I investigations are as follows:

- CBU Drum Storage Area
- Over Bank Disposal Area Northeast (OBDANE)

Step II Remedial Investigations

The Step II Remedial Investigations involve sites which have undergone the Step I field sampling/analysis program in which contamination was determined to be present. Step II investigations involve comprehensive site studies designed to determine the nature and extent of contamination, associated health and environmental risks, and conduct Feasibility Studies to evaluate remedial (cleanup) options. Step II investigations will be conducted at the following sites:

- Rubble Fill at Bunker A-86
- Torpedo Shops
- Goss Cove Landfill
- Spent Acid Storage and Disposal Area

Supplemental Step II Remedial Investigations

Supplemental Step II Remedial Investigations involve sites that have already undergone extensive Step II investigations. However, supplemental information is required to further define the extent of contamination, and health and ecological risks. Supplemental investigations will be conducted at the following sites:

- Area A

  - Landfill
  - Wetland
  - Downstream/OBDA
  - Weapons Center

- Defense Reutilization and Marketing Office (DRMO)
- Lower Subase

Additional Step I Sites

Two additional sites, Pier 33 and Berth 16/Former Incinerator, have also been added as Step I sites and are included in a separate Field Sampling Plan/HASP dated July 1992.

2.0 MEDICAL SURVEILLANCE PROGRAM

Atlantic maintains a continuous in-house medical surveillance program designed specifically for field personnel engaged in work at sites where hazardous or toxic materials may be present. Atlantic employs the services of Lawrence & Memorial Occupational Health Center and Martin G. Cherniak, M.D., M.P.H., a specialist in occupational health who conducts yearly comprehensive examinations of all field personnel on Atlantic staff. The medical results of the examinations aid in determining the overall fitness of employees participating in field activities.

Dr. Cherniak's address and telephone number are:

Office: Lawrence & Memorial Occupational Health Center
Suite 28
404 Thames Street
Groton, Connecticut 06340

Telephone: (203) 445-4551

Under Dr. Cherniak's supervision, all field personnel undergo a complete physical examination, including a detailed medical and occupational history, before they participate in hazardous waste site investigations. The following tests are performed as part of the examination:

- Complete blood workup (38 analyses), including screens for particular toxicants anticipated at the NSB-NLON sites (see Appendix A for list of recommended blood tests)
- Urine analysis, including screens for metals and indicators of proper kidney and liver function
- Pulmonary Function
- Electrocardiogram
- Chest X-ray

Upon completion of these tests, personnel are certified whether they are fit for field work in general, and fit to use all levels of respiratory protection, in particular.

In the event that an employee of Atlantic is exposed to some form of hazardous substance and wishes to be rechecked because he/she shows symptoms of exposure, he/she will be sent to Dr. Cherniak immediately. Dr. Cherniak also acts as a consultant to the subcontractors participating in Atlantic's field teams, providing information on health risks associated with various chemical substances.

All subcontractors or other personnel that will enter any active sampling area must certify that all of their personnel are in a medical surveillance program that complies with OSHA regulations for hazardous waste operations (29CFR 1910.120).

3.0 EMERGENCY SUPPORT AND PROCEDURES

3.1 Communications

Atlantic will utilize mobile telephones and/or two-way radios at the base of operations and for each field activity in order to have access to emergency support groups and between field team members. Atlantic's base of operations will be located in a field office trailer adjacent to Building 181 (near the DRMO site).

3.2 Local Emergency Support Units

In order to be able to deal with any emergency that might occur during the site investigations, the following information has been obtained and will be posted prominently in the field office. Field teams working away from the site office will carry a copy of these emergency numbers:

1.	Local emergency medical team located at NSB-NLON (ambulance/fire dispatcher):	Dial 449-3333
2.	Nearest emergency room (NSB-NLON Hospital):	449-3666
	Emergency Room at Lawrence and Memorial Hospital (New London):	911 or 442-0711
3.	Groton Police:	911 or 445-2451
4.	Groton Fire Department:	911 or 445-2456
5.	Toxicological Consultant/Dr. Cherniak:	445-4551
6.	Utility Emergencies (electric, gas, water and sewer) NSB-NLON Public Works:	449-3841
7.	Authorized Navy Site Personnel:	
	William Mansfield:	449-2276
	Deborah Stockdale:	(215) 595-0567
8.	NSB-NLON Security:	449-3224
9.	National Information Centers:	
	Chemtrec:	(800) 424-9300
	National Response Center:	(800) 424-8802

The NSB-NLON fire department has been notified of the field activities planned and the materials that potentially exist at each site so department personnel can respond effectively in case of an emergency.

3.3 Preparation for Medical Emergencies

Atlantic has contacted and met with supervisory staff from the NSB-NLON fire department, who will be the point of contact for all emergencies (i.e., chemical, fire, or injury) while work takes place at NSB-NLON. The fire department will be able to provide ambulance

and paramedic support to any incident, and it will make the critical decisions regarding where an injured person would be transported. In case of immediate threat to life, the Naval Hospital on NSB-NLON would be used; otherwise all cases would be directed to Lawrence and Memorial Hospital in New London.

Before field work on each site commences, personnel who will be working there or observing the operations will complete a brief medical history data sheet that includes the following information:

1. Name, address, home phone
2. Age, height, weight
3. Name of person to be notified in case of emergency
4. All prescription and non-prescription medications currently being used
5. Allergies
6. Particular sensitivities
7. Need for and type of corrective lenses
8. Short medical history including list of previous illnesses
9. Name of personal physician and phone

These data sheets will be filled out during an initial site safety training meeting before any field work begins. They will be filed in the field office, and their maintenance will be the responsibility of the designated Site Safety Officer or his designee (see Appendix B for sample medical data sheet).

In the event of an incident where a team member is injured or suffers from an acute symptom of toxic exposure and is taken to a hospital, a copy of his/her medical data sheet will be presented to the attending physician.

3.4 First Aid for Injuries Incurred During Field Work

All injuries will be reported to the Site Safety Officer immediately. An accident report (Appendix C) will be completed by the Site Safety Officer for all incidents.

A permanent first-aid station will be available at the field office trailer. A portable first aid station will accompany each field sampling team. During the site safety briefing, project personnel will be informed of the location of the first aid station(s).

When possible, site workers will refrain from administering first aid for serious injury or illness and await the arrival of NSB-NLON professional paramedics at the site to take the appropriate action. Unless required due to immediate danger, seriously injured persons will not be moved without direction from attending medical personnel. Some injuries, such as severe cuts and lacerations or burns, may require immediate treatment. Any first aid instructions given by medical personnel, before an emergency medical squad arrives at the site or before the injured person can be transported to the hospital, will be followed closely.

The route to Lawrence and Memorial Hospital (New London) is shown in Figure 3-1. The location of the NSB-NLON Naval Hospital is provided in Figure 3-2.

3.4.1 First Aid Equipment List

The first aid kits that will be kept at the site will consist of a weatherproof container with individually sealed packages for each type of item. The kit will include at least the following items:

- Gauze roller bandages, 1 inch and 2 inch
- Gauze compress bandages, 4 inch
- Gauze pads, 2 inch
- Adhesive tape, 1 inch
- Band aids, 1 inch
- Butterfly bandages
- Triangular bandages, 40 inch
- Ampules of ammonia inhalants
- Antiseptic applicators or swabs
- Burn dressing and sterilized towels
- Surgical scissors
- Eye dressing
- Emergency eye wash
- Alcohol
- Hydrogen peroxide
- Clinical Grade Thermometer

3.4.2 Other Emergency Equipment

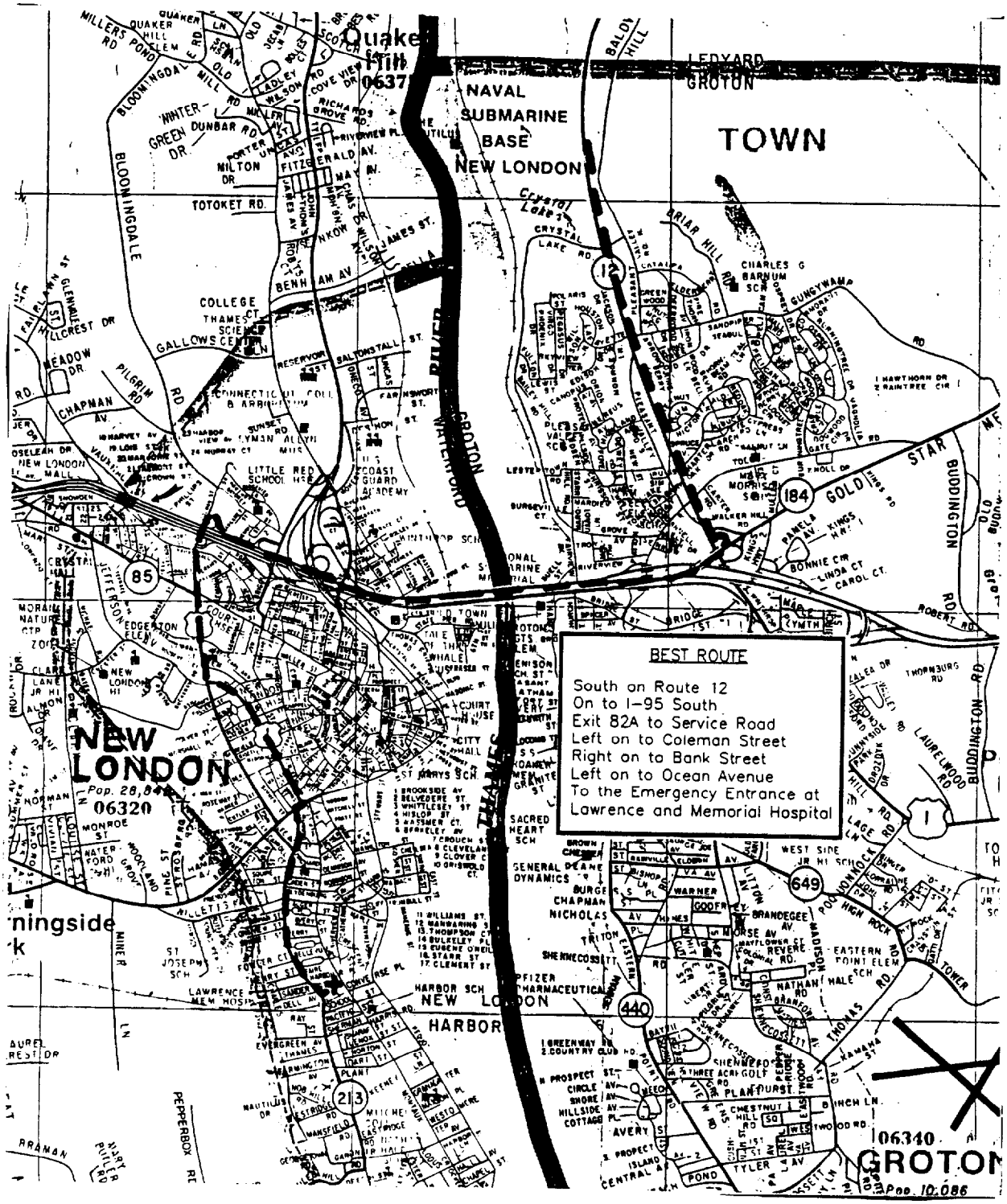
One portable fire extinguisher having a rating of 20ABC will be conspicuously and centrally located at the site office. In addition, extinguishers will be located at the drilling rig and on excavation equipment (i.e., backhoes) during drilling and excavating activities. Extinguishers will be properly maintained, tagged (indicating inspection/maintenance dates).

An emergency at any site, such as a fire or chemical release, might require that some appropriately trained site workers direct traffic on or near the site. Atlantic would be equipped to do this before NSB-NLON emergency support arrives. Reflective vests, flares, and flashlights to be used for traffic control will be kept readily available in the field office.

3.5 Record of Injuries Incurred Onsite

3.5.1 Occupational Injuries and Illnesses Form (OSHA 200)

All occupational injuries and illnesses that are required to be recorded under the Occupational Safety and Health Act will be registered on OSHA Form 200 (Appendix D). Occupational injuries and illnesses will be recorded by the Site Safety Officer within 48 hours of occurrence as is required by statute.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE - NEW LONDON
GROTON, CT

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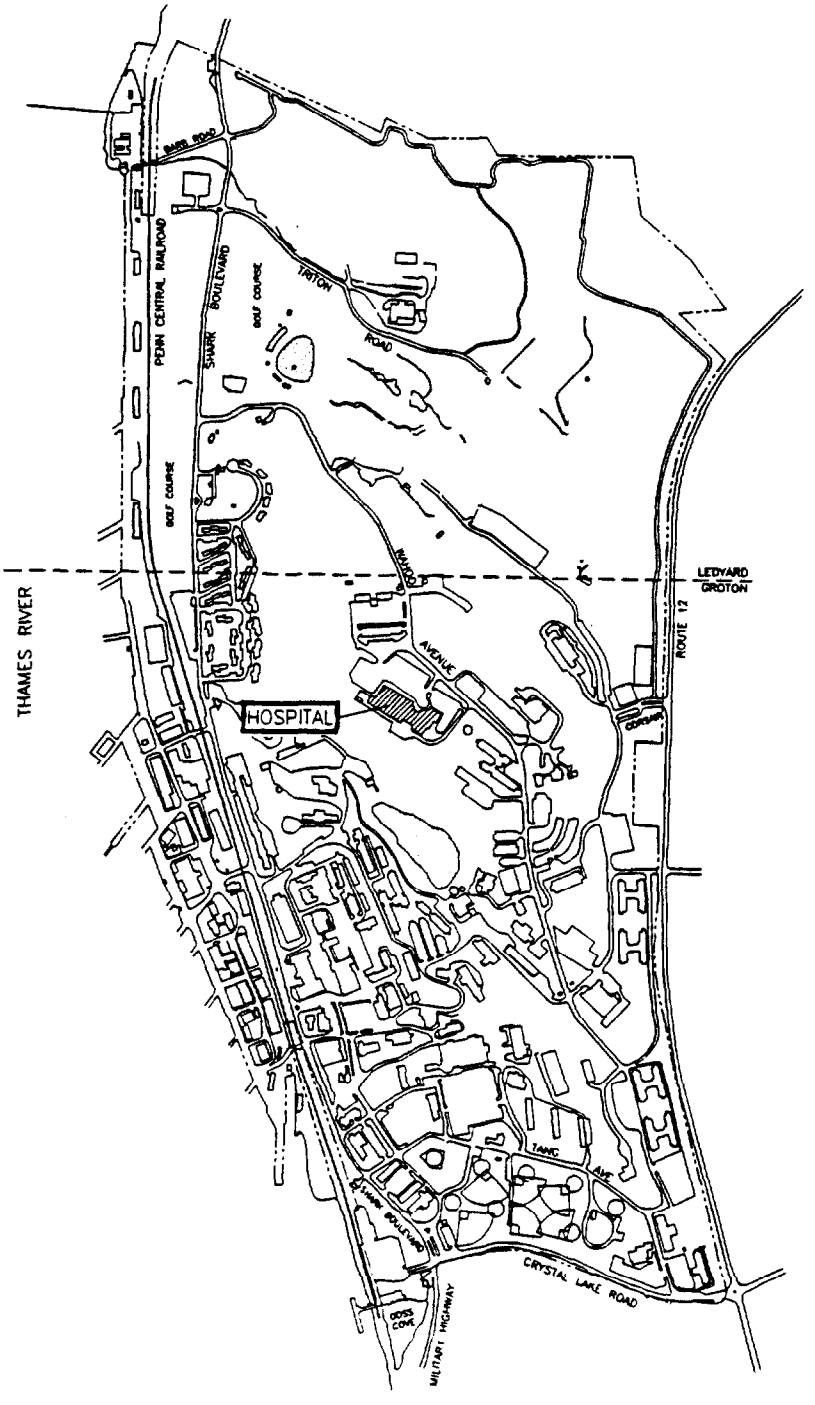
FIGURE 3-1
ROUTE TO
LAWRENCE AND MEMORIAL
HOSPITAL

ATLANTIC ENVIRONMENTAL SERVICES, INC.



INSTALLATION RESTORATION STUDY
NAVAL SUBMARINE BASE – NEW LONDON
GROTON, CT

SOURCE: Naval Submarine Base
Existing Conditions
April 1985
Loureiro Engineering Associates

N

0 600 1200
GRAPHIC SCALE IN FEET

FIGURE 3-2
NSB-NLON
HOSPITAL LOCATION

ATLANTIC ENVIRONMENTAL SERVICES, INC.

3.5.2 Employer's First Report of Injury

This form (Appendix E) will be completed by the Site Safety Officer for all accidents involving worker injury at the site. Follow-up procedures will include investigation of each accident or near-miss by the Site Safety Officer to assure that no similar accidents that may lead to injuries occur.

3.6 Emergency Site Evacuation Procedures

In order to mobilize the manpower resources and equipment necessary to cope with a fire or other emergency, a clear chain of authority has been established. The Site Safety Officer will take charge of all emergency response activities and dictate the procedures that will be followed until NSB-NLON personnel arrive. The Site Safety Officer will report immediately to the scene of the emergency, assess the seriousness of the situation, and direct whatever efforts are necessary until the emergency response units arrive. At his/her discretion, the Site Safety Officer may also shut down the site activity for an indefinite period.

All project personnel will be instructed on proper emergency response procedures and locations of emergency telephone numbers during the initial site safety meeting.

If an emergency occurs, including but not limited to fire, product spill, explosion, or significant release of gas into the atmosphere, an air horn will be sounded on the site. For those sites where only two or three people are working side by side, the air horn will not be necessary. For those operations where hearing is impaired or personnel are spread out, the horn will sound continuously for approximately 15 seconds, signaling that immediate evacuation of all personnel is necessary as a result of some immediate or impending danger. All heavy equipment will be shut down. Under no circumstances will incoming visitors be allowed to enter a site while an emergency is occurring. Visitors or observers present in the area of the emergency will be instructed to evacuate the area immediately.

All personnel will evacuate the work areas and assemble at a predetermined area, where the Site Safety Officer will give directions for implementing necessary actions. The Site Safety Officer will attend a mobile telephone and call for backup assistance. Should a fire or toxic-gas release occur, the Site Safety Officer will determine whether it is sufficiently upwind of the meeting place to ensure the health and safety of those assembling. If smoke or gas poses a danger, an alternative meeting location will be established.

After sounding the alarm and initiating emergency response procedures, the Site Safety Officer will check and attempt to ensure that access roads are not obstructed. If traffic control is necessary, as in the event of a fire or explosion, one of Atlantic's personnel who has been trained in these procedures and designated at the site safety meeting will take over these duties until emergency units arrive. Appropriate reflective warning vests will be worn by personnel involved with traffic control. Vests, flares, and flashlights, as may be necessary for traffic control, are available from the field office.

The Site Safety Officer will remain on the site to provide any assistance requested by emergency-response squads as they arrive to deal with the situation. The Site Safety Officer will have the authority to shut down the field investigation after an emergency until he/she deems it safe to continue the investigation. He/she will dictate any changes in site safety practices which are made necessary by specific aspects of the emergency that has occurred or are required for preventing further emergencies.

4.0 TRAINING PROGRAMS

4.1 Health and Safety Training

All of Atlantic's field personnel assigned to this project and its major subcontractors have attended a 40-hour health and safety training course as required by OSHA standards. Also, a number of Atlantic's supervisory personnel have completed the required eight-hour Supervisory Training Course required by OSHA. Atlantic personnel identified to work at the NSB-NLON sites, and titles and dates of the safety courses that they have attended include (but are not necessarily limited to):

Name	General Site Worker	Management and Supervisor
Paul Burgess	5/88	5/88
Barry Giroux	3/89	5/91
Erik Ness	3/90	5/91
Robert Breeding	7/90	5/91
John Bogdanski	6/91	12/91
Robert Cooney	6/91	12/91
Kevin Dinnean	5/92	7/92
Scott Chasse	5/92	

These training courses have been comprised of classroom instruction, field demonstrations, use of respirators, use of appropriate protective clothing, and written and field tests. They cover the following topics:

1. Identification of hazardous substances
2. Properties of hazardous substances
3. Routes of exposure
4. Toxicity of different substances and their synergistic effects
5. Practical considerations in health and safety management
6. Physical properties of chemicals
7. References for threshold limit values (TLV), lower explosion limits (LEL), toxicity data, cross references
8. Technical assistance organizations
9. Air monitoring and survey instruments
10. Site entry and egress procedures
11. Heat stress monitoring
12. Levels of personnel protection
13. Controlling access to work zones and other contaminated areas
14. Personnel decontamination
15. Equipment decontamination
16. Site/area safety planning

Everyone who attended the courses were tested for the fit of their personal respirator and were trained in using self contained breathing apparatus (SCBA). The courses also emphasized the importance of, and discussed the procedures for, decontamination.

Atlantic employees also receive and have documentation for 24 hours of supervised on-the-job (OTJ) training at a hazardous waste site.

Health and safety training is an ongoing activity at Atlantic. Annual health and safety refresher courses are provided to keep field personnel up to date with proper health and safety practices. Site-specific training programs are presented as needed.

All subcontractors or other personnel that will enter the active sampling area must certify that they have received the training specified in OSHA regulations for hazardous waste operations (29CFR1910.120), and have also received a minimum of 24 hours of supervised OTJ training at a hazardous waste site.

4.2 Onsite Training Program

After the Atlantic field office has been set up and initial site mobilization has taken place, but before any drilling, surveying or sampling activities, the Atlantic Site Safety Officer will conduct an onsite training meeting for all personnel and observers who will be involved in the various site investigations. This program will cover specific practices and potential problems inherent to each site. No person will be allowed to work at the site unless he/she has attended this training meeting. During the meeting, the HASP will be reviewed and copies given to all attending. Copies will be kept in the field office throughout the investigation. The major components of the onsite training are:

- Review of the scope of activities for each site.
- Review of suspected chemical hazards for each site, their forms (e.g. vapor, gas, liquid), and the warning signs of their presence.
- Review of potential hazards posed by drilling and sampling in the presence of underground utilities and other unidentified hazards.
- Operational Procedures:
  - control of site activities
  - control of site access and perimeter
  - zones of hazard
  - levels of protection
  - detection equipment
  - decontamination procedures
  - specific precautions for drilling near buried tanks, utilities, and medical waste

- Emergency Procedures:

  - first aid
  - emergency communications
  - local response groups and their phone numbers
  - evacuation procedures

- Fit testing requirements for all personnel on their personal respirator prior to commencing use at the site.

- Complete reading of the Site Safety Plan followed by initialing of the document to confirm the effort.

Any new personnel who join the field investigation team later in the study are required to go through a similar health and safety briefing before they may participate in any aspect of the field program.

Site-specific rules and regulations will be emphasized during the onsite safety meeting. The following rules will also be posted in the Atlantic office trailer:

1. No smoking, drinking, eating within restricted (contaminated) zones. Proper respiratory protection is required to be worn at all times within zones where toxic vapor/gas levels have been determined to be above recommended safety limits.

2. All rest, refreshment, and sanitary facility use will take place in "clean areas" outside of restricted zones and decontamination zones.

3. Those in contact with contaminated soils or other materials that are thought to be contaminated must go through decontamination upon egress from the restricted area based on the level of contamination and before they may enter a "clean area" or non-restricted area. Decontamination procedures are detailed in Section 5.8.

4. The Site Safety Officer has full authority over start-up and shutdown of operations from a safety standpoint. He/she will determine whether conditions are too extreme for work, and he/she will establish the working hours at the site.

Additional meetings will be held if necessitated by changing site conditions, new operation procedures, or the entry of new personnel unfamiliar with important daily safety topics. A record will be kept of safety meeting dates and topics discussed (see Appendix F).

5.0 SITE SAFETY PLAN

The nature of contaminants present at NSB-NLON vary from site to site. This Site Safety Plan establishes policies and procedures to protect workers, base personnel, and other contractors and the public from the potential hazards posed by investigation activities at NSB-NLON. General NSB-NLON information is presented and specific site descriptions and potential hazards are provided.

5.1 Introduction and Site Descriptions

Location: U.S. Naval Submarine Base, Groton and Ledyard, Connecticut
Prepared By: Robert E. Breeding, CHMM, REP
Date Prepared: October 1992

NSB-NLON consists of approximately 547 acres of land and is located off Route 12 in the Towns of Ledyard and Groton. The area surrounding NSB-NLON consists of primarily residential dwellings, undeveloped land, and some commercial establishments. The site is easily accessible to emergency response groups, both within NSB-NLON and from area municipalities. A Naval hospital is located on NSB-NLON, and the Lawrence and Memorial Hospital is located within four miles of the subject property.

The sites included in this Phase II Remedial Investigation and covered by this HASP are:

Supplemental Step I Investigations

- CBU Drum Storage Area
- OBDANE

Step II Remedial Investigations

- Rubble Fill at Bunker A-86
- Torpedo Shops
- Goss Cove Landfill
- Spent Acid Storage and Disposal Area

Supplemental Step II Remedial Investigations

- Area A
  - Landfill
  - Wetland
  - Downstream/OBDA
  - Weapons Center
- DRMO
- Lower Subase

These sites and results of previous contamination investigations were documented in the Phase I Remedial Investigation (NSB-NLON) completed in August 1992. Section 8.0 (Summary and Recommendations) of the Phase I RI report is provided as Appendix G. Appendix G includes information on the site background, nature and extent of contamination, and health and ecological risk assessment for the subject sites.

5.2 Site Safety Plan Objectives

This Site Safety Plan was developed to provide a predetermined level of safety for the investigations with contingencies during:

- land surveys
- soil gas surveys
- air sampling
- monitoring well installation, development and sampling
- test borings and soil sampling
- sediment sampling
- surface water sampling
- biological sampling and bioassays

5.3 Authorized Site Personnel and Their Responsibilities

The following responsibilities have been assigned to the personnel indicated below:

Principal-in-Charge:	Paul Burgess
Project Manager:	Barry Giroux
Health and Safety Officer:	Robert Breeding
Site Safety Officer:	John Bogdanski or Erik Ness
Field Team Leader:	John Bogdanski or Erik Ness
Field Team Members:	Erik Ness Robert Cooney Kevin Dinnean Scott Chasse Other Qualified Personnel as Required
Authorized Navy Representatives:	William Mansfield (Point of Contact) Deborah Stockdale (Engineer in Charge)
State/Federal Agency Representatives:	Carol Keating, USEPA Paul Jameson, CTDEP
Contractors:	To be selected

(Note: One person may be responsible for more than one job function)

5.4 Control of Site Access

- The Site Safety Officer will be responsible for controlling access to all work areas and contaminated zones on the site.

- The onsite sample location which is part of this investigation has been divided into restricted zones, decontamination zones, and the support zone(s) ("clean" areas, such as the field office or laboratory). These areas are described as follows:

  a. Restricted Zones:

     - In areas of drilling, including surface soil sampling, the work is defined as a circle around the sample point or drill rig with a radius of 20 feet. All sample locations are shown in the FSP. Only authorized site personnel will be able to enter this zone under the appropriate level of protection during sampling activities.

  b. Decontamination Zone(s):

     - Personnel decontamination as necessary will also be conducted outside the perimeter of each sampling location restricted zone and within the site area work zone.

     - All heavy equipment and drilling tools will be decontaminated at a centralized area in Area A (see Figure 5-1). All sediment and water from this operation will be contained and stored in drums prior to disposal.

  c. Support Zones (clean areas):

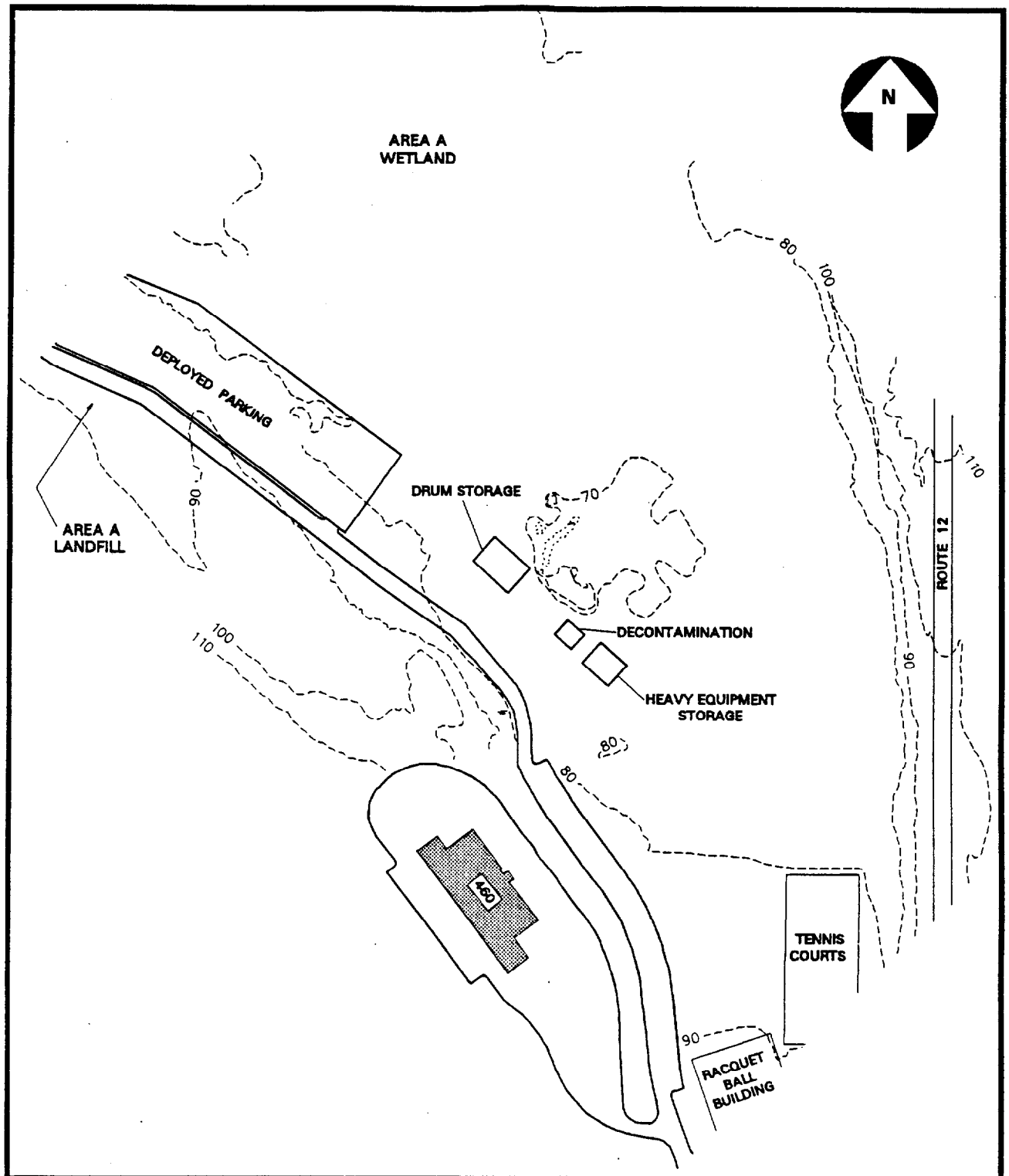
     - The site office will be located at a field trailer near Building 181.

     - The heavy equipment (e.g., drill rig) storage location will be situated in Area A.

Maps of the investigation sites and heavy equipment decontamination area will be posted/provided to the following:

- POC's Office
- Atlantic's Site Office
- NSB-NLON Security Office
- NSB-NLON Fire Department

If site conditions develop that require changes in the established zones, the Navy POC will be notified immediately. The zones will be revised, and a meeting will be held for site



INSTALLATION RESTORATION STUDY NAVAL SUBMARINE BASE - NEW LONDON GROTON, CT	LEGEND -- 95 --- Existing Grade	- Building Approximate Scale 0 80 160'	FIGURE 5-1 LOCATION OF ATLANTIC'S EQUIPMENT DECONTAMINATION AREA ATLANTIC ENVIRONMENTAL SERVICES, INC.

personnel to inform them of the changes, the reasons that caused them to be made, and any new health and safety practices that may be necessary as a result of the altered site conditions. The site maps will be revised to show the new configuration of controlled areas. The new maps will be posted at the locations listed above and attached to the copy of the HASP kept in the site office.

5.5 Evaluation of Potential Hazards

The primary hazards of each contaminant that may be encountered during these investigations (based on the results of the Phase I Remedial Investigation) are identified below.

Note that the locations and matrices specified for each contaminant are not necessarily exclusive, but are based on the best existing knowledge of the areas of investigation. Only contaminants found in excess of ARAR/TBC values are presented. This HASP is sufficiently stringent to ensure worker protection from all of the potential contaminants regardless of location or matrix.

CONTAMINANT:	**Volatile Organic Aromatics (benzene, ethylbenzene, xylenes, and toluene)**
Possible Sources:	Fuels, Oils, Lubricants and Other Petroleum-Based Products
Probable Locations:	Area A DRMO Goss Cove Lower Subase Torpedo Shops
Form:	Gas ___ Liquid _X_ Solid _X_ (Adsorbed) Other ___
Characteristic:	Corrosive ___ Ignitable _X_ Radioactive ___ Volatile _X_ Toxic _X_ Reactive ___ Other ___ Unknown ___
Matrix:	Soils _X_ Debris ___ Ground Water _X_ Other ___

CONTAMINANT:	**Chlorinated Solvents and Breakdown Products**
Possible Sources:	Cleaning Fluids, Degreasers
Probable Locations:	Area A DRMO Goss Cove Torpedo Shops

Form: Gas ___ Liquid _X_ Solid _X_ (Adsorbed) Other ___

Characteristic: Corrosive ___ Ignitable _X_ Radioactive ___
Volatile _X_ Toxic _X_ Reactive ___ Other ___
Unknown ___

Matrix: Soils _X_ Debris ___ Ground Water _X_ Other ___

CONTAMINANT: Metals (antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver)

Possible Sources: Disposal of metals or metal-bearing waste

Probable Locations: Area A
DRMO
Goss Cove
Lower Subase
Rubble Fill at Bunker A-86
Spent Acid Storage and Disposal Area
Torpedo Shops

Form: Gas ___ Liquid _X_ (mercury only) Solid _X_ Other _Sludge_

Characteristic: Corrosive ___ Ignitable ___ Radioactive___
Volatile ___ Toxic _X_ Reactive ___ Other ___
Unknown ___

Matrix: Soils _X_ Debris _X_ Ground Water _X_ Other ___

CONTAMINANT: Polychlorinated Biphenyls (PCBs)

Possible Sources: Transformer Oil, Electric Insulating Fluid

Probable Locations: Area A
DRMO

Form: Gas ___ Liquid _X_ Solid _X_ (Adsorbed) Other ___

Characteristic: Corrosive ___ Ignitable ___ Radioactive ___
Volatile ___ Toxic _X_ Reactive ___ Other ___
Unknown ___

Matrix: Soils _X_ Debris ___ Ground Water _X_ Other ___

CONTAMINANT: **Pesticides (DDT and its residual products)**

Possible Sources: Application for insect control; disposal

Probable Locations: Area A
DRMO
Goss Cove

Form: Gas ___ Liquid _X_ Solid _X_ Other ___

Characteristic: Corrosive ___ Ignitable ___ Radioactive ___
Volatile ___ Toxic _X_ Reactive ___ Other ___
Unknown ___

Matrix: Soils _X_ Debris ___ Ground Water ___ Other ___

CONTAMINANT: **Polyaromatic Hydrocarbons (PAHs), including naphthalene**

Possible Sources: Petroleum products, products of incomplete combustion

Probable Locations: Area A
DRMO
Goss Cove
Lower Subase
Rubble Fill Area at Bunker A-86

Form: Gas ___ Liquid _X_ Solid _X_ (Adsorbed) Other ___

Characteristic: Corrosive ___ Ignitable ___ Radioactive ___
Volatile ___ Toxic _X_ Reactive ___ Other ___
Unknown ___

Matrix: Soils _X_ Debris ___ Ground Water _X_ Other ___

The potential exposure routes associated with the contaminants that will potentially be encountered by workers during the investigations are listed below.

Substances Involved	Potential Exposure Routes
VOCs	Vapor inhalation, skin or eye contact
Solvents	Vapor inhalation, skin or eye contact
Metals	Inhalation of fugitive dust, ingestion
PCBs	Inhalation of fugitive dust, ingestion
Pesticides	Inhalation of fugitive dust, ingestion
PAHs	Inhalation of fugitive dust, ingestion

Material Safety Data Sheets for these compounds and chemicals used in decontamination procedures are included in Appendix H.

The following additional hazards, not related to NSB-NLON disposal activities, also are expected to be found onsite: equipment operation, overhead power lines, vehicular traffic around site vicinity, and buried utilities.

5.6 Levels of Protection For Site Workers

Levels of protection specified by the USEPA refer largely to requirements for respiratory protection. The lists below stipulate equipment for respiratory, clothing, and other types of protection that will be required for different tasks during the site investigations. The designated levels of protection are based on evaluation of potential hazards and risks associated with work at NSB-NLON.

Based on organic vapor readings using a HNu photoionization detector in the work area breathing zone (i.e., waist level and higher) for each site activity, the criteria for maintaining or revising levels of protection taken in respiratory areas are as follows:

Background (< 5 ppm)	Level D
5-50 ppm	Level C
50-500 ppm	Level B
500-1000 ppm	Level A

Note that, when practical, work areas should be positioned upwind of organic vapor sources to reduce potential for worker exposure.

5.6.1 Levels of Protection Required

Personal protective equipment required for each level of protection is as follows:

SAFETY EQUIPMENT	LEVEL A	LEVEL B	LEVEL C	LEVEL D
Half- or full-face respirators with organic vapor/acid gases/HEPA filters.			●	
Tyvek splash resistant suit			●	
Hard hats with splash shields or safety glasses			●	●
Steel-toe boots with over-boots			●	●
Chemical-resistant outer gloves			●	●
Tyvek suit or work overalls				●
Disposable, latex, inner gloves			●	●
Pressure-demand, full face SCBA or pressure-demand supplied air respirator with escape SCBA	●	●		
Chemical resistant clothing		●		
Inner and outer chemical resistant gloves	●	●		
Chemical resistant safety boots or shoes	●	●		
Two-way radio	●	●		
Fully encapsulating chemical resistant suit	●			
Hard hat	●	●		

Personal protection requirements for field activities are:

ACTIVITY	LEVEL OF PROTECTION	BACKUP PROTECTION
Land Surveys	D	C
Soil Gas Surveys	D	C
Air Sampling	D	C
Monitoring Well - installation, development, sampling	D	C
Test Borings and Soil Sampling	D	C
Sediment Sampling	D	C
Surface Water Sampling	D	C
Biological Sampling	D	C

The Site Safety Officer will closely monitor the work schedules listed in the FSP in order to be sure that all workers entering the site have had their safety briefing and that the amount of safety equipment kept on site, such as the number of respirators available, is sufficient for all of the workers present at any time.

5.6.2 Radiological Monitoring

Based upon the results of previous environmental radiation surveys of the subject sites, no radiological monitoring is required.

5.6.3 Ambient Air Monitoring and Protection Limits

During drilling, the air in work areas will be sampled periodically for the presence of contaminants. An HNu portable photoionizer will be utilized to periodically monitor the levels of organic vapors in the ambient air during the field work to ensure that appropriate levels of respiratory protection are employed at all times. An HNu reading will be taken during each advancement of test borings/monitoring wells and test pits. Measurements will be monitored from the top of the borings as an indicator of the worst case conditions; however, measurements will be monitored from the respiratory level (waist level and higher) for determining the actual safety conditions and whether there is a need to change to a higher level of safety (or whether the level of safety can be lowered).

In order to make a conservative assessment of when different levels of respiratory protection are needed during the field work, it will be assumed that the organic vapors detected by the air monitoring instruments consist of the most toxic volatile compounds expected to be found on the site. Preliminary evaluation of the risks expected at the site indicates that the most toxic volatiles that are probably present are VOCs including benzene, toluene, ethylbenzene and xylene (BTEX), and chlorinated organic solvents. Based on data published by OSHA, ACGIH, and NIOSH, the following levels of respiratory protection will be employed when the given concentrations of organic vapor are detected in the breathing zone (4'-5') above ground level:

Compound of Concern	Level D	Level C	Level B
Chemical Name	M* <X**	X<X<Y	M>Y
BTEX and other photoinonizable volatile organic compounds	M <5 ppm	5 ppm <M <50 ppm	M >50 ppm
Where: M = concentration of organic vapor measured in the field X,Y = concentrations at which different levels of respiratory protection are necessary.			

Odors derived from site contaminants may cause nausea in some site workers even though the contaminants are at low levels well below the safety limits as defined above. In such cases, respirators may be used to mitigate nuisance odors.

It is not possible to quantitatively measure the levels of fugitive dust in the air with a real-time monitoring instrument; however, the Site Safety Officer will make qualitative evaluations of the amount of particulate matter suspended in the air due to drilling or excavation on the site. If site activities or weather conditions cause a significant volume of dust to be suspended, appropriate respiratory protection will be employed.

5.6.4 Heat Stress Monitoring

Wearing personal protective equipment puts site workers at risk of developing heat stress which may result in health effects ranging from fatigue to serious illness to death. Heat stress is caused by the interplay of a variety of factors, including ambient conditions, workload, clothing, and the physical characteristics of each worker. The major symptoms of heat stress are listed in Table 5-1. When the temperature in the work area is at or above 70 degrees F (21 degrees C), all workers, even those not wearing protective clothing, will be monitored for heat stress during rest periods according to the following procedures:

- Take pulse over a 30-second period as early as possible in the rest period. If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one third and keep the rest time the same. If, at the next rest period, the heart rate still exceeds 110 beats per minute, shorten the following work period again by one third. Continue the process as necessary.

TABLE 5-1 SIGNS AND SYMPTOMS OF HEAT STRESS
Heat rash may result from continuous exposure to heat or humid air.
Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include: • muscle spasms • pain in the hands, feet and abdomen
Heat exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include: • pale, cool, moist skin • heavy sweating • dizziness • nausea • fainting
Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are: • red, hot, usually dry skin • lack of or reduced perspiration • nausea • dizziness and confusion • strong, rapid pulse • coma

- Take body temperature orally using a clinical thermometer kept under the tongue for three minutes. Take temperature at the end of each work cycle before drinking anything. If the temperature exceeds 99.6°F (37.6°C), shorten the next work period by one third without changing the rest period. If the

temperature still exceeds 99.6°F at the beginning of the next rest period, shorten the following work cycle by one third. No worker will be permitted to wear a semi-permeable or impermeable garment if their temperature exceeds 100.6°F (38.1°C).

- If possible, it is also a good practice to monitor worker's body water loss. Body water loss is determined by weighing each worker, on a scale good to 0.25 pounds, at the beginning and end of each day. The difference in weights will indicate whether an individual is drinking enough fluids to prevent dehydration. The body weight loss should not exceed 1.5 percent of the total body weight in one work day.

5.6.5 Effects of Cold Exposure

Persons working outdoors in temperatures at or below freezing may be frostbitten. Extreme cold for a short time may cause severe injury to exposed body surfaces, or result in profound generalized cooling, causing death. Areas of the body which have high surface area-to-volume ratio such as fingers, toes, and ears, are the most susceptible.

Two factors influence the development of a cold injury: ambient temperature and the velocity of the wind. Wind chill is used to describe the chilling effect of moving air in combination with low temperature. For instance, 10 degrees Fahrenheit with a wind of 15 miles per hour (mph) is equivalent in chilling effect to still air at -18 degrees Fahrenheit.

As a general rule, the greatest incremental increase in wind chill occurs when a wind of 5 mph increases to 10 mph. Additionally, water conducts heat 240 times faster than air. Thus, the body cools suddenly when chemical-protective equipment is removed if the clothing underneath is perspiration soaked.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- Frost nip or incipient frostbite: characterized by sudden blanching or whitening of the skin.

- Superficial frostbite: skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.

- Deep frostbite: tissues are cold, pale, and solid; extremely serious injury.

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages:

- shivering
- apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95 degrees Fahrenheit

- unconsciousness, glassy stare, slow pulse, and slow respiratory rate
- freezing of the extremities
- death

Standard reference books should be consulted for specific first aid treatments. Medical help must be obtained for the more serious conditions.

5.6.6 Indicators of Toxic Exposure

The following indicators of toxic exposure are generally observable by others and should be reported to the Site Safety Officer if observed in a worker:

- changes in complexion, skin discoloration
- lack of coordination
- changes in demeanor
- excessive salivation, pupillary response
- changes in speech pattern

The following symptoms of toxic exposure are generally non-observable by others, and should be reported to the Site Safety Officer if experienced:

- headaches
- dizziness
- blurred vision
- cramps
- irritation of eyes, skin, or respiratory tract.

Although the following hazards (medical waste, ordinance, buried compressed gas, confined space) are not expected to be encountered during this investigation, the following precautions are included in case unexpected conditions are encountered.

5.6.7 Precautions for Sampling or Contact with Buried Compressed Gas or Ordinance

Atlantic will use a metal detector, a photoionization organic vapor detector, and LEL (lower explosive limit) meters at the drilling operations to screen for potential releases of compressed gas. If a release is imminent, the Site Safety Officer and the activity POC will be notified and emergency procedures will be implemented.

5.6.8 Precautions for Confined Entry Work

The investigations do not call for performing any specific confined entry work. However, if any confined entry work is required, it will be performed in accordance with NAVSEA S6470-AA-SAT-010 (NAVSEA Gas Free Engineering Program) and NIOSH Standards for Working in Confined Spaces (December 1979). Copies of both standards will be kept on file in Atlantic's main office. Confined entry work will not be performed without first

notifying and receiving approval from the Site Safety Officer.

5.7 Communication Procedures

Atlantic will utilize mobile telephones and/or two-way radios at the base of operations and for each field activity in order to have communication with emergency support groups and between field team members.

5.8 Decontamination Procedures

Decontamination areas will be established for the following activities:

- Personnel Decontamination
- Equipment Decontamination

5.8.1 Personnel Decontamination Station

A personnel decontamination area will be set up at the boundary of each restricted zone within the site work and will consist of benches where workers can sit and remove protective clothing (e.g., boots and gloves) and other equipment, such as respirators. It will be equipped with basins for water, detergent, and other decontamination fluids. Once personnel have gone through decontamination at this station and taken off their protective gear, they will be able to proceed to a sink where they will wash themselves wherever they may have been exposed to any contaminants.

The following specific decontamination procedure will be used as necessary by site workers wearing protective clothing and equipment from Level D through Level B:

Step 1	Equipment drop
Step 2	Boot and glove wash and rinse, and tape removal and drop (wash with non-foaming detergent, rinse with fresh water spray, then dilute acetone, then fresh water spray)
Step 3	Hard hat and goggle removal (use same wash as in Step 2)
Step 4	Tyvek suit removal
Step 5	Respirator wash and rinse and drop (use same wash and rinse sequence as in Step 2 with a soft-bristle brush and a sponge)
Step 6	Inner glove removal
Step 7	Wash potentially exposed skin (use water and soap at indoor sink)

Wash water and used cleaning fluids will be stored in drums onsite as specified in the FSP.

5.8.2 Heavy Equipment Decontamination

The area designated for heavy equipment decontamination will be located at Area A. A shallow retainage structure will be built where the equipment will be parked during each cleaning

operation. A steam generator and brushes will be used to clean drill rigs, backhoes, auger flytes, casing materials, and other tools. The drilling equipment (e.g., auger flytes, casing materials) will be cleaned after each borehole operation. No heavy equipment will be permitted to leave NSB-NLON unless it has been thoroughly decontaminated.

To prevent the spread of potentially contaminated soil at each drilling location at NSB-NLON, the following procedure will apply:

- Prior to any drilling, a 20- x 20-foot heavy duty tarp will be placed on the ground centered over the borehole.
- All drilling cuttings will be retained on the plastic and may be placed in a 55-gallon drum as specified in the FSP.
- At the conclusion of the boring or well installation, the tarp and all soils may be drummed as specified in the FSP.
- All drums with contaminated materials will be temporarily stored at the Area A decontamination area pending waste classification.
- All drilling tools will be held within the tarp at each borehole site and transported to the heavy equipment decontamination area after the boring is completed.

All soil, sediment and water from the heavy equipment decontamination area will be removed from the cleaning structure and stored in properly labelled drums as specified in the FSP.

5.9 Location of Buried Utilities

Many areas of NSB-NLON are underlain by buried utilities. Therefore, it will be necessary for the field team to exercise a high degree of caution in determining the exact location of each test boring done on the site. The NSB-NLON Public Works Department will be contacted so that active lines in the site areas can be identified and marked out. No borings will be made without prior clearance from Navy Public Works personnel.

Site workers will use these data to choose apparently safe locations for borings. Atlantic will also use metal detectors and pipe locators for site screening. Drilling will proceed carefully at shallow depths to avoid rupturing a line that may be present but that was not detected.

5.10 Engineering Controls and Work Practices

Engineering controls and work practices specified by both OSHA and USEPA are directed primarily toward limiting exposure through application of engineered barriers. These requirements apply to practices on Superfund sites.

5.11 Handling Drums and Containers

Regulations for handling drums and containers are specified by OSHA and will be followed by field team personnel as required.

Handling of drums/containers of unknown materials is not anticipated during this investigation. Potential hazards associated with handling such drums include vapor generation, fire, explosions, and possible physical injury. Air quality monitoring should be conducted around drums using a portable organic vapor meter. However, should it be necessary to move drums of unknown materials, the following protocol will be followed.

Prior to handling of drums, they should be visually inspected to gain information regarding their content. The investigation team should look for:

- symbols or words which indicate that the contents are hazardous, radioactive, explosive, corrosive, toxic or flammable
- signs of deterioration (i.e., rust, corrosion or leaks)
- signs that drum is under pressure, such as bulging or swelling
- drum type

5.12 Illumination

Illumination requirements identified by OSHA are directed to work efforts inside buildings and/or during non-daylight hours. All field activities planned for NSB-NLON will occur outside during daylight hours.

5.13 Sanitation for Temporary Work Sites

Sanitary facilities at NSB-NLON will be available at adjacent facilities within existing Navy buildings. There will also be a portable toilet at the field office.

5.14 Biological Sampling

Sampling of benthic species is planned for the Thames River. Any boat-related activities will be conducted in accordance with applicable state and federal laws and regulations.

6.0 SIGNATURES OF FIELD TEAM MEMBERS AND OBSERVERS

THIS SITE SAFETY PLAN HAS BEEN RECEIVED AND READ BY:

(Signatures of site investigation team members and observers who have been through site safety briefing and have read this Health and Safety Plan.)

NAME	DATE	FIRM	TELEPHONE

APPENDIX A

RECOMMENDED BLOOD TESTS

RECOMMENDED BLOOD TESTS

MEDICAL SURVEILLANCE PROGRAM

Function	Test	Example
Liver	Blood Tests	Total protein, albumin globulin, total bilirubin (direct bilirubin if total is elevated).
Kidney	Blood Tests	Blood urea nitrogen (BUN), creatinine, uric acid.
Blood-Forming Function	Blood Tests	Complete blood count (CBC) with differential and platelet evaluation, including white cell count (WBC), red blood count (RBC),hemoglobin (HGB), hematocrit or packed cell volume (HCT), and desired erythrocyte indices. Reticulocyte count may be appropriate if there is a likelihood of exposure to hemolytic chemicals.

Note: From *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*; October 1985; DHHS (NIOSH) Publication No. 85-115.

APPENDIX B

SAMPLE MEDICAL DATA SHEET FORM

MEDICAL DATA SHEET

CONFIDENTIAL

THE FOLLOWING INFORMATION IS REQUESTED
TO DETERMINE YOUR CURRENT MEDICAL STATUS

DATE

1. Name (Last, First, Middle Initial)			3. Social Security Number
2. Employee Address (Number & Street)		City - State Zip Code	4. Telephone Number
5. Sex* ☐M ☐F	6. Birth Date*	7. Name and Address of Person to Notify in an Emergency	8. Telephone Number
9. Personal Physician	Address	Telephone Number	11. Type of Examination ☐Pre-Placement ☐Periodic ☐Other(Specify)
10. Division or Facility		Position	12. Employee Number
13. Work Location			
14. Please Check if You Have Been Immunized for. ☐Tetanus ☐Don't Know Last Date ☐Smallpox ☐Don't Know Last Date ☐Polio ☐Don't Know Last Date ☐ Others ☐Don't Know Last Date			15. Are You: ☐Right Handed ☐Left Handed ☐Ambidextrous

16. Family History*				CHECK EACH BOX (If Answer is Yes, state blood relationship)			
Relation	Age	State of Health	If Dead, Cause and Age		Yes	No	Relation
Father				Cancer			
Mother				Diabetes			
Spouse				Stomach Trouble			
Grandparents				Kidney Trouble			
				Heart Trouble			
				Tuberculosis			
Brothers and Sisters				Mental Disorder			
				Convulsions			
				Arthritis			
				Allergies			
Children				Other			

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MEDICAL DATA SHEET (con't)

17. PERSONAL HISTORY*

DO YOU HAVE, OR HAVE YOU EVER HAD ANY OF THE FOLLOWING. (Check Each Box)

	YES	NO		YES	NO		YES	NO
Asthma			Foot Trouble			Malaria		
Cancer, Cyst, Tumor or Growth			Frequent Indigestion or Heartburn			Nervous Breakdown		
Chest Pain or Shortness of Breath			Frequent or Painful Urination			Nervous Trouble of any Sort		
Fever, Night Sweats			Frequent Trouble Sleeping			Numbness, Weakness		
Chronic Cough or Colds			Gall Bladder Trouble			Palpitation or Pounding Heart		
Convulsions, Fits			Goiter or Thyroid Problem			Prostate Trouble		
or Fall Sickness			Hayfever or Allergies			Reaction from Medicines		
or coughing up, spitting or			Headaches, Frequent or Severe			Recent Gain or Loss of Weight		
vomiting blood			Heart Trouble			Rheumatism or Arthritis		
Expression of Excessive Worry			Hemorrhoids or Rectal Trouble			Scarlet Fever or Rheumatic Fever		
Diabetes, or Sugar in Urine			Hernia or Rupture			Skin Rash or Hives		
Dizziness			High Blood Pressure			Stomach Trouble, Ulcers		
Ear, Nose, or Throat Trouble			Jaundice or Hepatitis			Swelling of Ankles or Feet		
Epilepsy			Kidney Trouble or Blood in Urine			Swollen or Painful Joints		
Eye Trouble			Liver Trouble			Tuberculosis or Pleurisy		
Fainting			"Locked" Knee or "Trick Joint"			Varicose Veins		
Fatigue, Chronic or Frequent			Loss of Appetite, Chronic			Other		
Female Disorders			Venereal Disease			Other		

MEDICAL DATA SHEET (con't)

18. Injuries: Please Check Any Injuries You Have Had

- ☐ Fractures/Broken Bones
- ☐ Back Injury
- ☐ Low Back Pain
- ☐ None
- ☐ Other Injury
- ☐ Severe Cuts
- ☐ severe Burns
- ☐ Lost Consciousness
- ☐ Dislocations
- ☐ Loss of Arm
- ☐ Loss of Leg
- ☐ Loss of Finger(s)
- ☐ Loss of Toe(s)

19. Check Yes or No. If Yes, Give Details in Blank Area	Yes	No	Details
a. Any Time Loss From Work Past Two years Due to Illness			
b. Any Brace or Support Worn			
c. Discharged or Disqualified From Armed Services for any Reason.			
d. Military Service - Dates and Locations			
e. Applied for, or Received Workmen's Compensation			
f. Been Exposed to Work With Dusts, Radiation, Excessive Noise, Chemicals.			
g. Have You Been Unable to Hold a Job Because of:			
1. Sensitivity to Chemicals, Dust, Sunlight, etc.			
2. Inability to Perform Certain Motions.			
3. Inability to Assume Certain Positions.			
4. Other Medical Reasons.			
h. Been a Patient in a Hospital or Sanitarium			
i. Had Surgery Recommended or Performed. Date and Type			
j. Are You Taking Medicines Now.			
k. Have You Been Turned Down on a Physical Examination or Been Informed of Any Abnormal Findings From a Physical Examination.			
l. Do You Smoke - If Yes, Quantity Per Day.			
m. Do You Use Alcoholic Beverages - If Yes, Quantity per Day			
n. Have You Lived or Traveled Outside the Continental U.S.A.			

ATLANTIC
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APPENDIX C

ACCIDENT REPORT FORM

ACCIDENT REPORT FORM
ACCIDENT REPORT

Report No._____

SITE: _____ PROJECT NO. _____

Location: _____

Date of Report: _____ Preparers Name:_____

Name and Address of Injured: _____ SSN: ___-___-___ Age: _____

_____ Sex: _____

Years of Service: _____ Time on Present Job: _____ Title/Classification: _____

Division/Department _____ Date of Accident _____ Time: _____

Accident Category: ___ Motor Vehicle ___ Property Damage ___ Fire

___ Chemical Exposure ___ Near Miss ___ Other

Severity of Injury or Illinoiss: ____ Non-disabling ___ Disabling

____ Medical Treatment ___ Fatality

Amount of Damage: $_____ Property Damaged: _____

Estimated Number of Days Away from Job: _____

Nature of Injury or Illness: _____

CLASSIFICATION OF INJURY:

____ Fractures	____ Heat Burns	____ Cold Exposure
____ Dislocations	____ Chemical Burns	____ Frostbite
____ Sprains	____ Radiation Burns	____ Heat Stroke
____ Abrasions	____ Bruises	____ Heat Exhaustion
____ Lacerations	____ Blisters	____ Concussion
____ Punctures	____ Toxic Respiratory Exposure	____ Faint/Dizziness
____ Bites	____ Toxic Ingestions	____ Toxic Respiratory
____ Toxic Ingestions	____ Dermal Allergy	

Part of Body Affected: _____

Degree of Disability: _____

ATLANTIC
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ACCIDENT REPORT FORM
(Continued)

18. Injuries: Please Check Any Injuries You Have Had

- ☐ Fractures/Broken Bones
- ☐ BackInjury
- ☐ Low Back Pain
- ☐ None
- ☐ Severe Cuts
- ☐ Severe Burns
- ☐ Loss of Arm, Leg, Finger, Toe
- ☐ Loss of Consciousness
- ☐ Dislocations
- ☐ Other Injury

19. Check Yes or NO. If Yes, Give Details in Blank Area	Yes	No	
a. Any Time Loss From Work Past Two years Due to Illness			
b. Any Brace or Support Worn			
c. Discharged or Disqualified From Armed Services for any Reason.			
d. Military Service - Dates and Locations			
e. Applied for, or Received Workmen's Compensation			
f. Been Exposed to Work With Dusts, Radiation, Excessive Noise. Chemicals.			
g. Have You Been Unable to Hold a Job Because of:			
1. Sensitivity to Chemicals, Dust, Sunlight, etc.			
2. Inability to Perform Certain Motions.			
3. Inability to Assume Certain Positions.			
4. Other Medical Reasons.			
h. Been a Patient in a Hospital or Sanitarium			
i. Had Surgery Recommended or Performed. Date and Type			
j. Are You Taking Medicines Now.			
k. Have You Been Turned Down on a Physical Examination or Been Informed of Any Abnormal Findings From a Physical Examination.			
l. Do You Smoke - If Yes, Quantity Per Day.			
m. Do You Use Alcoholic Beverages - If Yes, Quantity per Day			
n. Have You Lived or Traveled Outside the Continental U.S.A.			
o. Allergies			

ACCIDENT REPORT FORM
(Continued)

Date Medical Care Was Received: _____

Where Medical Care was Received: _____

Address (if off-site): _____

ACCIDENT LOCATION:

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

_____

_____

_____

Was weather a factor? _____

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 of skill, slow reaction, fatigue):

_____

_____

_____

ACCIDENT REPORT FORM
(Continued)

Level of personal protection equipment required in Site Safety Plan: _____

_____

Modifications: _____

Was injured using required equipment _____

If not, how did actual equipment use differ from plan: _____

_____

What can be done to prevent a recurrence of this type of accident (Modification of machine; mechanical guards; correct environment training):

_____

_____

Detailed narrative description (How did accident occur, why; objects, equipment tools used, circumstance assigned duties) (Be specific):

_____

_____

_____

(Use back of sheet as required)

Witnesses to accident _____

_____

Signature of Preparer _____

Signature of Site Leader _____

APPENDIX D

OSHA FORM 200

Bureau of Labor Statistics
Log and Summary of Occupational
Injuries and Illnesses

U.S. Department of Labor

For Calendar Year 19 ______ Page ___ of ___

Form Approved
O.M.B. No. 1220-0029
See OMB Disclosure Statement on reverse

NOTE: This form is required by Public Law 91-596 and must be kept in the establishment for 5 years. Failure to maintain and post can result in the issuance of citations and assessment of penalties. (See posting requirements on the other side of form.)

RECORDABLE CASES: You are required to record information about every occupational death; every nonfatal occupational illness; and those nonfatal occupational injuries which involve one or more of the following: loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment (other than first aid). (See definitions on the other side of form.)

Company Name
Establishment Name
Establishment Address

Case or File Number	Date of Injury or Onset of Illness	Employee's Name	Occupation	Department	Description of Injury or Illness
Enter a nonduplicating number which will facilitate comparisons with supplementary records.	Enter Mo./day.	Enter first name or initial, middle initial, last name.	Enter regular job title, not activity employee was performing when injured or at onset of illness. In the absence of a formal title, enter a brief description of the employee's duties.	Enter department in which the employee is regularly employed or a description of normal workplace to which employee is assigned, even though temporarily working in another department at the time of injury or illness.	Enter a brief description of the injury or illness and indicate the part or parts of body affected. Typical entries for this column might be: Amputation of 1st joint right forefinger; Strain of lower back; Contact dermatitis on both hands; Electrocution—body.
(A)	(B)	(C)	(D)	(E)	(F)
					PREVIOUS PAGE TOTALS →
					TOTALS (Instructions on other side of form.) →

Extent of and Outcome of INJURY

Fatalities	Nonfatal Injuries				
Injury Related	Injuries With Lost Workdays				Injuries Without Lost Workdays
Enter DATE of death. Mo./day/yr.	Enter a CHECK if injury involves days away from work, or days of restricted work activity, or both.	Enter a CHECK if injury involves days away from work.	Enter number of DAYS away from work.	Enter number of DAYS of restricted work activity.	Enter a CHECK if no entry was made in columns 1 or 2 but the injury is recordable as defined above.
(1)	(2)	(3)	(4)	(5)	(6)

Type, Extent of, and Outcome of ILLNESS

Type of Illness							Fatalities	Nonfatal Illnesses				
CHECK Only One Column for Each Illness (See other side of form for terminations or permanent transfers.)							Illness Related	Illnesses With Lost Workdays				Illnesses Without Lost Workdays
							Enter DATE of death. Mo./day/yr.	Enter a CHECK if illness involves days away from work, or days of restricted work activity, or both.	Enter a CHECK if illness involves days away from work.	Enter number of DAYS away from work.	Enter number of DAYS of restricted work activity.	Enter a CHECK if no entry was made in columns 8 or 9.
(7)												
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(8)	(9)	(10)	(11)	(12)	(13)

INJURIES

ILLNESS

OSHA No. 200

Certification of Annual Summary Totals By ______ Title ______ Date ______

OSHA No. 200

POST ONLY THIS PORTION OF THE LAST PAGE NO LATER THAN FEBRUARY 1.

OMB DISCLOSURE STATEMENT

We estimate that it will take from 4 minutes to 30 minutes to complete a line entry on this form, including time for reviewing instructions, searching, gathering and maintaining the data needed, and completing and reviewing the entry. If you have any comments regarding this estimate or any other aspect of this recordkeeping system, send them to the Bureau of Labor Statistics, Division of Management Systems (1220-0029), Washington, D.C. 20212 and to the Office of Management and Budget, Paperwork Reduction Project (1220-0029), Washington, D.C. 20503.

Log and Summary of Occupational Injuries and Illnesses

Each employer who is subject to the recordkeeping requirements of the Occupational Safety and Health Act of 1970 must maintain for each establishment a log of all recordable occupational injuries and illnesses. This form (OSHA No. 200) may be used for that purpose. A substitute for the OSHA No. 200 is acceptable if it is as detailed, easily readable, and understandable as the OSHA No. 200.

Enter each recordable case on the log within six (6) workdays after learning of its occurrence. Although other records must be maintained at the establishment to which they refer, it is possible to prepare and maintain the log at another location, using data processing equipment if desired. If the log is prepared elsewhere, a copy updated to within 45 calendar days must be present at all times in the establishment.

Logs must be maintained and retained for five (5) years following the end of the calendar year to which they relate. Logs must be available (normally at the establishment) for inspection and copying by representatives of the Department of Labor, or the Department of Health and Human Services, or States accorded jurisdiction under the Act. Access to the log is also provided to employees, former employees and their representatives.

Changes in Extent of or Outcome of Injury or Illness

If, during the 5-year period the log must be retained, there is a change in an extent and outcome of an injury or illness which affects entries in columns 1, 2, 6, 8, 9, or 13, the first entry should be lined out and a new entry made. For example, if an injured employee at first required only medical treatment but later lost workdays away from work, the check in column 6 should be lined out, and checks entered in columns 2 and 3 and the number of lost workdays entered in column 4.

In another example, if an employee with an occupational illness lost workdays, returned to work, and then died of the illness, any entries in columns 9 through 12 should be lined out and the date of death entered in column 8.

The entire entry for an injury or illness should be lined out if later found to be nonrecordable. For example, an injury which is later determined not to be work related, or which was initially thought to involve medical treatment but later was determined to have involved only first aid.

III. **Posting Requirements**

A copy of the totals and information following the fold line of the last page for the year must be posted at each establishment in the place or places where notices to employees are customarily posted. This copy must be posted no later than *February 1 and must remain in place until March 1.*

Even though there were no injuries or illnesses during the year, zeros must be entered on the totals line, and the form posted.

The person responsible for the *annual summary totals* shall certify that the totals are true and complete by signing at the bottom of the form.

IV. **Instructions for Completing Log and Summary of Occupational Injuries and Illnesses**

Column A — CASE OR FILE NUMBER. Self explanatory.

Column B — DATE OF INJURY OR ONSET OF ILLNESS.
For occupational injuries, enter the date of the work accident which resulted in injury. For occupational illnesses, enter the date of initial diagnosis of illness, or, if absence from work occurred before diagnosis, enter the first day of the absence attributable to the illness which was later diagnosed or recognized.

Columns C through F — Self explanatory.

Columns 1 and 8 — INJURY OR ILLNESS-RELATED DEATHS.
Self explanatory.

Columns 2 and 9 — INJURIES OR ILLNESSES WITH LOST WORKDAYS.
Self explanatory.

Any injury which involves days away from work, or days of restricted work activity, or both must be recorded since it always involves one or more of the criteria for recordability.

Columns 3 and 10 — INJURIES OR ILLNESSES INVOLVING DAYS AWAY FROM WORK. Self explanatory.

Columns 4 and 11 — LOST WORKDAYS—DAYS AWAY FROM WORK.
Enter the number of workdays (consecutive or not) on which the employee would have worked but could not because of occupational injury or illness. The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work.

NOTE: For employees not having a regularly scheduled shift, such as certain truck drivers, construction workers, farm labor, casual labor, part-time employees, etc., it may be necessary to estimate the number of lost workdays. Estimates of lost workdays shall be based on prior work history of the employee AND days worked by employees, not ill or injured, working in the department and/or occupation of the ill or injured employee.

Columns 5 and 12 — LOST WORKDAYS—DAYS OF RESTRICTED WORK ACTIVITY.
Enter the number of workdays (consecutive or not) on which because of injury or illness:

(1) the employee was assigned to another job on a temporary basis, or
(2) the employee worked at a permanent job less than full time, or
(3) the employee worked at a permanently assigned job but could not perform all duties normally connected with it.

The number of lost workdays should not include the day of injury or onset of illness or any days on which the employee would not have worked even though able to work.

Columns 6 and 13 — INJURIES OR ILLNESSES WITHOUT LOST WORKDAYS. Self explanatory.

Columns 7a through 7g — TYPE OF ILLNESS.
Enter a check in only one column for each illness.

TERMINATION OR PERMANENT TRANSFER—Place an asterisk to the right of the entry in columns 7a through 7g (type of illness) which represented a termination of employment or permanent transfer.

V. **Totals**

Add number of entries in columns 1 and 8.
Add number of checks in columns 2, 3, 6, 7, 9, 10, and 13.
Add number of days in columns 4, 5, 11, and 12.
Yearly totals for each column (1-13) are required for posting. Running or page totals may be generated at the discretion of the employer.

If an employee's loss of workdays is continuing at the time the totals are summarized, estimate the number of future workdays the employee will lose and add that estimate to the workdays already lost and include this figure in the annual totals. *No further entries are to be made with respect to such cases in the next year's log.*

VI. **Definitions**

OCCUPATIONAL INJURY is any injury such as a cut, fracture, sprain, amputation, etc., which results from a work accident or from an exposure involving a single incident in the work environment.

NOTE: Conditions resulting from animal bites, such as insect or snake bites or from one-time exposure to chemicals, are considered to be injuries.

OCCUPATIONAL ILLNESS of an employee is any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases which may be caused by inhalation, absorption, ingestion, or direct contact.

The following listing gives the categories of occupational illnesses and disorders that will be utilized for the purpose of classifying recordable illnesses. For purposes of information, examples of each category are given. These are typical examples, however, and are not to be considered the complete listing of the types of illnesses and disorders that are to be counted under each category.

7a. Occupational Skin Diseases or Disorders
Examples: Contact dermatitis, eczema, or rash caused by primary irritants and sensitizers or poisonous plants; oil acne; chrome ulcers; chemical burns or inflammations; etc.

7b. Dust Diseases of the Lungs (Pneumoconioses)
Examples: Silicosis, asbestosis and other asbestos-related diseases, coal worker's pneumoconiosis, byssinosis, siderosis, and other pneumoconioses.

7c. Respiratory Conditions Due to Toxic Agents
Examples: Pneumonitis, pharyngitis, rhinitis or acute congestion due to chemicals, dusts, gases, or fumes; farmer's lung; etc.

7d. Poisoning (Systemic Effect of Toxic Materials)
Examples: Poisoning by lead, mercury, cadmium, arsenic, or other metals; poisoning by carbon monoxide, hydrogen sulfide, or other gases; poisoning by benzol, carbon tetrachloride, or other organic solvents; poisoning by insecticide sprays such as parathion, lead arsenate; poisoning by other chemicals such as formaldehyde, plastics, and resins; etc.

7e. Disorders Due to Physical Agents (Other than Toxic Materials)
Examples: Heatstroke, sunstroke, heat exhaustion, and other effects of environmental heat; freezing, frostbite, and effects of exposure to low temperatures; caisson disease; effects of ionizing radiation (isotopes, X-rays, radium); effects of nonionizing radiation (welding flash, ultraviolet rays, microwaves, sunburn); et

7f. Disorders Associated With Repeated Trauma
Examples: Noise-induced hearing loss; synovitis, tenosynovitis, and bursitis; Raynaud's phenomena; and other conditions due to repeated motion, vibration, or pressure.

7g. All Other Occupational Illnesses
Examples: Anthrax, brucellosis, infectious hepatitis, malignant and benign tumors, food poisoning, histoplasmosis, coccidioidomycosis, etc.

MEDICAL TREATMENT includes treatment (other than first aid) administered by a physician or by registered professional personnel under the standing orders of a physician. Medical treatment does NOT include first aid treatment (one-time treatment and subsequent observation of minor scratches, cuts, burns, splinters, and so forth, which do not ordinarily require medical care) even though provided by a physician or registered professional personnel.

ESTABLISHMENT: A single physical location where business is conducted or where services or industrial operations are performed (for example: a factory, mill, store, hotel, restaurant, movie theater, farm, ranch, bank, sales office, warehouse, or central administrative office). Where distinctly separate activities are performed at a single physical location, such as construction activities operated from the same physical location as a lumber yard, each activity shall be treated as a separate establishment.

For firms engaged in activities which may be physically dispersed, such as agriculture; construction; transportation; communications; and electric, gas, and sanitary services, records may be maintained at a place to which employees report each day.

Records for personnel who do not primarily report or work at a single establishment, such as traveling salesmen, technicians, engineers, etc., shall be maintained at the location from which they are paid or the base from which personnel operate to carry out their activities.

WORK ENVIRONMENT is comprised of the physical location, equipment, materials processed or used, and the kinds of operations performed in the course of an employee's work, whether on or off the employer's prem

APPENDIX E

EMPLOYER'S FIRST REPORT OF INJURY FORM

EMPLOYER'S FIRST REPORT OF INJURY

STANDARD FORM FOR EMPLOYER'S FIRST REPORT OF INJURY

Please submit this report in TRIPLICATE

Employer

1. Name of Employer _____
2. Office address: No. & St. _____ City/town _____ State _____
3. Insured by Name of Company _____
4. Give nature of business (or article manufactured) _____

Time and Place

5. (a) Location of plant or place where accident occurred _____
   (b) If injured in a mine, did accident occur on surface, under ground, shaft, drift or mill _____.
6. Date of injury _____ 19__ Day of week _____ Hour of day _____ a.m. _____ p.m. _____
7. Date disability began _____ 19__ a.m. ____ p.m. _____
8. Was injured paid in full for this day _____
9. When did you or foreman first know of injury _____
10. Name of foreman _____

Injured Person

11. Name of Injured _____
    (First Name) (Middle Initial) (Last Name) (SS#)
12. Address: No. and St. _____ City/Town _____ State __
13. Check (✓)Married__ Single__ Widowed__ Widower__, Divorced__, Male __, Female__;
14. Age _____ Did you have on file employment certificate or permit _____
15. (a) Occupation when injured _____
    (b) Was this his or her register occupation _____
    (If not, state in what department or branch of work regularly employed _____
16. (a) How long employed by your _____ (b) Wages per day $_____
17. (a) No. hours worked per day _____ (b) Wages per day $_____
    (c) No. days worked per week _____ (d) Average weekly earnings $_____
    (e) If board, lodging, fuel or other advantages were furnished in addition to wages, give estimated value per day, week or month _____

Cause of Injury

18. Machine, tool or thing causing injury _____
19. Kind of power (hand, foot, electrical, steam, etc.) _____
20. Part of machine on which accident occurred _____
21. (a) Was safety appliance or regulation provided _____ (b) Was it in use at time _____
22. Was accident caused by injured's failure to use or observe safety appliance or regulation _____
23. Describe fully how accident occurred, and state what employee was doing when injured _____
24. Names and addresses of witnesses _____

Nature of Injury

25. Nature and location of injury (describe fully exact location of amputations or fractures, right or left) _____
26. Probably length of disability _____
27. Has injured returned to work _____ If so, date and hour _____ At what wage $_____
28. At what occupation _____
29. (a) Name and address of physician _____
    (b) Name and address of hospital _____

Cases Fatal

30. Has injured died _____ If so, give date of death _____

Date of this report _____ Firm name _____

Signed by _____ Official Title _____

ATLANTIC
ENVIRONMENTAL SERVICES, INC.

APPENDIX F

RECORD OF SAFETY MEETINGS

RECORD OF SAFETY MEETINGS

Company	Date/Time	Location	Attended By	Affiliation

ATLANTIC
ENVIRONMENTAL SERVICES, INC.

APPENDIX G

SITE DESCRIPTIONS

Site desciptions are excerpted from Section 8.0 - Summary and Conclusions of the Phase I Remedial Investigation Report dated August 1992.

8.0 SUMMARY AND RECOMMENDATIONS

This section discusses the summary and conclusions of the investigations and evaluations at each site. Included are overviews of site background, nature and extent of contamination, and health and ecological risk assessment. Based on this information, for Step I sites, a recommendation is provided for proceeding to Step II, or for no further action. A no further action recommendation is based on identification of no significant contamination, exceedances of ARARs, and no health and ecological risk. Recommendations to proceed from Step I to Step II are based on identification of contaminants above applicable ARAR/TBC values, and where health and ecological risks are of concern. **ARAR/TBC values are detailed in Section 4.0.** In some cases, recommendations to proceed from Step I to II are based on the need for further delineation of the extent of contamination (e.g., Battery Acid Disposal Area), or to define the source of contaminants (e.g., Torpedo Shops).

Risk estimates for human health effects associated with exposure to potential carcinogens are expressed as the lifetime probability of excess cancer associated with the given exposure (e.g., a lifetime incremental risk of one in ten thousand). Risks above 1.0E-4 are described here as "generally unacceptable for environmental risks to humans, and risks below 1.0E-6 are described here as generally considered *de minimus* for environmental risk to humans. Risk estimates for human health effects associated with exposure to non-carcinogens are evaluated by using the total hazard index ratio. The total hazard index ratio is estimated by summarizing the hazard index ratios for each compound. The hazard index ratio for a compound is the ratio of its exposure dose to its reference dose. Ratios in excess of "1" are viewed here as benchmarks with regard to the potential for chronic, generally sublethal, effects. Risk characterization for the ecological risk assessment relies upon the toxicity quotient approach as well as on direct observations of conditions in the field. These approaches provide an overall "weight of evidence" approach for the assessment. The toxicity quotient is the ratio of a compound's exposure dose to its effects level, normally its NOAEL. Values above 1 indicate some potential for environmental effects. Values above 10 indicate good potential that greater exposure could result in effects based on experimental evidence, and values above 100 indicate effects may be expected based on the fact that this represents an exposure level at which effects have been observed in other species. In some cases, assessments regarding environmental risk were made by directly comparing exposure point concentrations to known toxicity data or developed criteria.

Step II sites will now proceed to the Feasibility Study (FS). The Feasibility Study is a detailed evaluation of remedial (clean-up) alternatives at each Step II site, including no action.

The following discussion of summary and recommendations is provided for each site.

8.1 Step I Sites

8.1.1 CBU Drum Storage Area

8.1.1.1 Summary

Background: The CBU Drum Storage Area is located in the northern section of NSB-NLON, adjacent to the deployed parking lot, and within the Area A Landfill. Twenty-six 55 gallon drums of waste oil, lube oil, and paint materials were previously located at this site.

Nature and Extent of Contamination: Seven (7) surface soil samples were collected from three sample locations to screen for potential contamination. Low concentrations of VOCs and SVOs were detected in the surface soils at this site. However, concentrations were below TBC values. Lead exceeded the TBC values for TCLP analysis, and was also slightly above the established background concentration at two sample locations. The pesticide DDD was also detected at a low concentration, consistent with the past application of pesticides within Area A. The chemicals detected at this site are generally consistent with the past storage of oil and indicate that a small release may have occurred.

Health and Ecological Risk Assessment: The low concentrations of chemicals detected at this site do not cause a risk with respect to health or ecological impact.

8.1.1.2 Recommendations

Supplemental Step I investigations are recommended to determine if Step II investigations are necessary or to support a no further action recommendation.

8.1.2 Rubble Fill at Bunker A-86

8.1.2.1 Summary

Background: Bunker A-86 is located on a dirt road off of Wahoo Avenue in the north central section of NSB-NLON. Area A Landfill is adjacent to the north, and the NSB-NLON hazardous waste storage facility is adjacent to the south. The rubble fill area is located to the north of the dirt access road and to the west of the bunker.

Discarded construction material is present at this site including concrete, asphalt, an electric motor, wood and gravel. Chemical containers found at this site included an empty 5-gallon container of monothanolanine (labelled as corrosive product), an empty 5-gallon container of thorite (labelled as non-shrinking compound for patching concrete), and a 55-gallon drum of lube oil that was approximately ten percent full.

Nature and Extent of Contamination: Five (5) surface soil samples were collected for analysis from this site from two sample locations to screen for contamination. Solvents (trichloroethene, tetrachlorethane) were detected in the 1-2 ppb range, below TBC values. One sample was analyzed for SVOs and contained elevated concentrations of PAHs, possibly indicative of an oil release or combustion by-products. Low concentrations of pesticides (delta-

BHC, methoxychlor) were detected which are likely associated with past Area A applications. Arsenic was present at a concentration well above background levels at the one sample analyzed on a mass weight basis. The concentration of arsenic (127 ppm) was one of the highest detected compared with all other sites investigated.

Health and Ecological Risk Assessment: Activity in this area is negligible. However, based on the elevated levels of PAHs and arsenic, there could be potential health risks if exposures were to occur under some future use condition.

8.1.2.2 Recommendations

It is recommended that this site proceed to the Step II phase of the IR program. Additional soil sampling and potential ground water monitoring is recommended at this site to further characterize the nature and extent of contamination and to conduct a quantitative health and environmental risk assessment.

In the interim, it is recommended that the containers at this site be removed and properly disposed.

8.1.3 Torpedo Shops

8.1.3.1 Summary

Background: The Torpedo Shops are located in the northern portion of NSB-NLON on the north side of Triton Avenue. The two buildings onsite (Nos. 325 and 450) are torpedo overhaul/assembly facilities. These facilities were connected to an onsite septic system leachfield until 1983, when they were connected to municipal sewers. A variety of fuels, solvents and petroleum products are used in these buildings. Direct disposal of these wastes to the septic system was reported not to be a routine practice, although sporadic, inadvertent chemical discharges to the subsurface septic system is of concern.

Nature and Extent of Contamination: Nine surface soil samples and three ground water samples were collected and analyzed to screen for potential contamination at the former subsurface septic systems.Low concentrations of VOCs and SVOs were detected in the north and south septic systems. Only one detection of benzene (4 ppb), was slightly above the TBC value of 1 ppb. Antimony exceeded background levels at the majority of sample locations in the south septic system, and silver was present close to or above background levels at the same sample locations. It is possible that the elevated antimony and silver are associated with a by-product of the torpedo overhaul process which occurred in Building 325. PCB was detected at 600 ppb (below TBC values) in a soil sample from the north septic system. DDE was detected at 210 ppb in a soil sample from the south septic system. The source of the PCB and DDE is unknown.

No primary drinking water standards were exceeded in the three ground water samples for VOCs or metals. No SVOs, pesticides/PCBs were detected in the ground water. Several VOCs were detected in the overburden ground water in the south septic system. These included 1,1,1 trichloroethane (42 ppb), 1,1 dichloroethene (30 ppb), and 1,1 dichloroethane (1 ppb),

which were present below applicable drinking water standards. Because the soil gas survey and subsurface soil sampling within the septic leaching field did not indicate the presence of significant levels of VOCs, the presence of these solvents in the ground water suggest the potential for an undefined source. It is possible that the source of these solvents is upgradient of this location, in the vicinity of the Torpedo Shop buildings. The former hazardous waste sump, Otto fuel storage tanks, and drum storage are possible sources. Also, due to the density of these solvents, higher concentrations may be present in the bedrock aquifer. Antimony exceeded the USEPA health advisory standard in the ground water (south septic system) by over 20 times. This correlates with the elevated levels of antimony detected in the soils at this site. Because the antimony was present in the upgradient soil sample (7MW1), but not necessarily a background sample, it is unclear if the antimony in the soil/ ground water is related to septic system discharges.

Health and Ecological Risk Assessment: The potential exposure scenario relates to utility repairs/installations within the former septic system area. Based on the relatively low levels of chemicals present at the site, and the health risk calculations made for utility workers at other sites (Area A Landfill, Lower Subase), the health risks associated with this exposure scenario are qualitatively predicted to be negligible. Based on the lack of potable water supply wells for existing and projected future land use in the area, there is no exposure, therefore, no human health risks are associated with the chemical constituents in the ground water. The site is developed, therefore there are no significant ecological risks.

8.1.3.2 Recommendations

It is recommended that this site proceed to the Step II phase of the IR program. Further soil and ground water investigation is recommended at this site to define the source, nature and extent of VOC contamination, and to further address the elevated antimony at this site. No further action is required relative to the septic systems, except as they may relate to the antimony issue. The testing will be in the vicinity of the buildings and at the Otto fuel sump.

8.1.4 Goss Cove Landfill

8.1.4.1 Summary

Background: The Goss Cove Landfill site is located in the southwest portion of NSB-NLON, adjacent to the Thames River. The Nautilus Museum and a paved parking lot are constructed directly over the former landfill. The Nautilus Museum is a submarine museum operated by the Navy and open to the public.

The landfill reportedly operated from 1946 until 1957 and filled in the northern portion of Goss Cove. The southern portion of Goss Cove remains. Incinerator ash, inert rubble, and potentially other unknown materials were disposed at the site.

Nature and Extent of Contamination: A radiation, geophysical, and soil gas survey were conducted. No radiation above background was detected. The geophysical survey identified several suspected buried metal objects, which were avoided during drilling operations. The soil gas survey assisted in defining elevated VOCs in several areas.

Seven subsurface soil samples, four ground water and one surface water sample were collected and analyzed to screen for potential contamination.

The subsurface test boring program indicated that landfill material consisted of sand and gravel with small quantities of brick, glass, ash, wood, and metal. Minor oil stains or sheens were observed in approximately one-half of the borings, indicating some petroleum disposal/spills took place.

VOCs were detected in five of seven soil samples. Xylene was the most prevalent constituent, detected in four samples, indicative of a petroleum product. Trichloroethene and tetrachlorethene were detected in one soil sample each. Petroleum hydrocarbons (benzene, toluene), and tetrachlorethene were detected above TBC values in one soil sample each.

SVOs, predominantly PAHs, were detected at all seven subsurface soil samples, several at relatively high levels. The PAHs are likely associated with the disposal of incinerator ash and potentially associated with the presence of petroleum hydrocarbons.

PCBs or pesticides (predominantly DDT, DDD and DDE) were present individually at all sample locations. All concentrations were below TBC values except for DDT at one sample location. The presence of PCBs and pesticides are likely associated with past landfill disposal.

Many inorganic constituents exceeded established background levels, and exceed TBC values based on TCLP analysis. Arsenic, cadmium, chromium, and lead exceed both background levels and TCLP TBC values. Mercury consistently exceeded background levels at most sample locations. Elevated metals are anticipated to be related to past landfilling activities and, potentially, battery related disposal (lead/cadmium).

The highest levels of VOCs in the ground water were detected in the two downgradient wells. Vinyl chloride or benzene were present individually in the ground water at a downgradient well above ARAR values. Petroleum hydrocarbons detected (which were detected in subsurface soils) included benzene, toluene, ethylbenzene, and xylene; trichloroethene and tetrachlorethene were not present in the ground water. Low levels of SVOs are present in the ground water, primarily the more soluble PAHs, including naphthalene. Naphthalene exceeded the TBC values (USEPA Health Advisory) in a downgradient monitoring well.

Barium exceeded the primary MCL at one well; secondary MCLs were exceeded in all wells for sodium, iron, and manganese. The sodium is related to the brackish water conditions.

Gross alpha and/or gross beta radiation screening values were exceeded in two ground water monitoring wells within the landfill. These elevated readings could be the result of naturally occurring radioisotopes, but further analysis is required for confirmation.

The one surface water sample collected in the Thames River adjacent to the site did not contain VOCs, SVOs, pesticides or PCBs. Inorganic constituent values appear consistent with brackish water. **Copper was present above water quality standards.**

In summary, the levels of VOCs and SVOs in the subsurface soils are having some impact on ground water quality (some slightly above ARARs/TBCs), but overall the concentrations are relatively low. The elevated inorganics in soils, principally arsenic, cadmium, chromium, lead and mercury, are not adversely impacting ground water quality.

Health and Ecological Risk Assessment: Future construction and excavation activities in the parking lot could result in some risk to workers, if proper health and safety procedures are not followed. There is some potential that vapors from within the landfill could enter the museum building, however, this possibility has not been fully investigated. There is also a possibility that children could come in contact with sediments in Goss Cove. At present there are no data on the level of contaminants in these sediments.

Although ground water quality exceeded drinking water standards, no drinking water wells are within the affected area, nor could they be due to the proximity to the brackish Thames River.

Ground water from Goss Cove Landfill discharges to the Thames River. Based on the data presented in this report, a qualitative assessment indicates that contaminant concentrations in ground water at these sites are expected to be below water quality criteria after further dilution in ground water, attenuation due to adsorption to soils, and dilution in the Thames River estuary. Risks to aquatic life due to contaminants in ground water discharge from the site are also expected to be low.

8.1.4.2 Recommendations

It is recommended that this site proceed to the Step II phase of the IR program. Specifically, the following recommendations are provided.

1. Specific worker health and safety provisions are recommended for all future subgrade construction projects at the site. Prior to construction in specific areas, further subsurface investigation should be conducted to characterize the quality/ disposal and health and safety requirements of the material to be encountered. **It should be noted that some utility reconstruction is being designed.**

2. The geophysical survey indicated the presence of buried metal objects at three locations as specified in Section 4.0. Any future planned construction near these areas should include exploratory excavation in these areas to identify construction health and safety requirements.

3. It is recommended that several borings/soil analyses be conducted in the area closer to the Nautilus Museum and remaining Goss Cove. This should be performed in conjunction with indoor air quality measurements within the Nautilus Museum building to assess potential health risks.

4. A quantitative health and environmental risk assessment of the potential impact of the site on the Thames River should be conducted to verify the

qualitative assessment that impacts appear negligible. This would include surface water samples at low tide (ground water discharge) conditions, sediment sampling, and biota survey/sampling along the Thames River and Goss Cove shoreline.

5. Conduct another ground water sampling and analysis round for TCL organics and TAL inorganics to confirm the analytical results. Also, perform specific radiological isotope ground water analysis to determine the source of the radiological constituents (natural or otherwise).

8.1.5 OBDANE

8.1.5.1 Summary

Background: The Over Bank Disposal Area Northeast (OBDANE) site is located in a heavily wooded area on the edge of a ravine northwest of Area A Landfill, and south of the Torpedo Shops. Inspections of this site have indicated the presence of several empty fiber drums in this area. No visual staining or stressed vegetation was observed.

Nature and Extent of Contamination: Five (5) surface soil samples were collected for analysis from this site, from two sample locations, to screen for potential releases at this site. One surface soil sample contained tetrachlorethene at 2 ppb, below the TBC value. No SVOs, PCBs, or pesticides were present. No inorganic compounds exceeded established background levels or TBC levels based on TCLP analysis.

Health and Ecological Risk Assessment: This site appears to pose a negligible risk based on the lack of activity and the low concentration of chemicals.

8.1.5.2 Recommendations

Supplemental Step I investigations are recommended to determine if Step II investigations are necessary or to support a no further action recommendation.

8.1.6 Spent Acid Storage and Disposal Area

8.1.6.1 Summary

Background: This site is located in the southeastern section of NSB-NLON, between the southern side of Buildings 409 and 410. A 4' x 4' x 12' long rubber-coated underground tank was used for temporary storage of waste battery acid around World War II. The tank top is still visible, but has been filled with earth and capped with concrete.

Nature and Extent of Contamination: Seven subsurface soil samples were collected to screen for potential release of battery acids from the subsurface tank. High levels of lead were present in six of seven soil samples based on TCLP analysis. Four samples are classified as a RCRA hazardous waste due to the lead concentrations. These samples were collected at the 0-4 foot depth interval. Several soil samples also had low pH values. The elevated levels

of lead and low pH values substantiate that a release of battery acid likely occurred. The present level of subsurface investigation has not defined the extent and degree of contamination.

Health and Ecological Risk Assessment: The area between Buildings 409 and 410 is scheduled for construction of a new building. There may be some risk to construction or utility maintenance personnel associated with contact with contaminated subsurface soils if they do not follow appropriate health and safety procedures. Based on similar levels of lead at DRMO, and the resulting risk for construction workers (Hazardous Waste Storage Building Construction), the risks at this site to unprotected construction workers could be above acceptable levels. The site is developed, therefore, there are no significant ecological risks.

8.1.6.2 Recommendations

It is recommended that this site proceed to the Step II phase of the IR program. Further subsurface soil investigation is recommended to characterize the extent of contamination in this area for possible remediation. A ground water quality investigation is also recommended to assess potential lead contamination, particularly in light of the low soil pH values, which may tend to make the lead more mobile. Should construction in the area be required, appropriate worker health and safety procedures should be developed.

8.1.7 Former Gasoline Station

8.1.7.1 Summary

Background: The former gasoline station site is located in the roadway and parking area just south of Building 164 (Dealey Center). The gasoline station operated from 1940 to the early 1960s. Several underground gasoline tanks and a waste oil tank existed onsite.

Nature and Extent of Contamination: The geophysical investigation identified the potential presence of one underground gas tank which appears to remain on the site. The soil gas survey did not detect the presence of significant VOC constituents, although organic vapor field measurements of subsurface soil samples indicated levels above background.

Five subsurface soil samples were collected from five test borings to screen for potential releases from the former gasoline station. Only one soil sample, located adjacent to the identified gas tank, contained VOCs. Trichloroethene and benzene were detected below TBC values. No metals exceeded established background concentrations, although three soil samples contained arsenic exceeding the TBC value based on TCLP analysis. The arsenic TCLP results do not appear significant, as arsenic concentrations do not exceed background values based on mass weight analysis.

Health and Ecological Risk Assessment: No risks are identified under existing conditions based on available data. Appropriate health and safety precautions should be followed during tank removal to confirm that no contamination is present. The site is developed, therefore, there are no significant ecological risks.

8.1.7.2 Recommendations

It is not recommended that this site proceed to the Step II phase of the IR program. However, it is unlikely that the potentially identified underground gasoline tank was abandoned in accordance with current requirements (e.g., cleaning/filling with inert material). It is recommended that the tank be removed, and at the time of removal, confirmation soil samples be collected from the tank grave. **Samples should be collected from excavation sidewalls, at a depth just below the tank bottom and at the depth of the ground water table interface.** If no contamination is identified at that time, then no further action would be recommended at this site. **If contamination is detected, corrective actions should be taken in accordance with the underground storage tank regulations.**

8.2 Step II Sites

8.2.1 Area A/OBDA

8.2.1.1 Summary

Background: The Area A Landfill is located in the northeastern and north-central section of NSB-NLON. It is approximately seven acres in size. Access is via a dirt road off Wahoo Avenue. The Area A Landfill is a relatively flat area bordered by a steep, wooded hillside that rises to the south, a steep wooded ravine to the west, and the Area A Wetland to the north. Aerial photographs show that the landfill appears to have extended east along the wetland to as far as the present position of the tennis courts. Runoff from the landfill drains as overland flow north into the Area A Wetland, which subsequently discharges to the Area A downstream watercourses and into the Thames River.

The landfill opened sometime before 1957. The base incinerator ceased operating in 1963, and from 1963 to 1973 all wastes were disposed in the landfill unburned. During this time, all non-salvageable materials generated by the submarines and base operations were disposed in the Area A Landfill.

Landfilling operations ceased in 1973. After closure, a concrete pad was constructed in the southwest portion of the landfill for above ground storage of industrial wastes. At the time of the IAS survey, 42 steel drums, 87 transformers (mineral and PCB), and 60 to 80 electric switches were stored on the pad. Two transformers and several electrical switches were leaking. Past leakage of oil was also evident. Most drums were stacked on wooden pallets and those having PCB labels were covered and bound with plastic sheeting. All of these materials have since been properly disposed offsite.

Sand bags and contractors' supplies and equipment have, in recent years, been stored over the former landfill. Several transformers, removed underground storage tanks, crane weights, and other equipment are stored on the concrete pad in the southwest portion of the landfill. The specific items stored in this area vary. The remainder of the landfill is not paved.

The construction of a paved parking lot on the southeast end of the Area A Landfill was planned, but has been delayed indefinitely.

The **Area A Wetland** abuts the north side of the landfill and is approximately 30 acres in size. The maximum wetland sediment thickness is approximately 35 feet, based on boring information. Until 1957, this portion of the site was undeveloped, wooded land. In 1957, dredge spoils from the Thames River were pumped to this area and contained within an earthen dike that extends from the Area A Landfill to the south side of the Weapons Storage Area. Atlantic learned during the course of this study that, previously, pesticide "bricks" were placed on the wetland ice during winter and allowed to melt and discharge into the wetland for mosquito control.

Several construction projects are planned for the Weapons Storage Facility at the north end of the Area A Wetland. The facility was constructed partially on the dredged fill material and settlement has occurred in several areas. Routine maintenance and security improvements that are planned include grouting and waterproofing bunkers, repaving roads, and the installation of culverts and regrading associated with these activities. The Navy also plans to build more magazines and bunkers in this area within ten years.

The **Area A Downstream Watercourses** drain the Area A Landfill and Wetland and ultimately flow into the Thames River. The Area A Downstream Watercourses include North Lake and several small streams which discharge from Area A and the Torpedo Shop and ultimately discharge to the Thames River.

Ground water also discharges from Area A to a small wetland at the base of the dike and the Over Bank Disposal Area site. A stream flows from this wetland west toward North Lake, a recreational swimming area for Navy officers. Under normal flow conditions, the stream enters a culvert which bypasses the pond and discharges to a stream below the outfall of the pond. This stream flows west under Shark Boulevard and through the golf course to the Thames River. There is a manhole adjacent to North Lake, that connects to another pipe, which was designed to discharge overflow water from North Lake. Under substantial runoff conditions, however, it is possible that some water discharges to the pond from this stream.

Further development is not planned for this area.

The Over Bank Disposal Area (OBDA) is located on the slope of the dike below and adjacent to the Area A Landfill. A small wetland exists at the base of the dike.

This area was a disposal site after the earthen dike was constructed in 1957. In 1982, it was the finding of the previous studies that the material had been there for many years and included 30 partially covered 200-gallon metal fuel tanks and scrap lumber.

Atlantic personnel inspected the site in September 1988, and observed approximately 30 empty, unlabeled 200-gallon tanks, old creosote telephone poles, several empty unlabeled 55-gallon drums, and rolls of wire. Bright orange, organic sediments were observed in the water discharging from the base of the dike embankment, apparently leachate from the landfill.

Area A Landfill - Nature and Extent of Soil Contamination: A radiation, geophysical and soil gas surveys were conducted. No radiation above background was detected. The geophysical survey identified several suspected buried metal objects, which were avoided during

drilling operations. The soil gas survey detected VOCs, predominantly petroleum hydrocarbons, in the deployed parking area.

VOC concentrations in the subsurface soil within Area A Landfill are generally low. No TBC values for VOCs in soil samples were exceeded. One surface soil sample collected near the concrete storage pad did contain elevated levels of petroleum hydrocarbons. SVOs, principally PAHs, were detected at relatively low levels in some of the landfill subsurface soil samples. The results of the SVOs analyses at Area A Landfill are significantly lower than at the DRMO and Goss Cove former landfill sites. The organic results, in general, do not indicate significant disposal of organic chemicals within the Area A Landfill.

No PCBs were detected in the subsurface soils within Area A Landfill. One surface soil sample contained PCBs above the TBC concentration of 10,000 ppb. This soil sample was collected adjacent to the concrete storage pad where drum storage, PCB transformers, and electric switches were once stored. The potential extent of the PCBs in this area was not defined based on the two surface soil sample locations.

Pesticides were detected at three subsurface sample locations (2LMW7S, 2LMW8S, and 2LMW18S) at Area A Landfill. DDTR were detected at these locations at relatively low concentrations and are below TBC values. The DDT was present above the TBC value of 500 ppb at one surface soil sample near the concrete storage pad.

Out of the 12 subsurface samples analyzed by TCLP analysis procedures, ten contained one or more metals exceeding TBC values. Metals exceeding TBC values included arsenic, cadmium, lead, and selenium. TCLP hazardous waste characteristic values were not exceeded for any samples. Some inorganic constituents exceeded established background levels based on mass weight analysis, including beryllium, cadmium, lead, and mercury. Other metals exceeding background levels included copper, nickel and boron. The majority of these elevated metals are likely related to a past landfill disposal.

The lead and cadmium values are generally low, and are not indicative of the existence of a significant source such as the reported historical battery acid disposal in this area. Levels of cadmium, and particularly lead, were much higher at the Former Acid Storage and Disposal Site and DRMO, where battery acid storage tanks existed.

Area A Wetland - Nature and Extent of Soil and Sediment Contamination: VOC concentrations in the subsurface soil and sediment within Area A Wetland are in the low to moderate range. VOCs are generally spatially distributed throughout the wetland area and generally present at uniform concentrations with depth. This is consistent with the origin of the sediments, from the Thames River dredge materials, deposited in the wetland. VOC TBCs exceeded included benzene (one sample), trichloroethene (three samples) and tetrachloroethene (four samples). The source of the VOCs in the wetlands subsurface soils would appear to be associated with sediments originally contained from the Thames River, and/or absorption of ground water chemicals onto the sediments. The origin of the VOCs in the sediments could be from several sources, including those mentioned above, runoff from the Weapons Center, and

general urban runoff. The samples collected near the landfill did not contain any VOCs above TBC values.

SVOs, principally PAHs, were detected at generally low levels in most of the wetland sediment and subsurface samples. Overall SVO concentrations were slightly higher in the 0-2 and 10-22 feet reporting intervals, although this may be attributable to the smaller number of samples collected in the 2-10 foot interval. The highest concentration of SVOs was detected within a drainage swale at a stormwater discharge location of the Weapons Center. The Verification Study sediment sampling of another stormwater culvert discharge location near the Weapons Center also indicated the presence of PAHs. Sediment samples recently collected from the Thames River also contain low levels of PAHs, consistent with the levels in the Area A Wetland.

PCBs (Arochlor 1260) were detected at two sample locations, but were below the TBC value. The source of the PCBs in the wetland near the landfill appears related to transport of contaminated surface soils from Area A Landfill. The source of the PCBs detected at the Weapons Center is unknown.

Pesticides (DDTR) were detected at five sample locations in the 0-2 foot reporting interval. Based on detection in the 0-2 foot interval, these appear to be related to the past reported surface application of pesticides at the wetland area. The pesticide detections were less frequent and the concentrations much less than for the samples from the Area A downstream watercourses. This may be related to the potential for higher concentration of pesticides present at locations not sampled (pesticide bricks were reportedly applied at point locations), and/or due to compositing of the samples. This may be supported by previous sediment sampling conducted within the wetland near its outlet and at an upgradient location (east side), which contained DDTR in the 17,000 ppb range. Alternatively, it could indicate more substantial application of pesticides in the downstream watercourse area.

In general, metal concentrations within the wetland subsurface soil and sediment samples were low. A total of 35 soil and sediment samples were collected within the wetland proper, with the remainder collected at adjacent locations. Several samples contained slightly elevated levels of lead (7), mercury (3), cadmium (1), and silver (2). Several samples exceeded TBC values based on TCLP extraction procedure. These included arsenic, cadmium, chromium, lead, selenium, and silver. Only two samples had metal values (lead, silver) which exceeded both established background concentrations and TBC values based on TCLP analysis. The elevated metals are likely associated with the origin of the sediment from the Thames River. Cyanide was detected at the drainage outlet from the Weapons Center. The previous Verification Study also reported cyanide at another surface water discharge location from the Weapons Center. These detections of cyanide, and the elevated PAHs, suggest a possible source of contaminants at the Weapons Center. The elevated levels of cyanide and PAHs suggest that spent Otto fuel may be the cause of this contamination, however, the specific source is unknown.

Area A Downstream/OBDA - Nature and Extent of Soil and Sediment Contamination: The subsurface soil samples were collected at well locations which were in wooded undeveloped areas where no past disposal was reported or apparent. The exception was

3MW12S, which was located adjacent to the wetland at the Over Bank Disposal Area, where past disposal is evident.

Trichloroethene (24 ppb) and tetrachloroethene (58 pp) were detected at a subsurface soil sample location near North Lake, both of which are above TBC values of 5 ppb. Low levels of toluene and 1,1-dichloroethene were also detected. The source of the solvents detected near North Lake is unknown. One possibility is an unconfirmed report from a retired Navy employee who stated that there was a past disposal area in this general vicinity. This could not be confirmed based on review of aerial photographs and discussions with other Navy personnel.

No SVO compounds were detected in subsurface soils, except for low levels of phthalates at one sample location. Low levels of SVOs, principally PAHs, were present in a subsurface soil sample at OBDA, which correlates with SVOs detected in the sediment samples at OBDA.

No PCBs were detected in the subsurface sample points. Pesticides, DDT and its derivatives, were detected in a subsurface soil sample near OBDA and at a sample near North Lake. The detection of pesticides at these locations appears related to past pesticide application in Area A. No significant detections of inorganics were noted in the subsurface soil samples.

Twenty-three sediment samples were collected for analysis from the OBDA wetland, the Area A downstream watercourses and associated ponds, and North Lake. The purpose of the sediment sampling and analysis programs was to assess the extent of sediment contamination (principally pesticides) within this area, due to past application and sediment transport from potential source areas. Previous analysis of sediments in this area indicated the presence of pesticides and metals.

No VOCs were detected above TBC values for samples collected. At sample locations near the outlet of Area A wetland, low levels of VOCs (methylene chloride, trichloroethene) were detected, indicating some limited migration of VOCs via sediment transport from Area A wetland. Within OBDA, all sediment samples contained low levels of VOCs, but below TBC values. VOCs detected include methylene chloride, 2-butanone (methyl ethyl ketone), tetrachloroethene, toluene, ethylbenzene, and xylene. This indicates that some past releases of solvents and petroleum hydrocarbons occurred at the OBDA site. These VOCs could also be partially attributable to adsorption of chemicals to the sediments from ground water. Low to moderate levels of SVOs were detected in most sediment samples.

The only detection of PCBs was at 2DSD12, which is at the outlet of the downstream watercourse, at the Thames River, adjacent to DRMO. Based on the elevated levels of PCBs at the DRMO site, it appears likely that this is associated with surface water runoff from the DRMO site and not Area A.

Pesticides (DDTR) were detected at moderate to very high concentrations within the Area A downstream watercourses and ponds. No pesticides were detected in the North Lake sediments. The TBC value was exceeded at ten of the 23 sample locations. The highest concentrations were detected in the two ponds below the Area A dike, and within the OBDA sediments. Based on these concentrations being much higher than those found within Area A wetland, this may be due to pesticides application rather than sediment transport. High

concentrations in these areas suggest that substantial quantities of pesticides were applied in this area. Lower concentrations downstream of these areas and extending to the Thames River are likely attributable to sediment transport from the higher concentration areas. The data indicates that some ongoing migrations of pesticides, due to sediment transport, to the Thames River is occurring from the pond source areas.

Several metals were detected above established background levels. These occurred in samples closest to the Area A wetland area. They included beryllium, cadmium, lead, selenium, zinc and boron. Cadmium was not detected above background levels in the Area A wetland sediments, therefore, the cadmium source does not appear to be related to sediment transport from the wetland. No metals were detected above background levels in North Lake sediments.

Ten sediment samples were collected from the OBDA area. Sediment samples contained metals above established background levels for cadmium (3), iron (2), lead (4), selenium (2), and zinc (2). Cadmium results based on TCLP analysis correlated with mass weight analysis for two samples. TCLP analysis detected no lead. The elevated iron concentration may partially explain the rust colored leachate that is visible in this wetland area and within the stream bed. The lead and cadmium may suggest battery/battery acid disposal in this area, which were the highest concentrations recorded throughout Area A. Alternately, it could be related to the cadmium present in the ground water at this location, and adsorption onto the sediments as it discharges to OBDA.

Area A - Nature and Extent of Ground Water Contamination: Twenty-eight ground water monitoring wells were installed and sampled within Area A, which includes the landfill, wetland, and downstream areas. Eleven were water table overburden wells and 17 wells were installed and screened in the bedrock aquifer.

VOCs were detected in only six of 28 monitoring wells within Area A. Of the six, only three locations exceeded TBC/ARAR values for drinking water. The solvent trichloroethene was detected above drinking water standards (ARARs) at 2LMW13D (10 ppb) at the west end of the landfill, and 2DMW16D (17 ppb) upgradient of North Lake. These are both bedrock wells. This suggests a low concentration plume of solvents within the bedrock aquifer extending from the western portion of the former landfill downgradient to the North Lake area. The ground water does not appear to discharge to North Lake, based on the vertical head gradient information at 2DMW16S&D. The plume appears to be fairly narrow, as no solvents were detected in the Area A downstream wells to the north. This is supported by review of the ground water specific conductivity data which is used as a landfill leachate indicator. Solvents were not detected in downgradient well 3MW12D (OBDA), suggesting preferred fracture flow is occurring in the bedrock aquifer. However, this does not correlate with the cadmium data, which indicated elevated levels of cadmium at 2LMW13S and 3MW12D. The downgradient extent of the solvent plume is undefined, which is flowing in a westerly direction. Benzene was detected at 10 ppb, above drinking water standards (5 ppb) at 2LMW18S, which may be related to the parked vehicles in this area; it was not detected in any other well in Area A.

Overall, the VOC concentrations for those wells where detected are low, given the historical use of Area A as a landfill. Although drinking water ARAR/TBC values are exceeded in three wells, the results do not indicate any significant ongoing release of VOC contaminants.

Based on the soil gas and subsurface soil data, low levels of petroleum hydrocarbons and solvents are present throughout much of the Area A landfill area. This suggests a generally uniform-low level of soil contamination within the landfill, and no substantial source area. The deployed parking area and adjacent area to the east (also used for automobile storage/parking) exhibited the most uniform level of petroleum hydrocarbons based on soil gas data.

PCB was detected in the ground water at one location within the landfill. The concentration exceeded its solubility and further sampling of the well would be required for confirmation of the result.

Cadmium was the only inorganic compound which exceeded primary drinking water standards (ARARs) within Area A. Cadmium was also detected in one instance above drinking water standards at a residential well located east of Area A. Cadmium was detected above the 5 ppb drinking water standard at **2LMW18D (7.2 ppb), 2WMW3D (7.7 ppb), 2WMW5S (6.4 ppb),** 2WMW3S (10.6 ppb), 2LMW18S (29.1 ppb), 2LMW13D (44.8 ppb), and 3MW12D (16 ppb). The source of these elevated levels of cadmium may be related to soils within the landfill and, possibly, OBDA. However, cadmium soil concentrations in the landfill only exceeded established background levels at one sample location (2LMW8S). It is possible that higher concentrations of cadmium exist in the landfill, at locations other than the sample points. Dissolved cadmium levels in Area A ground water may be partially attributable to low pH values for some wells. The upward ground water vertical head gradient within most of the landfill should minimize the transport of cadmium to the bedrock aquifer from an apparent landfill source. However, at bedrock well 2LMW13D, where there is a strong upward vertical head, the cadmium is present in the bedrock system, from a source either upgradient within the landfill, or another unknown upgradient source. The former Weapons Center is upgradient of this area along Wahoo Avenue, however, the lack of elevated levels of cadmium in other nearby bedrock wells (2LMW9D, 2LMW17D, and 2LMW14D) does not strongly support an offsite source, but rather a landfill source.

The overburden ground water flow along the central and eastern portion of the landfill is toward the wetland, and along the western portion of the landfill to the northwest, down the Area A downstream watercourse valley. Therefore, the cadmium ground water contamination appears confined to the landfill and the OBDA area. Cadmium was only detected in well 3MW2D in the OBDA, suggesting a potential confined plume to the northwest although, due to preferred bedrock flow patterns, other wells may not have intercepted the cadmium and, therefore, the cadmium plume may be undefined.

Of importance to this study is the direction of bedrock ground water flow in this area, due to the detection of cadmium in several offsite residential wells to the east of Route 12. Inspection of the bedrock ground water contour map indicates that the residential wells along Route 12, Baldwin Hill Road and North Pleasant Valley Road are upgradient of Area A, and would not be affected by conditions at the site. Most of these wells had bedrock ground water elevations substantially higher than wells containing cadmium in Area A (2WMW3D, elevation 76 feet). However, residential wells near the NSB-NLON east gate, southeast of Area A, had bedrock water elevations (75-80') in the same range as 2WMW3D, the closest bedrock well in Area A. Therefore, based on the available data, it is indeterminate if these wells are upgradient

or downgradient of the western portion of the Area A Landfill, however, cadmium does not exceed drinking water standards in these wells.

Iron and manganese exceeded secondary drinking water standards in many Area A wells. The results for 2WMW1D and 2WMW2D (upgradient wells) and the residential well analytical results were much lower for iron and manganese, which indicates a source of these inorganics within the Area A landfill material and wetland sediments.

Radiological screening parameters were exceeded in nine of the 20 samples. These occurred at three within the landfill area; one near the Weapons Center; and four within the Area A downstream area. These elevated readings could be the result of naturally occurring radioisotopes which do not meet the gross screening criteria. Further sampling and analysis is required for confirmation.

Residential Well Analytical Results: A residential well sampling and analysis program was conducted to assess ground water quality in offsite areas near Area A.

The first round sampling indicated low levels of chloromethane, methylene chloride, and xylene at OSW15 (16 Sleepy Hollow), but below drinking water standards. This well was resampled for VOCs in the second round and none were detected. The first sampling round indicated the presence of cadmium at OSW6 (1458 Route 12) above primary drinking water standards (10 ppb) at a concentration of 26.3 ppb. Other compounds (iron, manganese, aluminum and sodium) were detected in other wells which exceeded secondary drinking water standards, and are attributable to natural ground water conditions.

Due to the presence of cadmium, second **and third** sampling rounds **were** conducted to expand the sampling program to areas east of Area A on Route 12, North Pleasant Valley Road, and Baldwin Hill Road. The second **and third** sampling rounds did not detect any metals above primary drinking water standards. Also, cadmium was not detected at 1458 Route 12, where it was previously present. Cadmium was detected at low levels at five of 13 wells sampled in the 2.1-3.1 ppb range, below the 10 ppb standard. As previously discussed, an assessment of the ground water hydrogeology of this area indicates that the presence of cadmium in the offsite residential wells is not attributable to the detection of cadmium within Area A at NSB-NLON, with the possible exception of well OS25 to the southeast, which contained cadmium below standards, but could be downgradient of Area A Landfill.

The cadmium detected within the residential sample area appears to be a natural background concentration in the ground water. A further round of residential well sampling is planned to further confirm the analytical results.

Boron was found in all residential wells above the TBC value of 600 ppb, which is based on an EPA health advisory. Concentrations of boron ranged from 770 to 2,000 ppb. The source of this boron is unknown.

Nature and Extent of Area A Surface Water Contamination: Fifteen surface water samples were collected within Area A, including the wetland, downstream areas and Thames River. These samples were collected to assess the surface water quality.

Low levels of VOCs were detected at several sampling points 2DSW5, 2DSW7, 2DSW8, 2DSW12, and 2DSW13. Except for one sample, constituents detected are petroleum hydrocarbons and could be associated with runoff. One sample near Triton Avenue contained 3 ppb of tetrachlorethene and 2 ppb of styrene. No ARARs or TBCs were exceeded for the VOCs. No SVOs were detected at any of the sampling locations.

No pesticides or PCBs were detected at any of the sampling points except for 2DSW4, which contained 1.9 ppb of DDD. This sample is in the area where high levels of DDTR, including DDD, were detected in sediments. It is likely that the origin of DDD in the surface water is from the sediments.

ARARs/TBCs for inorganics were exceeded at several sample locations for cadmium (3 of 15), copper (15 of 15), iron (11 of 15), lead (11 of 15), manganese (13 of 15), zinc (14 of 15), and mercury (1 of 15). These ARARs are based upon in-stream water quality criteria and standards to protect aquatic life and may not be appropriate to the wetlands and small drainage streams. The presence of iron and manganese in surface water may be a result of the low pH and reduced conditions created by the Area A Landfill. Some of the iron and manganese may originate from wastes, however, the majority of what is detected in surface water is probably being leached from native soils. Of note are the ARAR exceedances in the Thames River at sample locations 2DSW12 for manganese and iron, and at 2DWS13 for manganese. Area A upstream surface water samples also contained elevated levels of iron and manganese, whereas surface water samples in the Thames River at DRMO and Goss Cove did not contain levels above ARARs. The iron standard of 1000 ppb is based on chronic aquatic toxicity water quality criteria and the manganese standard is based on water quality criteria for human health risks from fish consumption.

Copper and zinc, which exceeded water quality criteria or standards, were also detected in concentrations above background in soils at the Area A Landfill soils. It is assumed that the elevated concentrations originate from the Area A Landfill.

Cadmium and lead are present above ARARs and levels normally seen in natural surface waters and are present both in the Area A wetlands and landfill soils and sediments. The presence may be the result of historical disposal activities. However, cadmium and lead were also detected in the upgradient sample location (2LSW1) above ARARs.

Mercury was only detected in one surface water sample (2DSW9). This location (adjacent to Triton Road) is immediately downgradient of two sediment sampling locations where mercury was found. Although these two sediment mercury concentrations were below background, mercury was not detected in any other sediment samples. There was one occurrence of mercury above background concentrations in Area A Landfill soils. Mercury is rarely found in natural surface waters above 1 ppb. The source of the mercury in sediments is not apparent, however, historical disposal in Area A Landfill is possible. However, it is more likely that a past release upgradient of sample locations 2DSD7 and 2DSD8 along Triton Road occurred. It is noted that sediment sample 7SD1, within a runoff swale from the Torpedo Shop, contained no mercury, nor did any other soil or ground water sample at the Torpedo Shop, which implies that the Torpedo Shop is not the source.

All of the radiological results were below ARAR screening values.

Human Health Risk Assessment: Several identified exposure pathways were evaluated for Area A. They are listed as follows:

- Workers repairing utilities within Area A;
- Weapons Center personnel exposed to fugitive dusts from Area A Landfill;
- Workers moving pallets within Area A Landfill;
- Navy personnel exposed to fugitive dust while engaged in recreational activities near Area A Landfill;
- Groton/Ledyard residents exposed to fugitive dust from Area A Landfill;
- Citizens attending car auctions at Area A Landfill;
- Subase children exploring woods within Area A;
- Subase children exploring streambeds and Area A Wetland; and
- Children swimming in North Lake.

Negligible or *de minimus* risks were calculated for workers repairing utilities within Area A, Weapons Center personnel exposed to fugitive dust, Navy personnel exposed to fugitive dust while engaged in recreational activities, citizens attending car auctions, and children swimming in North Lake.

The following exposure scenarios did exhibit risks which fell within the one in one hundred thousand to one in one million excess cancer risk range:

- Workers moving pallets within Area A Landfill (risk due to presence of PCBs in landfill surface soils);
- Subase children exploring woods within Area A (risk due to PCBs in landfill surface soils); and
- Subase children exploring streambeds and Area A Wetland (risk due to pesticides in stream sediments).

Ground water within Area A contains VOCs and cadmium above ARAR and TBC drinking water standard/guidance values, indicating a potential health risk if the water were to be consumed. No potable water supply wells exist, or are planned by the Navy, in the potentially affected downgradient area. The Navy owns the land within the potentially affected area. Therefore, under existing and projected future land use conditions, no exposure pathways exists for human consumption of degraded ground water.

Ecological Risk Assessment: The ecological risk assessment addressed risks to a variety of trophic levels in the terrestrial and aquatic food chain in Area A. On the lower level of the food chain, risks to plants were low. Plants are unlikely to accumulate organic compounds to a great degree. Metals concentrations in soils and sediments were, in general, below levels that may adversely affect plants or higher trophic level organisms that feed on plants. However, cadmium concentrations in soil samples from the OBDA exceeded recommended levels protective of plants and organisms consuming plants.

Risks to terrestrial organisms due to DDTR in soil were greatest for soil invertebrates in the OBDA. The risks to soil invertebrates in the wetland and downstream areas due to contaminants were low.

The assessment indicates that DDTR in sediments of streams and ponds in the Downstream Watercourse Area poses a potentially great risk to biota. Organisms with the greatest exposure to DDTR contaminated sediments are benthic invertebrates. Frogs are also directly exposed to sediment during winter months. Other organisms potentially affected by these sediments are fish, if they are present in the ponds. Birds such as ducks, heron, and mammals such as raccoons and otter, may be exposed to DDTR by feeding on contaminated aquatic invertebrates and frogs, but this exposure will only account for a small part of their diet because they are likely to feed over a much greater geographical area than Area A.

Higher level organisms in the food chain may be exposed to the DDTR and, to a lesser extent, to PAHs bioaccumulated in soil invertebrates. The greatest potential risks are to small mammals such as the shrew that consume a diet consisting mainly of soil invertebrates at a rate equivalent to their body weight per day. Based on the assumption that they consume only contaminated soil invertebrates, there are potential risks to these animals. Risks to herbivorous birds and small mammals are much smaller than for the maximally exposed shrew since they have much less exposure to DDTR. Based on the low body burdens of DDTR in catbirds collected from Area A, risks to birds feeding on soil invertebrates appear to be low. This may be because the area they feed in is large in comparison to the portion of the OBDA with elevated levels of DDTR in soil.

The aquatic organisms in Area A at greatest risk are those exposed to elevated levels of DDTR in pond and stream sediments in the Downstream Watercourse Area. Therefore, benthic invertebrates and possibly frogs are at greatest potential risk. DDTR contaminated sediments have been transported by the streams in the downstream portion of Area A to the Thames River. However, DDTR concentrations and, therefore, potential risks due to DDTR are much lower at the stream outfalls than upstream.

8.2.1.2 Recommendations

It is recommended that this site proceed to the Feasibility Study phase to address the health and ecological risks identified. Additional data is recommended to be collected concurrent with the Feasibility Study to further assess several site conditions for input to the FS. Recommendations and data requirements are provided below.

Landfill Soils

- Further soil sampling is recommended around the Area A concrete pad (former hazardous waste storage area) to define the full extent of contamination identified in that area.

Wetland Sediments

- Further sediment sampling is recommended in the Area A Wetland to confirm the relatively low levels of pesticides detected compared with Area A Downstream sediments. Sampling in the pond and open water area near the wetland outlet is also recommended. These data are required for the Feasibility Study and further ecological assessment. The pond information would better allow assessment of risks to biota in these areas and to compare measured body burdens of DDTR in frogs from the wetland pond to sediment DDTR concentrations.

Ground Water

- Conduct another ground water sampling and analysis round for TCL organic and TAL inorganic parameters to confirm the analytical results. Also, perform specific radiological isotope ground water analysis to determine the source of the radiological constituents (natural or otherwise).

- The extent of VOC and cadmium ground water contamination in Area A Downstream should be defined and monitored.

- Further assessment of the ground water flow direction in the area of the southeastern portion of the landfill is required with respect to the homes served by private wells near NSB-NLON east gate. This would require the installation of additional monitoring wells in this area, and surveying the elevation of the water in the private wells.

Residential Wells

- **A further investigation of the sources of boron in residential wells is recommended.**

Weapons Center

- Further assessment of the source of elevated levels of cyanide and PAHs adjacent to the Weapons Center is recommended.

North Lake

- Surface soil sampling around the North Lake area is recommended to determine if contamination is present due to past pesticide application in the

general area. This is recommended to assure the safety of use of North Lake as a recreational area. Continued monitoring of North Lake is recommended should the lake remain open for public use. Should the lake remain open, access to the downstream watercourse areas should be restricted.

- **Long-term ground water elevation monitoring is recommended in this area to better determine ground water flow directions.**

- **The overflow pipe from North Lake to the stream which flows to the south of North Lake will be eliminated to prevent the possibility of water from the stream discharging into North Lake.**

Downstream Watercourses and Pond

- The ecological assessment was based on a limited number of surficial soil samples from the Area A Downstream Watercourse Area. At the time of designing the sampling program, it was unknown that DDTR levels would be the most elevated in this area. To gain a greater level of confidence in this assessment, we recommend additional surficial soil sampling and analysis in the downstream watercourse area.

- Additional information is required on biological conditions in the Area A Downstream Watercourses where elevated levels of DDTR were detected in pond and stream sediments. No biota sampling was performed in these areas. The assessment predicts risks to benthic invertebrates and possibly to frogs in these areas. To supplement this assessment with actual field data, additional field work is recommended to assess the biological community in the ponds and streams where DDTR was detected at elevated levels in sediments.

Thames River

- Pesticides are being transported to the Thames River. Although the levels in the river sediments detected to date are not high, further delineation is recommended to further evaluate this condition. Manganese has also been detected in the Thames River surface water samples at the outlet of Area A in concentrations above water quality criteria. In light of these facts, further ecological assessment of the Thames River, similar to that recommended at Goss Cove, DRMO, and Lower Subase is recommended to provide greater assurance regarding the current assessment of ecological risks. This assessment should consider the potential cumulative effects of NSB-NLON on the river.

8.2.2 DRMO

8.2.2.1 Summary

Background: The Defense Reutilization and Marketing Office (DRMO) site is adjacent to the Thames River in the northwest section of NSB-NLON. The DRMO is the storage and collection facility for items to be sold at auction sales held periodically through the year. Scrap metal is also temporarily stored prior to being transported off this site.

The DRMO site was used as a major base landfill and burning ground from 1950 to 1969. The materials burned and landfilled included construction materials, combustible scrap, and other non-salvageable waste items. These materials were reportedly burned on the shoreline, and disposed over the riverbank and partially covered. Also, a former battery acid handling facility was located adjacent to Building 491. An in-ground rubber-lined tank and associated pumping facilities were present, similar to the Spent Acid Storage and Disposal Area site.

DRMO operations at this site, after the closing of the landfill, include storage of various items, including submarine batteries, white goods, and empty drums.

Future plans for this site include the construction of a Conforming Storage Facility for the temporary storage of hazardous waste generated at NSB-NLON. Other routine grading and minor excavation occurs in the northern portion of the site.

Nature and Extent of Contamination: Radiation, geophysical and soil gas surveys were conducted. No radiation above background was detected. The geophysical survey identified several suspected buried metal objects, which were avoided during drilling operations. The soil gas survey assisted in defining VOCs in several areas.

Twenty-four soil samples were collected, from 12 test boring/monitoring well locations. Four surface soil samples were also collected. Six ground water samples were also collected and analyzed. These samples were analyzed to define the nature and extent of contamination at the former landfill site.

Some evidence of the former landfill was encountered during the drilling, including wood fragments, brick, metal, but predominantly earth fill material. The depth of fill varied from zero to eight feet.

VOC concentrations in soil at DRMO are generally low. However, many soil samples exceed TBC values for VOCs. Elevated VOCs were detected at 6TB4 (6-8'), where the following was found: vinyl chloride (1300 ppb), trichloroethene (20,000 ppb), and tetrachlorethene (210 ppb). The contamination appears to be generally isolated at the site based on results of the soil gas survey and other soil samples collected in this area.

SVOs were present in most samples collected in the former landfill area. The SVOs were predominantly comprised of PAH compounds, many of which were at elevated levels. The spatial density of the sample locations indicates that PAHs are likely present throughout the

DRMO site limits. Based on the former use of the site as a landfill, and an area where material was burned, the PAHs are likely a result of incomplete combustion and, perhaps to a lesser degree, due to petroleum releases.

PCB Arochlor 1260 is present at almost all sample locations except 6MW5S (background), and 6MW1S and 6MW2S (rear of office and storage building). Concentrations range from 52 ppb to 12,000 ppb. It is generally present in both the 0-2' and 2-6' depths. The presence of PCBs at this site is most likely associated with scrap metal storage (e.g., white goods) and associated capacitor leaks, and past storage of transformers, and not necessarily due to landfill disposal. PCB (Arochlor-1260) was also detected at sediment sample location 2DSD12, at the outfall of the storm drainage system from Area A, to the rear of Building 397 at DRMO. It was not present in other upgradient sample points along the Area A downstream watercourses, and may be a result of surface soil transport via surface water runoff from DRMO.

Pesticides were detected at one sample location at elevated concentrations; no other pesticides were detected at other sample locations. Total pesticide concentration was 57,800 ppb, consisting of DDT, DDD and DDE. The DDT concentration was detected above the TBC value. Due to pesticide detection at only one sample location and at a depth of 2-6 feet, it was likely associated with past landfilling rather than application.

Out of 24 samples analyzed for TCLP metals, 21 contained one or more metals exceeding TBC values. Metals exceeding TBC values included barium, cadmium, chromium, lead, mercury and silver. TCLP hazardous waste characteristic values were exceeded for lead (5 ppm) at 6MW3S (2-4') 52 ppm, at 6TB5 (2-6') 32 ppm, and at 6SS3 (0-0.5') 6.2 ppm. Lead values were generally elevated around Building 491 (former battery acid handling), indicating battery acid releases occurred in this area. Many inorganic constituents exceeded established background levels based on mass weight analysis. These included antimony, beryllium, cadmium, cobalt, copper, lead, mercury, nickel, zinc and boron. The majority of these elevated metals are likely related to a combination of past landfill disposal and scrap metal storage.

No petroleum hydrocarbons were detected in the ground water samples. Trichloroethene and 1,2 dichloroethene were present in three downgradient wells (6MW2S, 6MW3S, and 6MW4S). Trichloroethene exceeded the ARAR value (5 ppb) with a concentration of 8 ppb at well 6MW4S. The primary source of the solvents in the ground water, based on the soil analytical results and the soil gas data, is projected to be in the area of 6TB4, 6MW4S, 6TB6 and 6TB7.

No SVOs, PAHs, pesticides or PCBs were detected in any wells at the DRMO site. Low levels of phthalates and benzoic acid were detected in the upgradient well 6MW5D. The inorganic ground water analysis results indicate that selenium exceeds the primary drinking water standards (ARARs) at wells 6MW2S, 6MW3S, and 6MW4S. The cause of the selenium levels in the ground water is unclear, but appears to be site related. Radiological screening values were exceeded in two of the ground water sample locations for gross beta. The elevated readings could be the result of naturally occurring radioisotopes which do not meet the regulatory screening criteria, but further analysis is required for confirmation.

No VOCs, SVOs, pesticides, or PCBs were detected in the upgradient surface water sample. Comparison of the inorganic results for this sample with the downgradient water sample (Goss Cove) did not suggest any detectable impact on the Thames River from NSB-NLON based on this limited data set.

Human Health Risk Assessment: Several identified exposure pathways were evaluated for Area A. They are listed as follows:

- Citizens attending auctions and public sales at DRMO;
- Navy workers sorting scrap metal;
- Workers repairing/installing utilities;
- Construction of a Hazardous Waste Storage Facility; and
- Exposure to fugitive dust from DRMO.

Negligible or *de minimus* risks were calculated for Citizens attending auctions and public sales, Utility workers repairing/installing utilities, and Exposure to fugitive dust from DRMO. The following exposure scenarios did exhibit risks which fall within the one in ten thousand and one in one million excess cancer risk range:

- Navy workers sorting scrap metal (risk due to PCBs, PAHs, and beryllium in surface soils); and

- Construction of a Hazardous Waste Storage Facility (risk due to elevated level of lead at northern portion of site).

Although ground water quality exceeds drinking water standards, no drinking water wells are within the affected area, nor could they be due to the proximity of the brackish Thames River.

Ecological Risk Assessment: Ground water from this site discharges to the Thames River. Based on the available data, contaminant concentrations in ground water are predicted to be below water quality criteria after further dilution in ground water, attenuation due to adsorption to soils, and dilution in the Thames River estuary. Risks to fish due to contaminants in ground water discharge from these sites are expected to be low.

8.2.2.2 Recommendations

It is recommended that this site proceed to the Feasibility Study phase. In the interim, specific health and safety provisions are recommended for all future subgrade construction projects at the site. Prior to construction in specific site areas, further subsurface investigation may be required to characterize the quality, health and safety, and potential disposal requirements of the material. The geophysical survey indicated the presence of buried metal objects at three locations as defined in Section 4.0. Any future construction planned near these areas should include exploratory excavation to identify health and safety construction requirements.

Due to the potential risks to site workers resulting from contaminated surface soils, it is recommended that worker health and safety procedures be developed to mitigate this risk. The risks are primarily related to incidental oral and dermal exposure. It is suggested that coveralls and gloves be worn during these activities and that hands be cleaned following working.

The following additional data requirements are recommended to be developed during the Feasibility Study phase.

1. Further environmental risk assessment of the potential impact of the site on the Thames River should be conducted, to verify that the impacts are negligible. This would include surface water samples at low tide (ground water discharge conditions), sediment sampling, and biota survey/sampling along the Thames River shoreline.

2. Conduct another ground water sampling and analysis round for TCL organic and TAL inorganic parameters to confirm the analytical results. Perform specific radiological isotope ground water analyses to determine the source of the radiological constituents (natural or otherwise).

8.2.3 Lower Subase

8.2.3.1 Summary

Background: The Lower Subase is located along the western edge of NSB-NLON, adjacent to the Thames River. It is bounded by the Thames River to the west and by the Penn Central Railroad to the east. The Lower Subase is the original subase and, therefore, its history dates back to 1867. Most of the construction took place in the early 1900s with major expansion between 1935 to 1945. Extensive portions of this area have been filled. The Lower Subase has always been used for operations and maintenance functions. Those functions typically generate industrial and hazardous wastes such as petroleum oils and cleaning solvents. Also located at the Lower Subase are two sets of concrete underground storage tanks located at the northern end of the study area. Four USTs are located just north of the powerhouse, and seven USTs are located just south of Building 107. In addition, there is an extensive underground fuel oil and diesel oil distribution system at the Lower Subase.

Previous investigations (NESO, 1979 and Wehran, 1987) have identified subsurface oil contamination associated with both sets of underground storage tanks, a waste oil pit in Building 79, in which historically, diesel train engines were serviced, and the underground fuel oil distribution system.

The Navy has implemented a substantial program to replace these underground tanks and the fuel oil distribution system. Of the ten concrete underground storage tanks, six now serve as spill contaminant for new steel tanks, three have been properly abandoned, and one is out-of-service. The Navy, while retrofitting or abandoning these tanks, did not detect any major structural defects or cracks. The underground #6 oil lines will be abandoned in the future based upon present Navy plans. All of the subsurface #2 oil lines, which are direct buried, were replaced or installed in 1980.

Nature and Extent of Contamination: To determine the extent and degree of contamination at the Lower Subase, investigations included the installation of 17 new wells and five soil borings. Soils from the five soil borings were only field screened for contamination. Soil samples were collected from all monitoring well installations. Ground water from all 17 wells and seven existing wells were sampled. All soil and ground water samples were analyzed for TCL volatile organics, TAL inorganics, total petroleum hydrocarbons, and fluorescence "fingerprint" analysis. In addition, soils were also analyzed for TCLP metals.

The following findings and conclusions are provided.

- Ground water at the Lower Subase is relatively clean with only slight exceedances of ARAR values at six locations. VOC standards were exceeded at 13MW2 and 13MW13, and metal standards were exceeded at 13MW8, 13MW9, NESO10 and NES011. These ARARs are based on standards for drinking water.

- No free product was detected in the subsurface, other than very thin layers in 13MW5 and MH83. No oil releases were observed along the bulkhead at the Thames River.

- A large area of subsurface soil near of Building 29 contains petroleum hydrocarbons which apparently originate from both sets of underground storage tanks. Although petroleum contamination is evident, no ARAR/TBC values for soils are exceeded.

- Ground water near Building #29 had a pH ranging from 9-11. This high pH is indicative of an ongoing release, and is apparently due to the discharge of boiler blowdown to the subsurface.

- A smaller area of subsurface soil adjacent to Building 79 contains petroleum oils and low levels of organic solvent. TBC values for organics are only slightly exceeded at one sample location 13MW13. The apparent source of this contamination is the former onsite oil pit in Building 79.

- Low levels of petroleum products are ubiquitous in the Lower Subase soils and ground water. The apparent source of this contamination is the accumulation over the years of minor spills and leaks.

- Elevated lead levels in soils were detected in several locations scattered across the site. Of these, two locations had TCLP lead levels high enough to classify the soils as a hazardous waste (13MW11 and 13MW15). The lead contamination may have resulted from former lead-acid battery management operations that used to be performed at the Lower Subase. Lead was not detected in ground water above ARARs.

- The subsurface free product detected in previous studies is no longer present. It is concluded that some of this oil has migrated to the Thames River, and the

remainder has been adsorbed to soils.

- Low levels of thallium were detected in ground water at wells 13MW15 and 13MW16.

Human Health Risk Assessment: Several identified exposure pathways were evaluated for the Lower Subase. They are listed as follows:

- Utility workers exposed to soils and ground water in utility vaults;
- Utility workers exposed to soils and ground water during utility excavation work;
- Future construction of buildings in Lower Subase; and

Negligible or *de minimus* risks were calculated for these exposure scenarios.

Although ground water quality exceeds drinking water standards in a few wells, no drinking water wells exist in the affected area, nor could they due to the proximity of the site to the brackish Thames River.

Ecological Risk Assessment: Ground water from the Lower Subase discharges to the Thames River. Based on available data, contaminant concentrations in ground water are projected to be below water quality criteria after further dilution in ground water, attenuation due to adsorption to soils, and dilution in the much greater flow (compared to ground water flow) in the Thames River estuary. Risks to aquatic life due to contaminants in ground water discharge from these sites are expected to be low.

8.2.3.2 Recommendations

It is recommended that this site proceed to the Feasibility Study phase.

The following additional data requirements are recommended to be developed during the Feasibility Study.

- Further subsurface soil sampling with testing for total and TCLP lead should be performed in areas of elevated lead levels in soils to define the extent of soil that is classified as a hazardous waste.
- Conduct another ground water sampling and analysis round for TCL and TAL parameters detected to confirm analytical results and TCL SVOs to confirm the assumptions made in the risk assessment. The risk assessment estimated SVO concentrations based upon total petroleum hydrocarbon concentrations.
- A health and environmental risk assessment of the potential impact of the site on the Thames River should be conducted, to verify the qualitative assessment that impacts are negligible. This would include surface water samples at low

tide (ground water discharge conditions), sediment sampling, and potentially biota survey/sampling along the Thames River shoreline.

- A testing program should be developed for the buried #2 fuel oil lines (installed in 1980) to insure that they are not leaking and do not leak in the future.

- The abandonment of the #6 oil lines should be done in a manner to prevent any future subsurface release of #6 oil.

- The one tank (H) that is out-of-service should be properly abandoned.

- The apparent release of boiler blowdown to the subsurface at Building #29 should be investigated and corrected.

APPENDIX H

MATERIAL SAFETY DATA SHEETS

SUMMARY OF
MATERIAL SAFETY DATA SHEETS

Acetone
Antimony Metal/Powder
Aroclor 1254
Arsenic and Compounds
Benzene
Cadmium
Chromium Metal/Powder
Copper
DDT
Ethylbenzene
n-Hexane
Hydrochloric Acid
Lead (Inorganic)
Mercury
Methyl Alcohol
Naphthalene
Nitric Acid
Perchloroethylene
Polychlorinated Biphenyls (PCBs)
Silver
Selenium
Sulfuric Acid, Concentrated
Toluene
Trichloroethylene
Vinyl Chloride
Xylene

Material Safety Data Sheet

from Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 300

ACETONE
(Revision E)
Issued: September 1985
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

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Material Name: ACETONE

Description (Origin/Uses): Used as a solvent for fats, oils, waxes, resins, rubber, plastics, varnishes, and rubber cements; also used in the manufacture of methyl isobutyl ketone, mesityl oxide, acetic acid, diacetone alcohol, chloroform, iodoform, bromoform, explosives, rayon, photographic films, and isoprene. Used to store acetylene gas. Widely used in the chemical process industry (CPI).

Other Designations: Dimethylformaldehyde; Dimethylketal; Dimethyl Ketone; Ketone Propane; Pyroacetic Acid; Pyroacetic Ether; C_3H_6O; CAS No. 0067-64-1

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 3 / 1 / 0 / -

HMIS			
H	1	R	1
F	3	I	1
R	0	S	2
PPG*		K	4

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Acetone, CAS No. 0067-64-1	Ca 100	**OSHA PELs** 8-Hr TWA: 750 ppm, 1800 mg/m³ STEL: 1000 ppm, 2400 mg/m³ **ACGIH TLVs, 1988-89** TLV-TWA: 750 ppm, 1780 mg/m³ TVL-STEL: 1000 ppm, 2375 mg/m³ **Toxicity Data*** Man, Inhalation, TD_{Lo}: 440 µg/m³ (6 Mins) Man, Inhalation, TD_{Lo}: 10 mg/m³ (6 Hrs)

*See NIOSH, *RTECS* (AL3150000), for additional data with references to reproductive, mutagenic, and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 134°F (56°C)
Melting Point: -137°F (-94°C)
Vapor Density (Air = 1): 2
Vapor Pressure: 180 Torrs at 68°F (20°C)
Evaporation Rate: Faster than That of *n*-Butyl Acetate

Molecular Weight: 58 Grams/Mole
Solubility in Water (%): Complete
Specific Gravity (H_2O = 1): 0.778 at 77°F (25°C)
% Volatile by Volume: 100

Appearance and Odor: A clear, colorless, highly flammable, volatile liquid with a characteristic, pleasant, sweetish odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: 1.4°F (-17°C) CC	Autoignition Temperature: 869°F (465°C)	LEL: 2.9% v/v	UEL: 12.8% v/v

Extinguishing Media: Use "alcohol" foam, dry chemical, or carbon dioxide. Use a blanketing effect to smother flames. Use water spray to reduce the rate of burning and to cool containers. Water will probably not be effective in directly extinguishing an acetone fire.

Unusual Fire or Explosion Hazards: Acetone vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Acetone is stable in closed containers during routine operations. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Acetone can react dangerously with strong oxidizing agents such as nitrates, perchlorates, permanganates, and concentrated sulfuric acid; chromic anhydride; chromyl chloride; hydrogen peroxide; hexachloromelamine; nitrosyl chloride; permonosulfuric acid; mixtures of sulfuric acid and nitric acid; mixtures of nitric acid and acetic acid; and potassium *tert*-butoxide.

Conditions to Avoid: Do not expose acetone to sources of ignition and incompatible chemicals.

Hazardous Products of Decomposition: Carbon monoxide and carbon dioxide can be produced during acetone fires.

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SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Acetone is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Inhalation of high concentrations of acetone vapor can cause dryness of the mouth and throat; dizziness, nausea, incoordination, slurred speech, drowsiness, and, in severe exposures, coma. Inhalation of small quantities of acetone vapor for an extended period causes irritation of the respiratory tract, coughing, and headache. Prolonged or repeated skin contact with acetone has a defatting effect causing dryness, irritation, and mild dermatitis. Under routine operating conditions the amount of acetone absorbed through the skin is small. Ingestion of acetone may cause irritation of the gastrointestinal tract and narcosis. Acetone acts primarily as a depressant to the central nervous system (CNS) when exposures are severe or prolonged. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, and CNS. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** See Summary of Risks, above. **Chronic Effects:** None reported. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. Monitor the exposed person for symptoms of depression of the CNS such as incoordination and drowsiness. **Ingestion.** Unlikely.* If a small amount is ingested, dilute it slowly with 1 to 2 glasses of water or milk. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. ***Note to Physician:** Treatment for accidental ingestion of a small amount of acetone is unnecessary. If a large amount has been ingested, administer a charcoal slurry, either aqueous or mixed with a saline cathartic or sorbital.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation. Cleanup personnel need protection against this liquid's contact with skin or eyes as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.
Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations. Consider saving the waste hydrochloric acid for use as a neutralizing agent during cleanup operations of basic materials.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U002
CERCLA Hazardous Substance, Reportable Quantity: 5000 lbs (2270 kg), per the Resource Conservation and Recovery Act, § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious butyl or natural rubber gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of acetone below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Other:** Automatic sprinkler systems for fire protection are desirable in work areas. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale acetone vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store acetone in closed containers (carbon steel is recommended) in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers and pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks. **Other Precautions:** Use labeled safety cans when handling small amounts of acetone. Acetone presents a dangerous fire hazard; perform all work operations involving it carefully and in a way that will prevent exposing the liquid or its vapor to sources of ignition.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Acetone	**IMO Hazard Class:** 3.1
DOT Hazard Class: Flammable Liquid	**IMO Label:** Flammable Liquid
ID No. UN1090	**IMDG Packaging Group:** II
DOT Label: Flammable Liquid	

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: MJ Hardies, MD

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Material Safety Data Sheets Collection:

Sheet No. 70
Antimony Metal/Powder

Issued: 9/80 Revision: A, 11/89

Section 1. Material Identification

30

Antimony Metal/Powder Description: A naturally occurring ore found in sulfides, oxides, complex lead, silver, copper, and mercury sulfides. Prepared in the laboratory by reducing Sb_2O_5 with KCN. Used in manufacturing bullets, bearing metal, hard lead, blackening iron, coating metals, white metal, thermoelectric piles, storage batteries, cable sheaths, type metal, and alloys (Britannia or Babbitt metal). Pure antimony compounds are used as catalysts in organic synthesis, abrasives, plasticizers, pigment, and flameproofing compounds; also used in manufacturing paints, enamels, matches, glass, pharmaceuticals, explosives, and tartar emetic.
Other Designations: Stibium; antimony regulus; Sb; CAS No. 7440-36-0.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 3
S 3
K 1

Genium

HMIS
H 3
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Antimony, ca 99%

OSHA PEL	ACGIH TLV, 1989-90	NIOSH REL, 1987*	Toxicity Data†
8-hr TWA: 0.5 mg/m³ (as Sb)	TLV-TWA: 0.5 mg/m³ (as Sb)	10-hr TWA: 0.5 mg/m³	Rat, intraperitoneal, LD_{50}: 100 mg/kg Rat, oral, LD_{50}: 100 mg/kg

* NIOSH has proposed a 10-hr TWA of 0.5 mg/m³ with an action level at 0.25 mg/m³. The TLV was established at a level to prevent irritation and systemic effects.
† See NIOSH, *RTECS* (CC4025000), for additional data with references to toxic effects.

Section 3. Physical Data

Boiling Point: 2975 °F (1635 °C)
Melting Point: 1166.9 °F (630.5 °C)
Vapor Pressure: 1 mm Hg at 1627 °F (886 °C)
Molecular Weight: 121.76 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 6.68 at 77 °F (25 °C)
Water Solubility: Insoluble
Mohs Hardness: 3.0 to 3.5

Appearance and Odor: A brittle, flaky, crystalline solid with a lustrous blue-white color; however, a noncrystalline form is also known. The powder form is dark gray, lustrous.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: Cloud,* 788 °F (420 °C); dust layer,* 626 °F (330 °C)	LEL: Dust cloud explosion, 0.42 oz/ft³	UEL: None reported

Extinguishing Media: Dry chemical,powder.
Unusual Fire or Explosion Hazards: Antimony bulk metal is combustible in air at *high temperature*. When ignited it burns with a brilliant flame, giving off dense, white antimony trioxide (Sb_2O_3) fumes. When exposed to heat or ignition sources, powdered antimony is a moderate fire and explosion hazard. Particle size and dispersion in air determine reactivity.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Personal protective clothing and eye protection are essential.

* Ninety-one percent of dust goes through a 74-μm sieve. A 1.92-J spark can ignite an antimony dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Antimony metal (bulk) is stable in dry air at room temperature in closed containers. It slowly tarnishes in moist air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Antimony is not very reactive with cold, dilute acids, but it reacts readily with aqua regia and hot, concentrated sulfuric acid. Powdered antimony* also reacts with hot, concentrated hydrochloric acid (HCl). On contact with acid, it emits toxic antimony trihydride (SbH_3) fumes; electrolysis of acid sulfides and stirred antimony halide yields explosive antimony. Antimony can react vigorously or violently with oxidizing agents such as nitrate salts, halogens, nitric acid, perchloric acids, chlorine trifluoride (ClF_3), potassium permanganate ($KMnO_4$), ammonium nitrate (NH_4NO_3), bromine trinitride (BrN_3), bromine trifluoride (BrF_3), chlorine monoxide (ClO), chlorine trifluoride (ClF_3), potassium nitrate (KNO_3), sodium nitrate ($NaNO_3$), and potassium oxide (K_2O_2).
Conditions to Avoid: Nascent hydrogen can react with Sb, or its alloys with Mg or Zn, to form antimony trihydride, a colorless, highly toxic gas (causing headache, nausea, vomiting, abdominal pain, hemolysis (separation of hemoglobin from red blood corpuscles), hematuria (blood in the urine), and death) with a disagreeable odor (0.1-ppm TLV).
Hazardous Products of Decomposition: Thermal oxidative decomposition of antimony can produce toxic SbH_3 fumes.
* Powdered antimony reacts more vigorously than the bulk material and forms dangerous mixtures with oxidizing agents. Heating further increases its reactivity.

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists antimony as a carcinogen. However, its ore is a suspected carcinogen in antimony trioxide production. Antimony trioxide is prepared in the laboratory by a volatilization process involving antimony trichloride ($SbCl_3$) and water.
Summary of Risks: An irritant to mucous membranes, eyes, and skin. Exposures to dust/powder can cause eye inflammation (conjunctivitis), nasal irritation (rhinitis - perforation of the nasal septum), chronic dermatitis ranging from mild rashes to blemishes resembling chicken pox, and muscle pain and weakness. Some sources refer to antimony as a human poison by an unspecified route. Exposure to antimony may result in "metal fume fever," a flu-like syndrome with fever, fatigue, cough, and muscle ache.
Medical Conditions Aggravated by Long-Term Exposure: Chronic inhalation of subtoxic doses of dust or fume above the TLV may result in chemical pneumonia, intraalveolar lipid deposits, liver and cardiac involvement, and possible kidney disease.
Target Organs: Skin, eyes, mucous membranes, respiratory system, and cardiovascular system.
Primary Entry: Inhalation (dust and fume), ingestion.
Acute Effects: Acute ingestion may cause violent vomiting, diarrhea, slow pulse and low blood pressure, shallow breathing, and death.
Chronic Effects: Chronic exposures lead to dizziness, dry throat, sleeplessness, anorexia, and nausea.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: ***Contact physician!*** Never give anything by mouth to an unconscious or convulsing person. Give 1 to 2 glasses of water to dilute, although vomiting may be spontaneous after ingestion.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.
Physician's Note: If indicated, intravenous gastric lavage chelation therapy with BAL (British Anti-Lewsite) for 10 days is recommended.

Spill/Leak: Notify safety personnel of powder spills. Small spills can be removed by vacuuming or wet sweeping to minimize airborne dust. Cleanup personnel should use protective equipment.
Disposal: Return scrap metal to your supplier. Unsalvageable waste may be buried in an approved secure landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). Respirators should be available for nonroutine or emergency use for concentrations above the TLV: high-efficiency dust respirators for concentrations below 5 mg/m^3 and self-contained or air-supplied respirators with full facepiece for concentrations above 5 mg/m^3.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a dry, well-ventilated, low fire-risk area. Avoid heat and direct sunlight.
Engineering Controls: Avoid breathing dust or fumes. Practice good housekeeping and cleaning techniques to prevent dust accumulation and to minimize airborne particulates. Minimize skin contact by using barrier creams, rubber gloves and aprons, and good personal hygiene. Keep antimony dust off clothing. Provide preplacement and periodic medical examinations for those workers exposed regularly to antimony, with emphasis on the skin, mucous membranes, and the pulmonary, cardiac, and reproductive systems. Provide suitable training to those working with antimony. Monitor the workplace. Keep records.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Antimony compounds, inorganic, n.o.s.
IMO Hazard Class: 6.1
IMO Label: Poison/St. Andrews Cross (Stow away from foodstuffs)
IMDG Packaging Group: I, II, III

MSDS Collection **References:** 1, 2-12, 24, 26, 27, 31, 37, 38, 41, 81, 84, 87, 89, 90, 91, 100, 109
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

NO. 1200

AROCLOR 1254

Date May 1980

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: AROCLOR 1254
DESCRIPTION: Distillation cut of polychlorinated biphenyl (or diphenyl), containing 54% Cl.
OTHER DESIGNATIONS: PCB, an Askarel, PYRANOL, GE Material A13B1, CAS # 027 323 188
MANUFACTURER: Material was a product of Monsanto Co., but dropped in 1977. Except for uses specifically exempted and regulated by EPA (for example power transformers), legal manufacture, distribution in commerce, and use of PCB's in USA ended in 1979 under TSCA.

SECTION II. INGREDIENTS AND HAZARDS

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Mixture of Chlorinated Biphenyls, $C_{12}H_{10-x}Cl_x$:	ca 100	EPA exemption or authorization needed for any measurable exposure*
		Rat, Oral LD_{50} Adult 4-10 g/kg Weaning 1.2 g/kg
		Rat, Intravenous LD_{50} 358 mg/kg
		Rat, Oral, TDLo 1220 mg/kg/35 wk (neoplastic effect)

x	Approx. %
2	0.5
3	1
4	21
5	48
6	23
7	6

Includes 69 or more compounds with average of 4.98 Cl atom/molecule. Mixture may contain 0-2 ppm chlorinated dibenzofurans.

*Current ACGIH 8-hr TWA is 0.5 mg/m^3. NIOSH has proposed a 10-hr TWA of 1.0 µg/m^3. Materials with over 50 ppm PCB content are regulated for handling, storage, records, and waste disposal. EPA criterion in navigable waters is 0.001 µg/L. PCB's.

SECTION III. PHYSICAL DATA

Boiling range at 1 atm, deg C	ca 360-390	Specific gravity (65/15.5 C)	1.5
Vapor pressure at 150 C, mm Hg	<1	Pour point, deg C	10
Water solubility at 25 C, ppm	ca 0.01	Molecular weight (Av)	327
Viscosity at 100 F, cstk	ca 460	Partition Coef. (octanol/water)	>10^4

Appearance & Odor: A light yellow, viscous fluid.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
None to boiling point				

Extinguishing Media: Use media appropriate to the surrounding fire conditions. This material has very low combustibility, but it can undergo thermal-oxidative degradation in a fire situation.

Firefighters should use full protective clothing and self-contained breathing equipment when fighting fire where any PCB's are involved.

SECTION V. REACTIVITY DATA

AROCLOR 1254 and other PCB's are nearly inert materials with very high chemical stability; the higher chlorine levels usually give the greater stability. At about 300 to 600 C some PCB's can oxidize to produce chlorinated dibenzofurans which are much greater in toxicity than the PCB's. For complete incineration of PCB's a 2-second dwell time above 2000 F (1090 C) with 3% excess oxygen in the stack is suitable (see Sect. VI).

AROCLOR 1254 shows very little degradation after 3 weeks exposure to direct sunlight.

PCB's are strongly absorbed on particulates or sediments in aquatic systems (streams, lakes, ocean, etc.).

Mixed in activated sludge, biodegradation occurs slowly, but only very slowly or almost not at all with compounds above Cl_4.

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No. 1200

SECTION VI. HEALTH HAZARD INFORMATION

TLV (See Sect. II)

PCBs show high levels of bioaccumulation in fatty tissue and very slow metabolism, especially for Cl_5 compounds and above. They have become widely dispersed in world-wide environment and in the food chain (much like DDT) since their introduction in 1929. Effective control of PCB discharge into the environment began after 1970.

AROCLOR 1254 has a low vapor pressure, but it can be irritating to the eyes, nose, and throat if misted or heated to produce vapors. Excessive acute and chronic exposures may cause liver damage. Chronic exposure to or ingestion of PCB's (especially when thermally oxidized) can result in chloracne after 1-6 months. There is some evidence of possible carcinogenic risk and adverse reproductive effects with this material. PCB's may appear in the breast milk of an exposed mother.

FIRST AID:

Skin Contact: Clean exposed skin with waterless cleaner, wipe with a disposable towel, then wash with soap and water. Promply remove contaminated clothing. (Control separate disposal of PCB-contaminated materials.)

Eye Contact: Flush promptly & thoroughly with lots of running water for 15 minutes.

Inhalation: Remove to fresh air. Get medical help if symptoms continue.

Ingestion: Get medical help. NIOSH has recommended that vomiting be induced.

Get medical help in all cases of severe exposure, repeated exposures, or persistent symptoms.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of all PCB spills or leaks. Promptly contain spilled material! Prevent its release into the environment! Restrict PCB spill area to trained clean-up personnel; use proper protective gear; follow an established emergency plan.

Stop leakage if possible. Pick up spill. Absorb small spills and residues using a powdered, dry clay. Place leaking containers, picked-up PCBs, and PCB-contaminated materials and refuse into approved, properly labeled, closed containers for storage under controlled, EPA regulated conditions prior to disposal. EPA allows approved storage to 1/1/84.(See Sect.IX.) Storage: 40CFR761.42; Annual report: 40CFR761.45

DISPOSAL: Destroy PCB-containing material by burning in an EPA approved facility. Liquid 50-500 ppm PCB material can be burned as above or landfilled if not ignitable. Non-flowing, PCB-contaminated debris can be disposed of in an EPA approved landfill. (See 40CFR 761; Federal Register, Vol. 44, 31551-4, 66989; Vol.45, 20473.)

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide highly effective local exhaust ventilation (trap for exhaust vapors) especially if this material is heated or misted. Unless authorized by EPA an isolated system must be used for PCBs.

For nonroutine and emergency conditions of exposure use an approved canister respirator or self-contained breathing equipment.

Prevent skin contact for those who work with PCBs. Use neoprene or polyethylene gloves and apron, safety glasses and/or face shield, and other protective clothing as determined by use conditions. An eyewash station and washing facilities should be available to the work area.

Provide for special handling and disposal of PCB-contaminated materials, including paper towels and clothing (see Sect. VII). Provide locker and shower facilities. Workers must be trained for PCB work, and they must follow good hygienic practice.

Provide pre-placement medical exams for workers with emphasis on liver function, skin condition, and reproductive history. Provide annual medical exams for exposed workers.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

PCB materials in containers and in equipment must have proper labeling including the date of storage. Short term (up to 30 days) storage of non-leaking PCBs can be done. Long term storage requires an EPA approved facility, including such criteria as roof and walls to shield from rain, impervious base and diking which will contain 25% of stored volume or twice the volume of the largest container, no drains or openings to allow flow loss, and the base must be located above the 100-year flood water elevation. Prevent physical damage to containers. Inspect storage frequently.

Prevent skin contact with PCBs, or with solid products contaminated with PCBs. Prevent inhalation of airborne PCBs. Properly contain PCBs until legally disposed of; do not allow them to escape into the environment!

PCBs, and especially used PCBs, can contain higher toxicity contaminants.

DATA SOURCE(S) CODE: 1-6,20,26,31,36

APPROVALS: MIS CRD J.M. Gilson

Industrial Hygiene and Safety 5-29-80

MEDICAL REVIEW: June 1980

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Material Safety Data Sheets Collection:

Sheet No. 296
Arsenic and Compounds

Issued: 4/90

Section 1. Material Identification

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Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N_2 current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for dipoles and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.

Other Designations: CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R	1
I	4
S	2
K	0

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HMIS
H 3
F 2
R 2
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

OSHA PEL
8-hr TWA: 0.5 mg/m³,* 0.01 mg/m³†

ACGIH TLV, 1989-90
TLV-TWA: 0.2 mg/m³

NIOSH REL, 1987
Ceiling: 0.002 mg/m³

Toxicity Data‡
Man, oral, TD_{Lo}: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)
Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes
Rat, oral, TC_{Lo}: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

* Organic compounds.
† Inorganic compounds.
‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: sublimes at 1134 °F/612 °C
Melting Point: 1497 °F/814 °C
Vapor Pressure: 1 mm at 702 °F/372 °C (sublimes)
Atomic Weight: 74.92
Density: 5.724 at 57 °F/14 °C
Water Solubility: Insoluble†

Appearance and Odor: A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.
† Arsenic is soluble in nitric acid (HNO_3).

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, CO_2, water spray, or foam to fight fires.
Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.
Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals.
Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is a reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.
Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.
Target Organs: Liver, kidneys, skin, lungs, lymphatic system.
Primary Entry Routes: Inhalation, ingestion of dust and fumes, via skin absorption.
Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).
Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: If emesis is unsuccessful after two doses of Ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations*
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [† per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations‡
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.
‡ Listed as arsenic organic compounds (as As).

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.
Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Arsenic, solid
DOT Hazard Class: Poison B
ID No.: UN1558
DOT Label: Poison
DOT Packaging Requirements: 173.366
DOT Packaging Exceptions: 173.364

IMO Shipping Name: Arsenic, metallic
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II
ID No.: UN1558

MSDS Collection References: 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD M4

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Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

Issued: 11/78 Revision: E, 8/90

Section 1. Material Identification

32

Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.
Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R	1
I	4
S	2*
K	4

*Skin absorption

NFPA: 3 / 2 / 0 / -

HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8
Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
% Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	Autoignition Temperature: 928 °F (498 °C)	LEL: 1.3% v/v	UEL: 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.
Unusual Fire or Explosion Hazards: Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

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Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)	**IMO Shipping Name:** Benzene
DOT Hazard Class: Flammable liquid	**IMO Hazard Class:** 3.2
ID No.: UN1114	**ID No.:** UN1114
DOT Label: Flammable liquid	**IMO Label:** Flammable liquid
DOT Packaging Exceptions: 173.118	**IMDG Packaging Group:** II
DOT Packaging Requirements: 173.119	

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection **References:** 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 23

CADMIUM
(Revision C)
Issued: September 1977
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

2

Material Name: CADMIUM

Description (Origin/Uses): Used in electroplating other metals; in dentistry; in alloys; in nickel-cadmium batteries; and in reactor control rods.

Other Designations: Cd; CAS No. 7440-43-9

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Genium

HMIS	
H 3	R 1
F 1	I 4
R 0	S 1
PPG*	K 4 (Dust)
*See sect. 8	

SECTION 2. INGREDIENTS AND HAZARDS, EXPOSURE LIMITS

Cadmium, CAS No. 7440-43-9, ca 100%

OSHA PEL
8-Hr TWA: 0.1 mg/m³ (Cd Fume)
Ceiling: 0.3 mg/m³ (Cd Fume)
8-Hr TWA: 0.2 mg/m³ (Cd Dust)
Ceiling: 0.6 mg/m³ (Cd Dust)

ACGIH NIC,* 1988-89
TLV-TWA: 0.01 mg/m³ (Cadmium and Compounds, as Cd)
ACGIH A2, Suspected Human Carcinogen

ACGIH TLVs, 1988-89
TLV-TWA: 0.05 mg/m³ (Cadmium Dusts and Salts, as Cd)
TLV-Ceiling: 0.05 mg/m³ (Cadmium Oxide Fume, as Cd)
TLV-TWA: 0.05 mg/m³ (Cadmium Oxide Production)

Toxicity Data**
Human, Inhalation, LC_{Lo}: 39 mg/m³ (20 Minutes)

*Notice of Intended Changes, Genium reference 116, p. 39.
**See NIOSH, *RTECS* (EU9800000), for additional data referring to reproductive, tumorigenic, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 1413°F (767°C)
Melting Point: 610°F (321°C)
Vapor Pressure: 0.095 Torr at 610°F (321°C)
Molecular Weight: 112 Grams/Mole
Solubility in Water (%): Insoluble
Specific Gravity (H_2O = 1): 8.642

Appearance and Odor: A soft, blue white, malleable, lustrous metal that can be cut easily with a knife; odorless.
Comments: Cadmium has a significant vapor pressure of 0.000021 torr (corresponding to 0.12 mg/m³) at 315°F (157°C). Heating this metal without using correct engineering controls and/or personal protective equipment can result in overexposure.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method*	Autoignition Temperature*	LEL*	UEL*

Extinguishing Media: *Cadmium metal burns readily in air if it is heated. As with most metals, the reactivity/dust-cloud-explosion hazard increases as the cadmium metal becomes more finely divided. In fact, finely divided, powdered cadmium metal can be pyrophoric (it burns spontaneously in air without any source of ignition). Carbon dioxide, dry chemical, or sand are recommended extinguishing agents for cadmium fires. **Unusual Fire or Explosion Hazards:** Cadmium dust can explode during a fire. Massive cadmium metal does not present this potential explosion hazard; however, certain work operations such as grinding, welding, or cutting, can produce dust made of finely divided cadmium particles. **Warning:** Do not create a dust cloud of cadmium particles, especially during cutting, grinding, or welding operations. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Cadmium is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Cadmium reacts dangerously with ammonium nitrate, hydrazoic acid, tellurium, and zinc (Genium ref. 84). **Conditions to Avoid:** Avoid all exposure to sources of ignition and to incompatible chemicals. **Hazardous Products of Decomposition:** When heated, which is likely during fires and work operations such as welding and machining, cadmium metal can decompose into cadmium metal fume and cadmium oxide fume.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: The ACGIH classifies cadmium and its compounds as suspected human carcinogens (group A2); the IARC lists them as probable human carcinogens (group 2B); and the NTP classifies them as anticipated human carcinogens (group b). **Summary of Risks:** Heating cadmium metal produces intensely irritating cadmium metal fume. The acute effects of its excessive inhalation, which include severe tracheobronchitis, pneumonitis, and pulmonary edema, are life threatening and are usually delayed for several hours; their mortality rate is about 20%. Nonfatal pneumonitis has resulted from exposure to 0.5 to 2.5 mg/m³; a fatality has been reported for five hours' exposure at 9 mg/m³ and for 1 hour's exposure at 40 to 50 mg/m³. There is no warning discomfort or immediate irritation from exposure to cadmium fume. Acute gastroenteritis and symptoms of metal fume fever are associated with even lower acute exposure. Symptoms of acute overexposure include excessive salivation, a dry, burning throat; headache; aching muscles; coughing; chest tightness and pain; nausea; chills, and fever chills; and fever. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, kidneys, and blood. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** See Summary of Risks, above. **Chronic Effects:** Long-term, chronic inhalation of cadmium dust, salts, or fume causes chronic cadmium poisoning characterized by a distinctive, nonhypertrophic emphysema with or without renal tubular injury, accompanied by the urinary excretion of a protein with a molecular weight

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SECTION 6. HEALTH HAZARD INFORMATION, cont.

of 20,000 to 30,000. This protein is itself a sign of early but reversible chronic poisoning. (Possible chromosomal aberrations and decreased birth weight among babies of women exposed to cadmium have been noted.) **Danger:** Continued overexposure from inhalation causes irreversible renal tubular damage. Cancer, anemia, eosinophilia, anosmia, chronic rhinitis, yellowed teeth, and bone changes have been reported. Bone pain in the ribs, backbone, and femur is common; disorders of calcium metabolism develop; and kidney stones and pulmonary fibrosis have been described. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** If a physician is not readily available, give the exposed person 2 to 3 glasses of water to drink and induce vomiting. A physician may administer a gastric lavage followed by saline catharsis. **Comments:** A comprehensive medical program is advised for those who work with cadmium or its compounds. This should include chest X rays and forced-vital-capacity tests. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Chelation therapy may be useful in treatment; calcium disodium edetate and pencillamine are recommended. Dimercaprol (BAL) is not recommended because of reported renal toxicity of the cadmium-BAL complex.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation. Cleanup procedures must not create dusty conditions. Pick up the spilled material using vacuuming, mopping, or wet-sweeping techniques. Cleanup personnel need protection against inhalation of dust and fume (see sect. 8). **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations. Concentrated solutions of cadmium waste can be precipitated with lime and collected by filtration. Effluent should be treated as needed to reduce the concentration of the cadmium to a level that is within regulatory compliance limits.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. D006 (40 CFR 261.24 [Characteristic of EP toxicity])
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of a cadmium solution is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne levels of cadmium below the OSHA PEL cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommnedations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. Do not wear work clothes home. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale cadmium fume. Do not expose individuals with lung, liver, kidney, and blood ailments to cadmium until such exposure is approved by a physician.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store cadmium in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. Avoid storage situations where corrosion can occur. Keep powdered cadmium in closed containers; prevent the airborne dispersion of powdered cadmium. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations to prevent static sparks. **Other Precautions:** The toxic effects of cadmium are influenced by the presence or absence of other elements such as zinc and selenium. If these materials are present in the workplace, careful evaluation of any exposure to cadmium is required to understand any contributing factors.

Hazardous Materials Table (49 CFR 172.101): Not Listed
Optional Hazardous Materials Table (49 CFR 172.102)

ID No. UN2570

IMO Shipping Name: Cadmium Compounds
IMO Hazard Class: 6.1
IMO Labels: Poison or Saint Andrew's Cross (X)*

*Harmful—Stow away from Foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Material Safety Data Sheets Collection:

Sheet No. 83
Chromium Metal/Powder

Issued: 3/81 Revision: A, 11/89

Section 1. Material Identification

30

Chromium Metal/Powder Description: Obtained from chrome ore, chromite ($FeCr_2O_4$), by electrolysis of chromium solutions, by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals; for greatly increasing metal resistance and durability; in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel); as a constituent of inorganic pigments; as protective coating for automotive and equipment accessories; and in nuclear and high-temperature research.
Other Designations: Chrome; Cr; CAS No. 7440-47-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 1
K 1

Genium

HMIS
H 2
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder, ca 100%

OSHA PEL	ACGIH TLV, 1988-89*	NIOSH REL, 1987†	Toxicity Data‡
8-hr TWA: 1 mg/m³	TLV-TWA: 0.5 mg/m³	8-hr TWA (for chromium metal and insoluble salts): 1 mg Cr/m³	Rat, implant, TD_{Le}: 1200 µg/kg body weight administered intermittently over six weeks

* This TLV is applicable to Cr^{+2} and Cr^{+3} compounds. For water soluble and water-insoluble Cr^{+6}, the 8-hr TWA is 0.05 mg Cr^{+6}/m^3. Certain water-insoluble Cr^{+6} compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen).
† The NIOSH REL (10-hr TWA) for carcinogen Cr^{+6} compounds is 1 µg/m³; for noncarcinogenic Cr^{+6} compounds (including chromic acid), the RELs (10-hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and Cr^{+6} (chromic acid anhydride). Any and all Cr^{+6} materials excluded from the noncarcinogenic group above are carcinogenic Cr^{+6} compounds.
‡ See NIOSH, *RTECS* (GB4200000), for additional data with references to tumorigenic effects.

Section 3. Physical Data

Boiling Point: 4788 °F (2642 °C)
Melting Point: 3452 °F (1900 °C)
Vapor Pressure: 1 mm Hg at 2941 °F (1616 °C)
Vapor Density (Air = 1): 1.79
Atomic Weight: 51.996 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 7.2 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: Steel-gray, lustrous metal; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: Cloud, 1076 °F (580 °C); dust layer, 752 °F (400 °C)	LEL: Dust cloud explosion, 0.230 oz/ft³	UEL: None reported

Extinguishing Media: Use dry chemical or sand.
Unusual Fire or Explosion Hazards: Particle size and dispersion in air determine reactivity. Chromium powder explodes spontaneously in air, while chromium dust suspended in CO_2 is ignitable and explosive when heated.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents, including high O_2 concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.
Hazardous Products of Decomposition: Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes.

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Section 6. Health Hazard Data

Carcinogenicity: The NTP and OSHA list chromium as a human carcinogen.

Summary of Risks: When ingested chromium is a human poison, with gastrointestinal (GI) effects. Chromium 3 (Cr^{+3}) compounds show little or no toxicity. Less soluble chromium 6 (Cr^{+6}) compounds are suspected carcinogens and severe irritants of the larynx, nasopharynx, lungs, and skin (Sec. 2). Chromic acid or chromate salts cause irritation of the skin and respiratory passage. Ingestion leads to severe irritation of the gastrointestinal tract, renal damage, and circulatory shock. Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis. Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis).

Medical Conditions Aggravated by Long-Term Exposure: An incresed incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.

Target Organs: Respiratory system.

Primary Entry: Inhalation, percutaneous absorption, and ingestion.

Acute Effects: Acute exposures to dust may cause headache, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of the conjunctiva, and dermatitis.

Chronic Effects: Asthmatic bronchitis.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Brush off chromium dust. After rinsing affected area with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person slowly drink 1 to 2 glasses of water to dilute. Do not induce vomoting. A physician should evaluate all ingestion cases.

After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Physician's Note: Acute toxicity causes a two-phase insult: 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal, hematopoetic insult. Treatment should use ascorbic acid as a neutralizer with gastric lavage. If the ingestion is substantial, exchange transfusions and/or consider hemodialysis. Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce Cr^{+6} to Cr^{+3}. Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of large spills. Cleanup personnel should wear protective clothing and approved respirators. Remove heat and ignition sources. Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse.

Disposal: Reclaim salvageable metal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

EPA Designations

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Wear a NIOSH-approved respirator if necessary. Wear an SCBA with a full facepiece when the particle concentration's upper limit is 50 mg/m^3.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

Other: Wear impervious rubber gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store material in cool, dry, well-ventilated area separate from acids and oxidizing agents. Seal and protect containers from physical damage. Keep away from heat or ignition sources.

Engineering Controls: Avoid dust inhalation. Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates and to prevent dust accumulation. Use nonsparking tools and ground electrical equipment and machinery.

Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection **References:** 1, 2, 26, 38, 80, 87, 88, 89, 100, 109, 124, 126

Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

M8

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Material Safety Data Sheets Collection:

Sheet No. 162
Copper

Issued: 12/85 Revision: A, 8/90

Section 1. Material Identification

32

Copper (Cu) Description: Widely distributed in nature in elemental state, arsenites, sulfides, chlorides, and carbonates. Prepared by crushing, grinding, and concentrating copper ores by flotation and leaching or by smelting copper ore concentrates to yield a blister (96 to 98%) copper which is electrolytically refined to yield 99.9+% copper. Copper is the most widely used structural metal, next to iron and aluminum. Used in electric wiring; switches, heating, plumbing, roofing, and building construction; alloys (brass, bronze, Monel metal, beryllium-copper); coins; chemical and pharmaceutical machinery; electroplated protective coatings and undercoats for nickel, chromium, zinc, etc., cooking utensils; insecticides; antifouling paints; and as a catalyst. Copper whiskers are used in thermal and electrical composites. Copper flakes are used as insulation for liquid fuels.

Other Designations: CAS No. 7440-50-8, bronze powder, copper slag-airborne, copper slag-milled.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

Cautions: *Copper may be toxic through contact, inhalation, and ingestion.* It may cause skin and eye irritation and metal fume fever. Copper is not considered a fire hazard, but fine particles may burn in air.

R 0
I 4
S 1
K 0

Genium

HMIS
H 2
F 0
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Copper, ca 100%

1989 OSHA PELs	1989-90 ACGIH TLVs	1988 NIOSH REL	1985-86 Toxicity Data‡
8-hr TWA: 1 mg/m³*	TLV-TWA: 1 mg/m³*	None established	Human, oral, TD_{Lo}: 120 µg/kg affects the gastrointestinal tract (nausea or vomiting)
8-hr TWA: 0.1 mg/m³†	TLV-TWA: 0.2 mg/m³†		Rat, oral, TD_{Lo}: 1210 µg/kg (35 weeks prior to mating) affects fertility (pre- and post-implantation mortality)

* Copper dusts and mists, as Cu.
† Copper fume.
‡ See NIOSH, *RTECS* (GL5325000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 4703 °F (2595 °C)
Melting Point: 1981 °F (1083 °C)
Vapor Pressure: 1 mm Hg at 2962 °F (1628 °C)
Molecular Weight: 63.546
Density/Specific Gravity: 8.94
Water Solubility: Insoluble

Appearance and Odor: Solid, various shapes, odorless, red/brown-colored metal or powder. Copper is ductile, tough, and easily worked. It is very resistant to corrosion, but readily attacked by alkalies.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use extinguishing media appropriate to the surrounding fire since copper does not burn. Finely divided copper burns in air, and in extreme cases ignites spontaneously.

Unusual Fire or Explosion Hazards: Liquid copper explodes on contact with water. High concentrations of fine copper particles in the air may present an explosion hazard.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit.

Section 5. Reactivity Data

Stability/Polymerization: Copper is stable at room temperature in closed containers under normal storage and handling conditions. However, on long standing, a white, highly explosive peroxide deposit may form. Copper's vapors are uninhibited and may form polymers in vents and flame arresters.

Chemical Incompatibilities: Copper reacts violently with ammonium nitrate, bromates, iodates, chlorates, ethylene oxide, hydrazoic acid, potassium oxide, dimethyl sulfoxide + trichloroacetic acid, hydrogen peroxide, sodium peroxide, sodium azide, sulfuric acid, hydrogen sulfide + air, and lead azide. A potentially explosive reaction occurs with actylenic compounds. Copper ignites on contact with chlorine, fluorine [above 250 °F (121 °C)], chlorine trifluoride, and hydrazinium nitrate [above 158 °F (70 °C)]. It is also incompatible with 1-bromo-2-propyne; an incandescent reaction occurs with potassium dioxide.

Conditions to Avoid: Avoid prolonged exposure to air and moisture. On exposure to moist air, copper slowly converts to the carbonate.

Hazardous Products of Decomposition: Thermal oxidative decomposition of copper can produce metallic oxides (copper fumes).

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Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list copper as a carcinogen. Experimental studies show tumorigenic and teratogenic effects in laboratory animals.
Summary of Risks: Copper is a necessary human nutrient, excessive intake levels of which the kidneys normally eliminate. In individuals with kidney disease or, rarely, Wilson's disease (abnormal retention and storage of copper in the body that damages the liver, kidneys, brain, blood, bones, and endocrine glands), copper levels may accumulate. Significant industrial exposure to copper occurs mainly through inhalation of fumes during welding, smelting, or refining operations; or through exposure to copper dusts and mists during mining, extracting, refining, or manufacturing processes. Copper particles may irritate, discolor, and damage eyes. Exposure to copper salts in many applications is potentially toxic. Copper dusts, fumes, and salts may irritate the upper respiratory tract. Long-term exposure may irritate the skin and discolor the skin or hair.
Medical Conditions Aggravated by Long-Term Exposure: Individuals with impaired pulmonary or renal function should avoid exposure.
Target Organs: Respiratory system, skin, eyes, liver, kidneys.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Inhalation of copper fumes may give rise to metal fume fever (after an incubation period of about 5 hr), an allergic reaction with flu-like symptoms—high temperature, metallic taste, nausea, coughing, general weakness, muscle aches, and exhaustion. These symptoms usually disappear within 24 hr. Direct contact with copper causes skin and (less often) eye irritation, and itching of the linings of the nose, mouth, and respiratory tract. Exposure to copper dust may cause a greenish-black skin discoloration. Copper ingestion causes nausea, vomiting, abdominal pain, and diarrhea. Ingestion of large doses may cause stomach and intestine ulceration, jaundice, and kidney and liver damage.
Chronic Effects: Continued exposure to copper may cause mild dermatitis and degeneration of the mucous membranes. Repeated or prolonged exposure to copper dusts and mists can discolor skin and hair and irritate the skin. Repeated inhalation can cause chronic respiratory disease. Individuals with Wilson's disease (1 in 200,000 individuals) are more susceptible to chronic copper poisoning. If undetected and untreated, this progressive condition is eventually fatal.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing with artificial respiration.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: A blood count shows leucocytosis if an individual has metal fume fever. Consider chellation with penicillamine or BAL (British Anti-Lewisite or dimercaprol) for chronic intoxication.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, remove all heat and ignition sources, and provide adequate ventilation. Avoid creating dusty conditions. Cleanup personnel should protect against vapor inhalation and skin and eye contact. Cleanup methods such as vacuuming (with the appropriate filter) or wet mopping minimizes dust dispersion. Absorb liquid containing copper with vermiculite, dry sand, or other inert materials. Place in appropriate containers for disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Some recommendations follow. For copper dust and mists greater than 50 mg/m^3, wear a high-efficiency particulate respirator, a supplied-air respirator, or an SCBA, all with a full facepiece. For copper dust and mists greater than 2000 mg/m^3, wear a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode. For copper fumes over 100 mg/m^3, wear either a powered air-purifying respirator with a high-efficiency filter, or a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Eye and face protection is required when grinding, welding, cutting, or remelting. Protect skin from molten metal and radiant heat when melting scrap. Machine turnings may also present a laceration hazard. When handling oil-contaminated copper, wear rubber gloves to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PELs and ACGIH TLVs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store copper in tightly closed containers in a cool, dry, well-ventilated area. Avoid exposure to air and moisture.
Engineering Controls: Avoid dust and fume inhalation and direct contact with skin and eyes. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Maintain exposures below the PEL/TLV. Monitor copper dust and mist levels in the air.
Other Precautions: Provide placement and periodic examinations that emphasize the skin, eyes, and respiratory system. Prevent exposing individuals with chronic respiratory disease or Wilson's disease.
Transportation Data (49 CFR 172.101, .102): Not listed

MSDS Collection **References:** 26, 38, 73, 84, 88, 89, 100, 101, 103, 109, 124, 126, 127, 132, 133, 134, 136, 138, 139, 143, 144
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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TOXICITY DATA: 2	CODEN:
ihl-rat LCLo:520 mg/m3/4H	HYSAAV 31,383,66
unk-rat LDLo:452 mg/kg	HYSAAV 31,383,66
unk-mus LDLo:580 mg/kg	HYSAAV 31,383,66

THR: MOD ihl, unk. See also esters.
Disaster Hazard: When heated to decomp it emits tox fumes of Cl^-.

DDT

CAS RN: 50293 NIOSH #: KJ 3325000
mf: $C_{14}H_9Cl_5$; mw: 354.48

Colorless crystals or white to slightly off-white powder. Odorless or with slight aromatic odor. mp: 108.5°-109°.

SYNS:

ALPHA,ALPHA-BIS(P-CHLORO-PHENYL)-BETA,BETA,BETA-TRICHLORETHANE
2,2-BIS(P-CHLOROPHENYL)-1,1,1-TRICHLOROETHANE
CHLOROPHENOTHANE
P,P'-DDT
P,P'-DICHLORODIPHENYLTRI-CHLOROETHANE
4,4'-DICHLORODIPHENYLTRI-CHLOROETHANE
DIPHENYLTRICHLOROETHANE
ENT 1,506
NCI-C00464
1,1,1-TRICHLOOR-2,2-BIS(4-CHLOOR FENYL)-ETHAAN (DUTCH)
1,1,1-TRICHLOR-2,2-BIS(4-CHLOR-PHENYL)-AETHAN (GERMAN)
1,1,1-TRICHLORO-2,2-DI(4-CHLO-ROPHENYL)-ETHANE
1,1,1-TRICLORO-2,2-BIS(4-CLORO-FENIL)-ETANO (ITAL-IAN)

TOXICITY DATA: 3	CODEN:
cyt-hmn:lym 200 ug/1/72H	MUREAV 40,131,76
dlt-rat-ori 100 mg/kg	FCTXAV 11,53,73
spm-rat-ori 1 gm/kg/2D-I	BECTA6 14,171,75
cyt-mus-ipr 50 ppm	CNJGA8 16,491,74
cyt-mus-unk 50 mg/kg	PHTHDT 6,147,79
dlt-mus-ori 100 mg/kg	PHTHDT 6,147,79
dlt-mus-unk 200 mg/kg/10W-I	PHTHDT 6,147,79
ori-rat TDLo:19 gm/kg/2Y-C:NEO	IJCNAW 19,179,77
ori-mus TDLo:73 mg/kg/26W-C:CAR	FCTXAV 7,215,69
scu-mus TDLo:370 mg/kg/80W-I:NEO	IJCNAW 19,725,77
ori-mus TD:11 gm/kg/78W-C:ETA	NCITR* NCI-CG-TR-131,78
ori-mus TD:7560 mg/kg/90W-C:NEO	FCTXAV 11,433,73
ori-mus TD:5600 mg/kg/80W-I:NEO	IJCNAW 19,725,77
ori-rat TD:8100 mg/kg/2Y-C:ETA	TXAPA9 11,88,67
ori-inf LDLo:150 mg/kg	BMJOAE 2,845,45
ori-hmn TDLo:6 mg/kg:CNS	DTLVS* 3,68,71
unk-man LDLo:221 mg/kg	85DCAI 2,73,70
ori-rat LD50:113 mg/kg	TXAPA9 2,89,60
skn-rat LD50:1931 mg/kg	SPEADM 74-1,-,74
ipr-rat LD50:74 mg/kg	ANTBAL 14,316,69
scu-rat LD50:1500 mg/kg	BMJOAE 1,865,45
ivn-rat LDLo:30 mg/kg	JPETAB 86,213,46
ivn-rat LD50:68 mg/kg	ANTBAL 14,316,69
ori-mus LD50:135 mg/kg	FEPRA7 12,368,53
ipr-mus LD50:77 mg/kg	ANTBAL 14,316,69
ivn-mus LD50:68500 ug/kg	ANTBAL 14,316,69
ori-dog LDLo:300 mg/kg	MEMOAQ 4,25,50
ivn-dog LDLo:75 mg/kg	JPETAB 86,213,46
ori-mky LD50:200 mg/kg	AVPCAQ 12,31,75
ivn-mky LDLo:50 mg/kg	JPETAB 86,213,46
ori-cat LDLo:250 mg/kg	JPETAB 86,213,46
ivn-cat LDLo:40 mg/kg	JPETAB 86,213,46
ori-rbt LD50:250 mg/kg	PCOC** -,347,66
skn-rbt LD50:300 mg/kg	BMJOAE 1,865,45
scu-rbt LD50:250 mg/kg	BMJOAE 1,865,45
ivn-rbt LDLo:50 mg/kg	JPETAB 86,213,46
ori-gpg LD50:150 mg/kg	JETOAS 7,159,74
skn-gpg LD50:1000 mg/kg	BMJOAE 1,865,45
scu-gpg LD50:900 mg/kg	BMJOAE 1,865,45
ori-ckn LDLo:300 mg/kg	MEMOAQ 4,25,50
ori-frg LD50:7600 ug/kg	ENVPAF 20,45,79
scu-frg LD50:35 mg/kg	AIPTAK 74,343,47
ori-dom LDLo:300 mg/kg	MEMOAQ 4,25,50
dlt-oin-ori 200 ppm	ETEAAT 12,221,69
cyt-hmn:lym 200 ug/L/72H	MUREAV 40,131,76
cyt-rat:oth 10 ug/L	34LXAP -,555,76
ori-rat TDLo:390 mg/kg (1-20D preg)	GISAAA 45(6),14,80
ipr-rat TDLo:60 mg/kg (3D pre)	TXAPA9 18,348,71
scu-mus TDLo:418 mg/kg (6-14D preg)	NTIS** PB223-160
unk-mus TDLo:3 mg/kg (10-17D preg)	TXAPA9 22,327,72
ori-dog TDLo:3540 mg/kg (MGN)	AECTCV 6,83,77
ori-rbt TDLo:150 mg/kg (7-9D preg)	AIPTAK 192,286,71
ori-mus TDLo:3408 mg/kg (MGN) TFX:NEO	IJCNAW 11,688,73

Aquatic Toxicity Rating: TLm96:under 1 ppm WQCHM* 2,-,74. Carcinogenic Determination: Animal Suspected IARC** 5,83,74. *TLV:* Air: 1 mg/m3 DTLVS* 4,117,80; *Toxicology Review:* JSIRAC 34,462,75; AABIAV 35,505,48; ATXKA8 29,1,72; ADCSAJ 1,160,50; ENVRAL 7(2),243,74; RREVAH 48,141,73; RREVAH 59,119,75; ADCSAJ 1,160,50; RREVAH 61,37,75; NOALA4 41(217),271,75; MZUZA8 (8),90,73; CNDQA8 10(3),43,75; ECMAAI 14(3),141,73; DTTIAF 80(20),485,73; RREVAH 56,107,75; AJDDAL 20,331,53; AJMEAZ 38,409,65; ETOXAC 7,1,76; IRGGAJ 24,193,68; BISNAS 20,958,70; 85CVA2 5,250,70; PTPAD4 7,513,79; CTOXAO 13,231,78; EESADV 1,89,77; EESADV 1,503,78; BNYMAM 54,413,78; 27ZTAP 3,45,69. OSHA Standard: Air: TWA 1 mg/m3 (skin) (SCP-S) FEREAC 39,23540,74. DOT: ORM-A, Label: None FEREAC 41,57018,76. NCI Carcinogenesis Bioassay Completed: Results Negative (NCITR* NCI-CG-TR-131,78). "NIOSH Manual of Analytical Methods" VOL 3 S274. Reported in EPA TSCA Inventory, 1980. EPA TSCA 8(a) Preliminary Assessment Information Proposed Rule FERREAC 45,13646,80.

THR: HIGH via oral and dermal routes. Used as a food additive permitted in the food and drinking water of animals and/or for the treatment of food-producing animals. Also a food additive permitted in food for human consumption. *Note:* DDT is a common air contaminant.

DDT is readily absorbed from the intestinal tract and, if it occurs in the air in the form of an aerosol or dust, it may be taken into the lung and readily absorbed. DDT is not, however, absorbed from the skin unless it is in solution. Solutions are absorbed from the skin and, by the same token, emulsions are absorbed to some extent. Likewise, fats and oils from whatever source increase the absorption of DDT from the intestine. DDT acts on the CNS, but the exact mechanism of this action either in man or in animals has not been elucidated. DDT is an exper MUT, CARC, ETA, NEO. See chlorinated hydrocarbons. Large doses of DDT also induce nausea and/or diarrhea in man; how-

Tever, whether this is a central or local action is not yet clear. Chronically, DDT produces microscopic changes in the liver and kidneys in some exper animals. This has not been demonstrated in man. DDT is secreted in the milk and, as an acid derivative is excreted in the urine of rabbits, dogs and man. DDT and certain of its degradation products, particularly DDE, are stored in fat. Such storage results either from a single large dose or from repeated small doses. DDT stored in the fat is at least largely inactive since a greater total dose may be stored in an exper animal than is sufficient as a lethal dose for that same animal if given at one time. A study based on 75 human cases reported an average of 5.3 ppm of DDT stored in the fat. A higher content of DDT and its derivatives (up to 434 ppm of DDE and 648 ppm of DDT) was found in workers who had very extensive exposure. Without exception, the samples were taken from persons who were either asymptomatic or suffering from some disease completely unrelated to DDT. Careful hospital examination of workers, who had been very extensively exposed and who had volunteered for examination revealed no abnormality which could be attributed to DDT. Much higher levels than have been found in man have been observed in the fat of exper animals which were apparently asymptomatic. DDT stored in the fat is eliminated only very gradually when further dosage is discontinued. After a single dose, the secretion of DDT in the milk and its excretion in the urine reach their height within a day or two and continue at a lower level thereafter.

Dangerous Acute Dose in Man: A dose of 20 g has proved highly dangerous though not fatal to man. This dose was taken by 5 persons who vomited an unknown portion of the material and even so recovered only incompletely after 5 weeks. Smaller doses produced less important symptoms with relatively rapid recovery. Exper ingestion of 1.5 g resulted in great discomfort and moderate neurological changes including paraesthesia, tremor, moderate ataxia, exaggeration of part of the reflexes, headache, and fatigue. Vomiting followed only after 11 hours. Recovery was complete on the following day. The fatal dose of DDT for man is not known. Judging from the literature, no one has ever been killed by DDT in the absence of other insecticides and/or a variety of toxic solvents. However, these common solvent formulations are highly fatal when taken in small doses, partly because of the toxicity of the solvent, and perhaps because of the increased absorbability of the DDT; several fatal cases in man have been reported. Acute oral toxicity for man = 250 mg/kg. Acute oral LD_{50} (rat) = 113 mg/kg (tech grade). Federal fruit and vegetable tolerance = 7 ppm.

Dangerous Chronic Dose in Man: Even less is known of the hazard of chronic DDT poisoning. It is known that certain exper animals fed diets containing one part of DDT per million store the compound in their fat. The storage of DDT in man has been mentioned above. The exact significance of these findings is not known and their further investigation is of the greatest importance. Human volunteers have ingested up to 35 mg/day for 21 months with no ill effects.

Signs and Symptoms of Poisoning in Man: In patients who ate substantial doses of DDT in flour, the symptoms observed were vomiting, numbness and partial paralysis of the extremities, mild convulsions, loss of proprioception and vibratory sensation of the extremities, and hyperactive knee jerk reflexes. Symptoms appeared in 30 to 60 min after eating the DDT. The paralysis and numbness were most evident in the most distal portions of the extremities, and their intensity was directly proportional to the amount of DDT ingested. All the patients were apprehensive and excited; respiration was moderately rapid; pulse remained slow to normal. The immediate protective mechanism in man, following substantial doses, is vomiting. With smaller doses, nausea and vomiting are less prominent, but diarrhea has been observed. Signs and symptoms of chronic poisoning in man are unknown, although, judging from the observed microscopic changes in exper animals, liver and kidney dysfunctions should be looked for. The primary irr of DDT is practically nil, and it has little or no tendency to produce allergy. Dermatitis induced by DDT has occasionally been reported, but these reports are unconfirmed; nevertheless the phenomenon should be expected to occur in rare instances.

Laboratory Findings: Laboratory findings are essentially negative except for the presence of DDT which may be quantitatively measured in stomach contents, urine, or tissues.

Treatment of Poisoning: Depending on the condition of the patient, attention should first be given to the sedation or to the removal of poison which may have been taken internally. Stomach lavage and saline laxatives may be used. Oil laxatives should be avoided; they promote absorption of DDT and of many organic solvents. The five drugs of choice, arranged roughly in order of their effectiveness, are phenobarbital, pentobarbital, paraldehyde, urethane, and calcium gluconate. Phenobarbital, which has been used in doses up to 0.7 g per day in epilepsy, and pentobarbital (0.25 to 0.5 g) are the barbiturates known to control convulsions of central origin. Paraldehyde (average dosage 15 cc orally, 1 cc undiluted intravenously, 35 cc rectally in normal saline) controls the convulsions of DDT-poisoned animals. Urethane (human dosage 1 to 4 g) has proved very effective in rats, but it should be remembered that the hypnotic and narcotic effects of urethane are not correspondingly high in man. Urethane has an added advantage, however, of being tolerated in the young and the aged. The object of sedation is not to induce sleep but to restore a relative calm; however, the proper dosage in the presence of poisoning may be so large that it would induce anesthesia if poisoning were not present.

Calcium gluconate has been used less than the other antidotes, but it is reported to control DDT-induced convulsions in several animals. Since its mechanism

of action is entirely different, it may be used in addition to sedatives. Epinephrine is contraindicated.
For further information see Vol. 1, No. 3 of *DPIM Report.*

DEACETYLCEPHALOTHIN SODIUM SALT

NIOSH #: XI 0383500
mf: $C_{14}H_{13}N_2O_5S_2 \cdot Na$; mw: 376.40

SYN: DESACETYLCEPHALOTHIN SODIUM

TOXICITY DATA:	1	CODEN:
ipr-rat LD50:8877 mg/kg		JJANAX 28.81.75
ivn-rat LD50:6116 mg/kg		JJANAX 28.81.75
ipr-mus LD50:8754 mg/kg		JJANAX 28.81.75
ivn-mus LD50:6600 mg/kg		JJANAX 28.81.75

THR: LOW ipr, ivn.
Disaster Hazard: When heated to decomp it emits very tox fumes of SO_x and NO_x.

DEACETYL-HT-2 TOXIN

CAS RN: 34114-98-2 NIOSH #: YD 0105000
mf: $C_{19}H_{30}O_7$; mw: 370.49

SYNS:
12,13-EPOXY-3-ALPHA,4-BETA,8-ALPHA,15-TETRAHYDROXY TRICHOTHEC-9-ENE-8-ISOVALERATE
3-ALPHA,4-BETA,15-TRIHYDROXY-8-ALPHA (3-METHYLBUTYRYLOXY)-12,13-EPOXY-TRICHOTHEC-9-ENE

TOXICITY DATA:	3	CODEN:
orl-ckn LD50:30180 ug/kg		AEMIDF 35.636.78

THR: HIGH orl.
Disaster Hazard: When heated to decomp it emits acrid smoke and fumes.

DEACETYLMULDAMINE

CAS RN: 36069462 NIOSH #: QG 1360000
mf: $C_{27}H_{46}NO_2$; mw: 416.74

TOXICITY DATA:	3	CODEN:
orl-ham TDLo:150 mg/kg (7D preg)		JAFCAU 26.561.78

THR: HIGH orl.
Disaster Hazard: When heated to decomp it emits tox fumes of NO_x.

2-DEAMINOACTINOMYCIN D

CAS RN: 10118328 NIOSH #: AU 1595000
mf: $C_{62}H_{85}N_{11}O_{16}$; mw: 1240.0

TOXICITY DATA:	CODEN:
ind-mam-ivm 5200 nmol/L	JMCMAR 20.1055.77

THR: MUT data.
Disaster Hazard: When heated to decomp it emits tox fumes of NO_x.

7-DEAZAINOSINE

CAS RN: 2862160 NIOSH #: UY 9450000
mf: $C_{11}H_{13}N_3O_5$; mw: 267.27

TOXICITY DATA:	3	CODEN:
orl-rat LD50:26 mg/kg		CNREA8 29.116.69
ipr-rat LD50:25 mg/kg		CNREA8 29.116.69
scu-rat LD50:24 mg/kg		CNREA8 29.116.69
ipr-mus LD50:30 mg/kg		CNREA8 29.116.69
orl-dog LDLo:48 mg/kg		CNREA8 29.116.69
ivn-dog LDLo:48 mg/kg		CNREA8 29.116.69

THR: HIGH orl, ipr, scu, ivn.
Disaster Hazard: When heated to decomp it emits tox fumes of NO_x.

DECABORANE(14)

CAS RN: 17702419 NIOSH #: HD 1400000
mf: $B_{10}H_{14}$; mw: 122.24

Colorless needles, mp: 99.7°, d: 0.94, (solid), d: 0.78 (liquid @ 100°), vap. press: 19 mm @ 100°.

SYN:
DECABORANE (DOT)
BORON HYDRIDE

TOXICITY DATA:	3-2	CODEN:
orl-rat LD50:64 mg/kg		MLSR** No.8.51
ihl-rat LC50:46 ppm/4H		AMIHAB 17.362.58
skn-rat LD50:740 mg/kg		AMIHAB 11.132.55
ipr-rat LD50:23 mg/kg		AMIHBC 8.335.53
orl-mus LD50:40 mg/kg		AMIHAB 11.132.55
ihl-mus LC50:12 ppm/4H		NTIS** AD224-006
ipr-mus LD50:32 mg/kg		AMIHAB 11.132.55
ipr-dog LDLo:10 mg/kg		AMRL** TR-65-49
skn-rbt LD50:71 mg/kg		AMIHAB 11.132.55
ipr-rbt LD50:28 mg/kg		AMIHBC 8.335.53

TLV: Air: 0.05 ppm DTLVS* 4.118.80. OSHA Standard: Air: TWA 300 ug/m3 (skin) (SCP-Q) FEREAC 39.23540.74. DOT: Flammable Solid, Label: Flammable Solid and Poison FEREAC 41.57018.76. Reported in EPA TSCA Inventory, 1980. EPA TSCA 8(a) Preliminary Assessment Information Proposed Rule FEREAC 45.13646.80. AIHQA5 16.280.55.
THR: HIGH orl, ihl, ipr, skn. MOD skn. See also boron compounds and boron hydrides. Self-ignites in O_2.
Disaster Hazard: When heated to decomp it emits tox fumes of B oxides.
Incomp: ethers, halocarbons; O_2 @ 100°; dimethyl sulfoxide.
For further information see Vol. 1, No. 8 of *DPIM Report.*

1,1a,3,3a,4,5,5a,5b,6-DECACHLOROOCTAHYDRO-2-HYDROXY-1,3,4-METHENO-1H-CYCLOBUTA(c,d)-PENTALENE-2-LEVULINIC ACID, ETHYL ESTER

CAS RN: 4234791 NIOSH #: PC 8400000
mf: $C_{17}H_{12}Cl_{10}O_4$; mw: 634.79

SYNS:
GC-9160
KELEVAN

TOXICITY DATA:	3	CODEN:
orl-rat LD50:255 mg/kg		BESAAT 15.96.69
orl-dog LD50:400 mg/kg		BESAAT 15.96.69
skn-rbt LD50:188 mg/kg		BESAAT 15.96.69

Toxicology Review: RREVAH 63.45.76.

Material Safety Data Sheet

from Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 385

ETHYL BENZENE
(Revision A)
Issued: August 1978
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name: ETHYL BENZENE

Description (Origin/Uses): Used as a solvent and as an intermediate in the production of styrene monomer.

Other Designations: Phenylethane; Ethylbenzol; $C_2H_5C_6H_5$; CAS No. 0100-41-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 3 / 2 / 0 / -

HMIS
H 2
F 3
R 0
PPG*
*See sect. 8

R 1
I 3
S 2
K 4

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Ethyl Benzene, CAS No. 0100-41-4	Ca 100	**OSHA PELs** 8-Hr TWA: 100 ppm, 435 mg/m³ 15- Min STEL: 125 ppm, 545 mg/m³ **ACGIH TLVs, 1988-89** TLV-TWA: 100 ppm, 435 mg/m³ TLV-STEL: 125 ppm, 545 mg/m³ **Toxicity Data*** Human, Inhalation, TC_{Lo}: 100 ppm (8 Hrs) Rat, Oral, LD_{50}: 3500 mg/kg

*See NIOSH, *RTECS* (DA0700000), for additional data with references to reproductive, irritative, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 277°F (136°C)
Melting Point: -139°F (-95°C)
Vapor Pressure: 7.1 Torrs at 68°F (20°C)
Vapor Density (Air = 1): 3.7
% Volatile by Volume: Ca 100

Molecular Weight: 106 Grams/Mole
Solubility in Water (%): Slight
Specific Gravity (H_2O = 1): 0.86258 at 77°F (25°C)

Appearance and Odor: A clear, colorless, flammable liquid; characteristic aromatic hydrocarbon odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method: 64°F (18°C) CC	Autoignition Temperature: 810°F (432.22°C)	LEL: 1% v/v	UEL: 6.7% v/v

Extinguishing Media: Use foam, dry chemical, or carbon dioxide to put out ethyl benzene fires. A water spray may be ineffective in extinguishing the fire, because it can scatter and spread the burning liquid. Use water spray to cool fire-exposed containers of ethyl benzene, to disperse ethyl benzene vapor, and to protect personnel attempting to stop an ethyl benzene leak. **Unusual Fire or Explosion Hazards:** This liquid can readily form explosive vapor-air mixtures, especially when heated. Ethyl benzene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back to its origin. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Ethyl benzene is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Hazardous chemical reactions can occur between ethyl benzene and strong oxidizing agents, acids, ammonia, and bases. **Conditions to Avoid:** Avoid any exposure to sources of ignition such as heat, sparks, open flame, and lighted tobacco products, etc., and to incompatible chemicals. Use caution when entering confined spaces, particularly low-lying areas where explosive concentrations of ethyl benzene vapor may be present. Provide good ventilation to such areas to prevent the concentration of this vapor. **Hazardous Products of Decomposition:** Thermal-oxidative degradation can include toxic gases such as carbon monoxide and/or aromatic hydrocarbon gases.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Ethyl benzene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Ethyl benzene vapor is severely irritating to the eyes and to the mucous membranes of the respiratory system. Sustained inhalation of excessive levels can cause depression of the central nervous system (CNS) characterized by dizziness, headache, narcosis, and coma. Skin contact with liquid ethyl benzene causes irritation; dermatitis and defatting can also develop. The acute oral toxicity of ethyl benzene is low; however, ingestion of it presents a serious aspiration hazard. Aspirating even a small amount into the lungs can result in extensive edema (lungs filled with fluid) and hemorrhaging of the lung tissue. No systemic effects are expected at the levels that produce pronounced, unignorable, disagreeable skin and eye irritation. The TLVs cited in section 2 are set to prevent this intolerable irritation. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, and CNS. **Primary Entry:** Inhalation, skin contact **Acute Effects:** Irritation of the skin, eyes, and respiratory system. Also, cardiac-rhythm disturbance due to sensitization; acute bronchitis, bronchospasm, pulmonary and laryngeal edema; euphoria; headache; giddiness; dizziness; and incoordination, as well as possible depression; confusion; and coma. **Chronic Effects:** None reported. **First Aid: Eyes.** Immediately

SECTION 6. HEALTH HAZARD INFORMATION, cont.

flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with plenty of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Unlikely. Should this type of exposure occur, the aspiration hazard must be considered. Do not induce vomiting unless directed to do so by a physician. To prevent aspiration by spontaneous vomiting, keep the victim's head low (between his or her knees). **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Professional judgment is required as to whether or not to induce vomiting because of the possibility of aspiration. A gastric lavage may be administered, followed by saline catharsis, if this procedure is appropriate to the specific incident. Monitor cardiac and pulmonary functions.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

EPA Designations (40 CFR 302.4)

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), §§ 311 (b) (4) and 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard: soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale ethyl benzene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store ethyl benzene in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. **Special Handling/Storage:** Outside, isolated, detached, or remote storage is recommended for large quantities of ethyl benzene. Isolate bulk storage areas from acute fire hazards. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations. **Other:** Use safety cans for transferring small amounts of ethyl benzene.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Ethyl Benzene
DOT Hazard Class: Flammable Liquid
ID No. UN1175
DOT Label: Flammable Liquid
DOT Packaging Exceptions: 49 CFR 173.118
DOT Packaging Requirements: 49 CFR 173.119

IMO Shipping Name: Ethylbenzene
IMO Hazard Class: 3.2
IMO Label: Flammable Liquid
IMDG Packaging Group: II

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 397
***n*-Hexane**

Issued: 8/83 Revision: C, 8/89

Section 1. Material Identification

***n*-Hexane Description:** ***n*-Hexane** is the chief constituent of petroleum ether or liqroin. Used to determine the refractive index of minerals; and as a mercury replacement in thermometers (usually with blue or red dye).
Other Designations: Normal-hexane; C_6H_{14}; CAS No. 0110-54-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.
Comments: See *MSDS Colletion*, No. 397A, for isohexanes.

R 1
I 3
S 2
K 4

NFPA
HMIS
H 1
F 3
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

n*-Hexane, ca 100%

OSHA PEL
8-hr TWA: 50 ppm, 180 mg/m³

ACGIH TLV, 1988-89
TLV-TWA: 50 ppm, 180 mg/m³

Toxicity Data†
Human, inhalation, TC_{Lo}: 5000 ppm/10 min
Rat, oral, LD_{50}: 28,710 mg/kg

* *n*-Hexane is this product's major component; however, possible contaminants are other isomers of hexane, C_5 to C_7 saturated hydrocarbons, C_5 to C_7 olefinic hydrocarbons, and aromatic hydrocarbons.
† See NIOSH, *RTECS* (MN9275000), for additional data with references to reproductive, irritative, and neurological effects.

Section 3. Physical Data

Boiling Point: 156.11 °F (68.95 °C)
Melting Point: ca -139 °F (-95 °C)
Vapor Pressure: 124 torr at 68 °F (20 °C)
Vapor Density (Air = 1): 3.0
Molecular Weight: 86 g/mol
Specific Gravity (H_2O = 1): 0.66 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear, colorless, mobile, volatile, flammable liquid: a mild hydrocarbon odor.

Section 4. Fire and Explosion Data

Flash Point: -22 °F (-30 °C) CC	Autoignition Temperature: 473 °F (223 °C)	LEL: 1.2% v/v	UEL: 8% v/v

Extinguishing Media: Use carbon dioxide (CO_2), foams, or dry chemical to put out *n*-hexane fires. Never direct solid streams of water into burning pools of liquid since this can scatter and spread the fire. Use water sprays to cool fire-exposed containers, prevent dangerous pressure rise and/or rupture, disperse vapors, and flush unignited spills away from sensitive exposures.
Unusual Fire or Explosion Hazards: *n*-Hexane is a very flammable, volatile liquid which burns like gasoline. It represents a dangerous fire and explosion hazard. Since it evaporates quickly, the resulting denser-than-air vapors can flow along surfaces, collect in low-lying or enclosed areas like sumps and utility rooms, reach distant sources of ignition, and flash back to the original liquid.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

Section 5. Reactivity Data

Stability/Polymerization: *n*-Hexane is stable at room temperature during routine operations. Hazardous polymerization cannot occur.
Chemical Incompatibilities: *n*-Hexane can react violently with strong oxidizing agents.
Conditions to Avoid: Never expose this liquid to any ignition source (heat, sparks, open flames, or uninsulated heating elements).
Hazardous Products of Decomposition: Thermal oxidative degradation of *n*-hexane can produce carbon dioxide and toxic carbon monoxide (CO).

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Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists *n*-hexane as a carcinogen.
Summary of Risks: The metabolic products of *in vivo* partial oxidation of *n*-hexane include 2, 5-hexanedione. This metabolite is the most highly neurotoxic compound formed from *n*-hexane. Occupational exposures to *n*-hexane are associated with chronic neurotoxic damage to the central nervous system (CNS) and the peripheral nervous system (PNS). The effects are not permanent; Genium reference 100 notes that recovery from neuropathy is usually complete within a year after the exposure. Methyl *n*-butyl ketone (MBK) (*MSDS Collection*, No. 425) produces the neurotoxic metabolite 2, 5-hexadione in even greater quantities than the *n*-hexane. Prevent simultaneous exposures to *n*-hexane and MBK. Genium reference 89 notes: "...concurrent exposure to methyl ethyl ketone, and possibly other chemicals or drugs which boost liver oxidative mechanisms, reduces the time for neuropathy to appear as a result of exposure to both *n*-hexane and MBK." **Medical Conditions Aggravated by Long-Term Exposure:** CNS and PNS disorders, vision defects, and memory diminution. **Target Organs:** Skin, eyes, CNS, PNS. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Irritation of eyes, nose, and upper respiratory tract (URT); dermal erythema (abnormally red skin from capillary congestion), edema (abnormal accumulation of clear, watery fluid in body tissue), and vesiculation (blistering). Acute inhalation causes headache, dizziness, nausea, narcosis, and coma. High concentrations may act as asphyxiants. **Chronic Effects:** Anorexia, nausea, weight loss, malaise; muscular weakness, pain, and spasms in extremities; neurotoxic effects like sensorimotor polyneuropathy, generalized polyneuropathy, and other degenerative changes in the peripheral nervous system (PNS).

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Have a qualified medical personnel adminsister oxygen as required. **Ingestion:** Never induce vomiting! Severe aspiration hazard exists. If vomiting occurs spontaneously, lower victim's head to the knee level. Never give anything by mouth to an unconscious or convulsing person. Administer several ounces of edible oil to drink.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a n-hexane spill control and countermeasure plan (SCCP).* When a spill occurs, notify safety personnel, evacuate unnecessary personnel, eliminate heat and ignition sources, provide maximum explosion-proof ventilation, and implement the SCCP. Cleanup personnel should wear fireproof personal protective equipment (Sec. 8).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Subpart Z)
EPA Designations
Assigned the RCRA Hazardous Waste No. D001 (40 CFR 261.21, Ignitability)
Assigned as a CERCLA Hazardous Substance (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg)
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Where splashing is possible, wear a full face shield. **Respirator:** Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, washing facilities, and properly serviced fire extinguishers. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Other:** Preplacement and periodic medical exams focusing on the skin nd the central nervous system are advised.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Handle this flammable, volatile material with appropriate caution.

Section 9. Special Precautions and Comments

Storage Requirements: Store *n*-hexane in closed containers in a cool, dry, well-ventilated, fireproof area away from heat and ignition sources and incompatible chemicals. Protect these containers from physical damage; shield them from direct sunlight.
Engineering Controls: To prevent static sparks, electrically ground and bond all containers, tank cars, and pipes used in shipping, receiving, or transferring operations in production and storage areas. All electrical services, including lights, must be sparkproof.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Hexane
DOT Hazard Class: Flammable liquid
DOT ID No.: UN1208
DOT Label: Flammable liquid
DOT Packaging Requirements: 49 CFR 173.119
DOT Packaging Exceptions: 49 CFR 173.118

IMO Shipping Name: Hexane *(and its isomers)*
IMO Hazard Class: 3.1
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection **References:** 1, 6, 7, 84-94, 100, 116, 117, 119, 120, 122
Prepared by: PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 30A

HYDROCHLORIC ACID
(Revision B)
Issued: October 1977
Revised: November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name: HYDROCHLORIC ACID

Description (Origin/Uses): Used in the production of chlorides; in refining ore in the production of tin and tantalum; for the neutralization of bases; for pickling and cleaning metal products; for oil- and gas-well treatments; and in removing scale from boilers and heat-exchange equipment.

NFPA: 3 0 0 -

Other Designations: Aqueous Hydrogen Chloride; Muriatic Acid; HCl/H_2O; CAS No. 7647-01-0

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS	
H 3	R 1
F 0	I 4
R 0	S 4
PPG*	K 0
*See sect. 8	

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Hydrogen Chloride, CAS No. 7647-01-0	38 or Less	**OSHA PEL** Ceiling: 5 ppm, 7 mg/m³
Water	Balance*	**ACGIH TLV, 1988-89** TLV-Ceiling: 5 ppm, 7 mg/m³
*Impurities such as iron, chlorine, and traces of organic matter may be present in small amounts, depending on the grade of acid. **See NIOSH, *RTECS* (MW4025000), for additional data with references to reproductive and mutagenic effects. Continue to monitor NIOSH, *RTECS* (MW40300000), for toxicity data on hydrochloric acid itself.		**Toxicity Data**** Human, Inhalation, LC_{Lo}: 1300 ppm (30 Mins) Rat, Inhalation, LC_{50}: 3124 ppm (1 Hr) Rabbit, Oral, LD_{50}: 900 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 227°F (109°C) (20.22%)
Melting Point: -85°F (-65°C) (20.69%)
Vapor Density (Air = 1): 1.268
pH: Strong Mineral Acid
Molecular Weight: Not Applicable
Solubility in Water (%): Complete
Specific Gravity (H_2O = 1): >1
% Volatile by Volume: Ca 100

Appearance and Odor: A clear, colorless-to-lightly yellowed, fuming liquid; sharp, pungent, characteristic, irritating odor of hydrogen chloride gas. This odor is detectable at 1 to 5 ppm and becomes unpleasant and irritating at 5 to 10 ppm; however, the odor serves as a good warning property.

Comments: The specific physical properties of aqueous hydrochloric acid solutions vary with the amount of dissolved hydrogen chloride gas. Hydrochloric acid forms a constant boiling azeotrope (a mixture of hydrochloric acid and water that behaves like a single substance in that its vapor has the same composition as the mixture itself) with water (at 227°F or 109°C) that contains 20.22% hydrogen chloride and has a density of 1.096. Boiling weaker or stronger aqueous solutions results in the loss of either component until the constant boiling acid is produced.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	LEL	UEL
*	*	*	*

Extinguishing Media: *Hydrochloric acid solutions do not burn. Use extinguishing agents that will put out the surrounding fire. **Unusual Fire or Explosion Hazards:** Use a water spray to cool fire-exposed containers of hydrochloric acid to prevent ruptures. Explosive hydrogen gas can be produced by the reaction of hydrochloric acid with metals such as iron. Neutralize spilled hydrochloric acid with limestone, slaked lime, or soda ash to minimize the possible generation of hydrogen gas. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Special neutralization procedures, if applicable, include the application of chemically basic substances such as soda ash or slaked lime.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Hydrochloric acid is stable in closed containers during routine operations at room temperature. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Hydrochloric acid reacts dangerously with acetic anhydride, 2-aminoethanol, ammonium hydroxide, calcium phosphide, chlorosulfonic acid, ethylene diamine, ethylenimine, oleum, perchloric acid, ß-propiolactone, propylene oxide, silver perchlorate and carbon tetrachloride, sodium hydroxide, sulfuric acid, uranium phosphide, vinyl acetate, sodium, and many carbide compounds (Genium ref. 84). This material is a strong mineral acid that is very reactive with bases. **Conditions to Avoid:** Avoid exposure to incompatible chemicals and to any other material whose compatibility with hydrochloric acid or its vapor has not yet been established. The corrosive action of hydrochloric acid on most metals can liberate extremely flammable/explosive hydrogen gas (H_2); piping systems and containment systems must be chosen carefully. **Hazardous Products of Decomposition:** During fires hydrochloric acid may decompose by reacting with certain metals to produce very flammable and explosive hydrogen gas (H_2). Significant amounts of hydrogen chloride gas (HCl) are given off at room temperature; the rate of this generation increases as the temperature and the strength (1%) by weight of HCl in H_2O increase. **Comments:** Reactions between hydrochloric acid and cyanides, sulfides, and formaldehyde, will produce extremely toxic hydrogen cyanide (HCN), hydrogen sulfide (H_2S), sulfur dioxide (SO_2), and *bis*chloromethylether, respectively.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Hydrochloric acid is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: See Genium Industrial MSDS 30 for details of the health effects of hydrogen chloride gas. Hydrochloric acid solutions will generate hydrogen chloride gas with all its health effects. These are irritating to the skin, eyes, and mucous membranes of the upper respiratory tract (URT). The severity of eye injury from splashes depends upon quantity, concentration/strength, and duration of the contact. Permanent visual damage has been reported. Ingestion of hydrochloric acid causes corrosion of the mucous membranes, esophagus, and stomach, as well as nausea, vomiting, intense thirst, and diarrhea. Erosion of exposed teeth may occur. Circulatory collapse and death are possible. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, URT. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Corrosive skin and eye burns, tissue damage, and severe irritation of the URT. **Chronic Effects:** None reported. **FIRST AID:** **Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water and then wash it with soap and water. Remove contaminated clothing under a safety shower. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Not likely. Should this type of exposure occur, and the exposed person is responsive, give him or her 2 to 3 glasses of water, then milk of magnesia or limewater to drink. Do not induce vomiting. Spontaneous laryngeal spasms can occur. Never give anything by mouth to someone who is unconscious or convulsing. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to physician:** Treatment for respiratory effects following inhalation of hydrogen chloride gas includes using a 5% sodium bicarbonate solution as an aerosol; maintaining a proper fluid balance (diuretics may be useful); and decreasing the inflammatory response of the lungs by administering steroids on a short-term basis (2 to 4 days). Severe inhalation exposure requires hospitalization and observation (72-hour minimum) for the delayed onset of pulmonary edema. Serial chest X rays and respiratory support, including intubation, may be required as an early intervention.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately (hydrogen gas may be generated), and provide adequate ventilation. Cleanup personnel need a full set of protective clothing, including a self-contained breathing apparatus (SCBA). Small spills and residue can be covered with an excess of a mixture of soda ash and slaked lime. After neutralization, do not flush waste directly to a sewer or into lakes, ponds, or streams. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. The allowable concentration of neutral salt in the effluent discharge is apt to be regulated; study and follow Federal, state, and local regulations. Consider saving the waste hydrochloric acid for use as a neutralizing agent during cleanup operations of basic materials.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
CERCLA Hazardous Substance, Reportable Quantity: 5000 lbs (2270 kg), per the Clean Water Act (CWA), §311 (b) (4)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. All respirators must be acid resistant. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent any contact with this material. All clothing must be acid resistant. **Ventilation:** Install and operate general and local maximum-explosion-proof ventilation systems powerful enough to maintain airborne levels of hydrogen chloride below the OSHA PEL cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. Make ventilation system ductwork and exposed fan components acid resistant. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Other:** Design all engineering systems to be acid resistant and explosion proof (hydrogen gas may be accidentally generated). **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale hydrochloric acid vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store hydrochloric acid in closed containers in a cool, dry, well-ventilated area away from sources of ignition, strong oxidizers, strong bases, out of direct sunlight, and away from incompatible chemicals (see sect. 5). Protect containers from physical damage. **Special Handling/Storage:** Storage areas should have acid-resistant floors and approved drainage facilities. Use nonsparking tools in areas around tanks and pipes where hydrogen gas may be generated. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum-explosion-proof design. Ground and bond all containers and pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent static sparks. Hydrogen gas may become concentrated inside metal equipment; perform operations to search out possible hidden areas of hydrogen gas carefully. **Other Precautions:** Carefully follow your supplier's recommendations concerning the proper handling and storage procedures for hydrochloric acid. Provide emergency neutralization materials (soda ash, limestone, or slaked lime) and equipment near storage and use areas.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Hydrochloric Acid
DOT Hazard Class: Corrosive Material
ID No. UN1789
DOT Label: Corrosive
DOT Packaging Requirements, DOT Packaging Exceptions: 49 CFR 173.263

IMO Shipping Name: Hydrochloric Acid, Solution
IMO Hazard Class: 8
IMO Label: Corrosive
IMDG Packaging Group: II

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.

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Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

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Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.
Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R	0
I	4
S	-
K	0

Genium

HMIS
H 3
F 1
R 0
PPG*
* Sec. 8

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 μg/m³
Action Level TWA*: 30 μg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 μg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 μg/m³

1988 NIOSH REL
10-hr TWA: <100 μg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 μg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*

Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system . The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

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Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[107]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

MSDS Collection **References:** 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 26

MERCURY
(Revision C)
Issued: September 1981
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION 26

Material Name: MERCURY

Description (Origin/Uses): Used in barometers, thermometers, hydrometers, and pyrometers; in mercury arc lamps producing ultraviolet rays; in switches and fluorescent lamps; as a catalyst in oxidations of organic compounds; in alloys; in explosives; and for extracting gold and silver from ore.

Other Designations: Colloidal Mercury; Metallic Mercury; Quicksilver; Hg; Hydrargyrum;
CAS No. 7439-97-6

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: Inorganic and organic mercury compounds are highly toxic, as is pure mercury.

Genium

HMIS			
H	3	R	1
F	0	I	4
R	0	S	1
PPG*		K	0

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Mercury, CAS No. 7439-97-6	Ca 100	**OSHA PEL** Ceiling: 1 mg per 10 m³ **ACGIH TLV (Skin*), 1987-88** TLV-TWA: 0.05 mg/m³ as Hg (Mercury Vapor) **Toxicity Data**** Rabbit, Inhalation, LC_{Lo}: 29 mg/m³ (30 Hrs)

*Mercury can be absorbed through intact skin, which contributes to overall exposure.

**See NIOSH, *RTECS* (OV4550000), for additional data with references to reproductive, mutagenic, and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 673°F (357°C)
Specific Gravity (H_2O = 1): 13.546 at 68°F (20°C)
Vapor Pressure: 0.0018 Torr at 77°F (25°C)
Water Solubility (%): Insoluble
Molecular Weight: 201 Grams/Mole
Melting Point: -37.93°F (-38.85°C)

Appearance and Odor: A silver, heavy liquid; odorless. **Danger:** Mercury vapor has no warning properties.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Mercury does not burn. Use extinguishing agents that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: When exposed to the high temperatures that occur during a fire, mercury can vaporize to form extremely toxic fumes.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Mercury is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous reactions involving mercury and acetylene, ammonia, boron phosphodiiodide, chlorine, chlorine dioxide, methyl azide, sodium carbide, nitric acid, oleum, and sulfuric acid are reported (Genium ref. 84).

Conditions to Avoid: Do not expose mercury to incompatible chemicals.

Hazardous Products of Decomposition: Extremely toxic mercury metal fumes are likely to be produced during fires.

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SECTION 6. HEALTH HAZARD INFORMATION

Mercury is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Mercury is very toxic due to its liquid and fat solubility, lack of charge, and membrane permeability. It is a slowly cumulative poison that concentrates in the brain, kidneys, and liver. It is very hazardous when spilled or heated. Mercury and its vapor are rapidly absorbed by the membranes lining the respiratory tract, the gastrointestinal (GI) tract, and the skin. Mercury is a teratogen (causes physical defects in embryos). **Medical Conditions Aggravated by Long-Term Exposure:** Preexisting problems of the target organs can be worsened. Provide preplacement and periodic medical exams emphasizing the target organs. **Target Organs:** Skin, eyes, respiratory system, central nervous system (CNS), kidneys. **Primary Entry:** Skin absorption/contact, inhalation. **Acute Effects:** Erosion of the respiratory/GI tracts, nausea, vomiting, bloody diarrhea, shock, headache, metallic taste. Inhalation of high concentrations for short periods can cause pneumonitis, chest pain, dyspnea, coughing, stomatitis, gingivitis, and salivation. **Chronic Effects:** Tremors, emotional problems, loss of concentration, depression, drowsiness, fatigue, insomnia, loss of memory, kidney problems, eye lesions, vision disturbances, sore mouth and throat, problems with the sense of taste or smell, nosebleeds, nasal inflammation, loss of weight or appetite, poor hand-eye coordination, awkwardness, and unsteadiness, as well as dermatitis. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water because of the increased exposure from skin absorption. **Inhalation.** Remove exposed person to fresh air; restore and/or support his or her breathing as needed. Have medical personnel administer oxygen to treat the chemical pneumonitis that may develop. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Note to physician: If indicated by degree of ingestion, saline cathartics and charcoal should be used. Chelation therapy with d-penicillamine may also be indicated.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. Treatment of chronic mercury poisoning requires expert medical care. At the first signs, immediately remove the exposed person from further exposure and have him or her examined and treated by a physician trained in occupational mercury poisoning.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, restrict access to the spill area to necessary personnel, and provide adequate ventilation. Clean up spills promptly. Specialized equipment and/or techniques may be required to safely deal with large mercury spills; if large quantities of mercury are used in the workplace, detailed, prior spill-management planning is recommended. Collect spilled mercury by using a suction pump and an aspirator bottle with a long capillary tube. For finely divided mercury in inaccessible cracks, corners, etc., treatment with calcium polysulfide and excess sulfur is recommended to convert the mercury globules into mercury sulfide. Vacuum cleaners may be used if they are equipped with specially designed mercury-absorbent exhaust filters. Collect the mercury into tightly sealed containers for later disposal or reclamation. Cleanup personnel must use the recommended personal protective equipment (see sect. 8).

Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Do not pour mercury down a drain. Mercury is very harmful to the environment. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Air Contaminant (29 CFR 19010.1000 Subpart Z)

EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste No. U151
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg)*

*Per the Clean Water Act, § 407 (a); Clean Air Act, § 112; and Resource Conservation and Recovery Act, § 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of mercury may occur, wear a full face shield or splash guard. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent any contact with mercury and the skin.

Ventilation: Install and operate general and local ventilation systems powerful enough to continuously maintain airborne levels of mercury below the OSHA PEL standard cited in section 2.

Safety Stations: Make emergency eyewash stations, washing facilities, and safety/quick-drench showers available in work areas.

Contaminated Equipment: Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean mercury from shoes and equipment. Separate work and street clothes; store work clothes in special lockers and always shower before changing to street clothes.

Comments: Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store mercury in a cool, dry, well-ventilated area in tightly closed unbreakable polyethylene containers. Protect these containers from physical damage.

Special Handling/Storage: Construct storage areas to have smooth, hard, nonporous floors with no cracks or spaces so that spilled mercury globules do not form in inaccessible areas.

Comments: Mercury evaporates slowly, but if it is spilled it can form many tiny globules that evaporate much faster than a single pool of it will. In an unventilated area, significant concentration of mercury vapor can develop from this enhanced evaporation effect. This poisonous vapor is particularly hazardous if breathed over a long period of time, so spills or releases of mercury require very meticulous cleaning procedures.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Mercury, Metal
DOT Hazard Class: ORM-B
DOT Label: None
DOT ID No. NA2809
IMO Class: 8
IMO Label: Corrosive

References: 1, 2, 8, 26, 38, 84-94, 100.

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Material Safety Data Sheets Collection:

Sheet No. 354
Methyl Alcohol

Issued: 11/77 Revision: D, 11/91

Section 1. Material Identification

36

Methyl alcohol (CH_3OH) Description: Derived from destructive distillation of wood, oxidation of hydrocarbons, or high-pressure catalytic synthesis from hydrogen and carbon dioxide or carbon monoxide. Used as a solvent in manufacturing industrial chemicals and chemical pharmaceuticals, a raw material for making formaldehyde and methyl esters, a softening agent for pyroxylin plastics, a dehydrator for natural gas, a feedstock for manufacturing synthetic proteins by continuous fermentation, an octane booster in gasoline, an extractant for animal and vegetable oils; in antifreeze for automotive radiators, air brakes, gasoline, and diesel oil; and in denaturing ethanol.
Other Designations: CAS No. 67-56-1, carbinol, Columbian spirits, methanol, methyl hydroxide, methylol, monohydroxymethane, pyroxylic spirit, wood alcohol, wood naphtha, wood spirit.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 2
S 1*
K 4
* Skin absorption

NFPA
3 / 1 / 0 / -

HMIS
H 2
F 3
R 0
PPG†
† Sec. 8

Cautions: Methyl alcohol is moderately toxic by ingestion and mildly toxic by inhalation and skin absorption. It is flammable, volatile, and a dangerous fire hazard.

Section 2. Ingredients and Occupational Exposure Limits

Methyl alcohol, ca 100%

1990 OSHA PELs (Skin)
8-hr TWA: 200 ppm (260 mg/m³)
15-min STEL: 250 ppm (310 mg/m³)

1990 IDLH Level
25,000 ppm

1991-92 ACGIH TLVs (Skin)
TWA: 200 ppm (262 mg/m³)
STEL: 250 ppm (328 mg/m³)

1990 DFG (Germany) MAK
200 ppm (260 mg/m³)

1990 NIOSH RELs (Skin)
TWA: 200 ppm (260 mg/m³)
Ceiling: 250 ppm (325 mg/m³)

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 300 ppm caused eye (visual field change), CNS (headache), and pulmonary effects
Human, oral, LD_{Lo}: 428 mg/kg causes CNS (headache) and pulmonary (respiratory change) effects
Rat, oral, TD_{Lo}: 7500 mg/kg administered continuously to the female during the 17th to 19th day of gestation produced behavioral effects on newborns
Rat, inhalation, TC_{Lo}: 20,000 ppm/7 hr administered continuously to the female during the 1st to 22nd day of gestation produced specific developmental abnormalities

* See NIOSH, *RTECS* (PC1400000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: 148 °F (64.5 °C)
Freezing Point: -144.04 °F (-97.8 °C)
Vapor Pressure: 29 mm Hg at 68 °F (20 °C)
Vapor Density (air = 1): 1.11
Viscosity: 0.00593 P at 68 °F (20 °C)
Molecular Weight: 32.05
Density: 0.7924 at 68 °F (20 °C)
Water Solubility: Soluble
Other Solubilities: Soluble in ethanol, ether, benzene, ketones, and most organic solvents

Appearance and Odor: Clear, colorless, volatile liquid with a slight alcohol odor when pure, a disagreeably pungent odor when crude, and a low 10-ppm odor threshold.

Section 4. Fire and Explosion Data

Flash Point: 54 °F (12 °C), CC	Autoignition Temperature: 878 °F (470 °C)	LEL: 6% v/v	UEL: 36.5% v/v

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray, or alcohol-resistant foam. For large fires, use water spray, fog, or alcohol-resistant foam. Do not scatter material with any more water than needed to extinguish fire.
Unusual Fire or Explosion Hazards: Methyl alcohol is a dangerous fire hazard when exposed to heat, flame, or oxidizers. It is explosive in its vapor form when exposed to heat or flame. Vapors may travel to an ignition source and flash back.
Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear full protective clothing. Structural firefighters' protective clothing is *ineffective* for fires involving methyl alcohol. If possible without risk, remove container from fire area. Apply cooling water to sides of fire-exposed container until fire is well out. Stay away from ends of tanks. Leave area immediately if you hear a rising sound from venting safety device or see any tank discoloration due to fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Methyl alcohol is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Methyl alcohol is incompatible with beryllium dihydride, metals (such as potassium or magnesium), oxidants (such as barium perchlorate, bromine, chlorine, hydrogen peroxide, and sodium hypochlorite), potassium tertbutoxide, carbon tetrachloride + metals; reacts explosively with chloroform + heat, and diethyl zinc; and reacts violently with alkyl aluminum salts, acetyl bromide, chloroform + sodium hydroxide, cyanuric chloride, and nitric acid.
Conditions to Avoid: Avoid vapor inhalation and contact with oxidizers and other incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of methyl alcohol can produce carbon oxides (CO and CO_2), possible formaldehyde (HCHO) and acrid smoke, and irritating fumes.

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Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA do not list methyl alcohol as a carcinogen.
Summary of Risks: Methyl alcohol is toxic mainly to the nervous system, particularly optic nerves, where damage can progress to permanent blindness. Poisoning may also result in metabolic acidosis. Methyl alcohol oxidizes in the body to form formaldehyde and formic acid. These derivatives are believed responsible for many of methyl alcohol's poisonous and toxic effects. Since it is eliminated slowly from the body, methyl alcohol is considered a cumulative poison. The fatal ingestion dose is 100 to 250 ml, although death is reported from less than 33 ml.
Medical Conditions Aggravated by Long-Term Exposure: None reported
Target Organs: Eyes, central nervous system, skin, and digestive tract.
Primary Entry Routes: Inhalation, ingestion, skin absorption.
Acute effects: Inhalation can cause irritation of eyes and nose, headache, fatigue, nausea, visual impairment (optic nerve neuropathy or visual field changes) or complete and possibly permanent blindness, acidosis, convulsions, circulatory collapse, respiratory failure, and death. Ingestion can cause gastrointestinal (GI) irritation followed by the symptoms described for inhalation and possible kidney impairment. Skin contact results in a feeling of coldness, dryness, and cracking possibly leading to dermatitis. Methyl alcohol can absorb through skin and may cause headache, fatigue, and visual disturbances. Eye contact causes irritation and watering of eyes, inflamed lids, and painful sensitization to light.
Chronic Effects: Chronic inhalation or skin absorption may produce visual impairment or complete blindness.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do not let victim rub or keep eyes tightly shut. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Since methyl alcohol is volatile and flammable, carefully dispose of contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Consider administering 10% ethanol in D5W intravenously to maintain ethyl alcohol blood level at 100 mg/dl. Check formic acid in urine and measure blood pH and plasma bicarbonate. After ingestion, there is typically an 18- to 48-hr latency period before clinical toxicity

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources—no flares, smoking, or flames in hazard area. Cleanup personnel should wear fully encapsulating, vapor-protective clothing for spills or leaks with no fire. Water spray may reduce vapor, but not prevent ignition in closed spaces. For small spills, use nonsparking tools to take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of spill and await disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Degradation: Aquatic toxicity rating: TLm 96, over 1000 ppm.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): Hazardous Waste No. U154
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Select the respirator based on its suitability to provide adequate worker protection for the given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent all skin contact.
Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in cool, dry, well-ventilated flammables storage area, away from strong oxidizers and other incompatibles. To prevent static sparks, electrically ground all equipment used in methyl alcohol storage, manufacture, and transportation. Use nonsparking tools.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control hazardous airborne contaminants and to maintain concentrations at the lowest practical level.
Other Precautions: Consider preplacement and periodic medical examinations of exposed workers emphasizing neurological, kidney, liver, and visual function. Practice good personal hygiene and housekeeping procedures. If respirators are used, institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Methyl alcohol
DOT Hazard Class: Flammable liquid
ID No.: UN1230
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Methanol
IMO Hazard Class: 3.2
ID No.: UN1230
IMO Label: Flammable Liquid, Poison
IMDG Packaging Group: II

MSDS Collection References: 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 140, 143, 146, 148, 149, 153, 159, 163
Prepared by: M Gannon, BA; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: AC Darlington, MD, MPH; Edited by: JR Stuart, MS

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GENIUM PUBLISHING CORP.

No. 624

NAPHTHALENE

Issued: November 1987

SECTION 1. MATERIAL IDENTIFICATION

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Material Name: NAPHTHALENE

Description (Origin/Uses): Used as a moth repellant and in many industrial processes.

Other Designations: Naphthalin; Naphthene; Tar Camphor; $C_{10}H_8$; NIOSH *RTECS* No. QJ0525000; CAS No. 0091-20-3

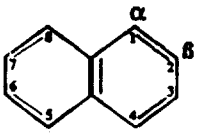
Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyer's Guide* (Genium ref. 73) for a list of suppliers.

HMIS
H 2
F 2
R 0
PPG*
*See sect. 8

R 1
I 4
S 1
K 2

SECTION 2. INGREDIENTS AND HAZARDS | % | EXPOSURE LIMITS

Naphthalene, CAS No. 0091-20-3



*Immediately dangerous to life and health
**See NIOSH *RTECS* for additional data with references to irritative, mutagenic, reproductive, and tumorigenic effects.

%	EXPOSURE LIMITS
ca 100	IDLH* Level: 500 ppm
	ACGIH TLVs, 1987-88
	TLV-TWA: 10 ppm, 50 mg/m³
	OSHA PEL
	8-Hr TWA: 10 ppm, 50 mg/m³
	Toxicity Data**
	Child, Oral, LD_{Lo}: 100 mg/kg
	Man, Unknown, LD_{Lo}: 74 mg/kg
	Rat, Oral, LD_{50}: 1250 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 424°F (218°C)
Vapor Density (Air = 1): 4.4
Vapor Pressure: 0.087 Torr at 77°F (25°C)
Water Solubility: Insoluble

Specific Gravity (H_2O = 1): 1.162 at 68°F (20°C)
Melting Point: 176°F (80°C)
Molecular Weight: 128 Grams/Mole
% Volatile by Volume: ca 100

Appearance and Odor: White crystalline flakes; strong coal tar odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
174°F (79°C) OC; 190°F (88°C) CC	979°F (526°C)	% by Volume	0.9	5.9

Extinguishing Media: Use water spray, dry chemical, or carbon dioxide to fight fires involving naphthalene. **Caution:** Foam or direct water spray applied to molten naphthalene may cause extensive foaming.

Unusual Fire or Explosion Hazards: Naphthalene is a volatile solid that gives off flammable vapor when heated (as in fire situations). This vapor is much denser than air and will collect in enclosed or low-lying areas like sumps. In these areas an explosive air-vapor mixture may form, and extra caution is required to prevent any ignition sources from starting an explosion or fire.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Naphthalene is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

Chemical Incompatibilities: Naphthalene is incompatible with strong oxidizing agents, chromic anhydride, and mixtures of aluminum trichloride and benzoyl chloride.

Conditions to Avoid: Ignition sources like open flame, unprotected heaters, excessive heat, lighted tobacco products, and electric sparks must not occur in work areas where naphthalene vapor may become concentrated.

Hazardous Products of Decomposition: Toxic gases like carbon monoxide are produced during fire conditions. Irritating, flammable vapor forms below the melting point because even solid naphthalene has a significant vapor pressure.

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SECTION 6. HEALTH HAZARD INFORMATION

Naphthalene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Renal shutdown (kidney failure), hemolytic effects (breakdown of red blood cells), hematuria (blood in the urine), oliguria (low volume of urine), jaundice, eye damage, and depression of the central nervous system (CNS) are the primary health concerns associated with exposure to naphthalene. The ACGIH TLVs in section 2 are set to prevent eye damage. These recommended exposure limits may not be low enough to prevent blood changes in genetically hypersensitive individuals.
Medical Conditions Aggravated by Long-Term Exposure: Diseases of the blood, liver, and kidneys. Administer medical exams emphasizing these organs. **Target Organs:** Eyes, skin, kidneys, liver, blood (red blood cell effects), and CNS.
Primary Entry: Inhalation, skin contact. **Acute Effects:** Inhalation of naphthalene vapor causes excitement, confusion, headache, nausea, and loss of appetite. **Chronic Effects:** Increased incidence of cataracts.
FIRST AID
Eye Contact: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes to remove particles.
Skin Contact: Immediately wash the affected area with soap and water.
Inhalation: Remove victim to fresh air; restore and/or support his breathing as needed.
Ingestion: Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. Administer a gastric lavage followed by saline catharsis. Monitor blood and electrolytic balance. Other sources recommend giving the victim several glasses of water to drink.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all ignition sources immediately. Cleanup personnel need protection against contact and inhalation of vapor (see sect. 8). Contain large spills and collect waste. Use nonsparking tools to place naphthalene into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.
Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U165
CERCLA Hazardous Substance, Reportable Quantity: 100 lbs (45.4 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines of 29 CFR 1910.133. **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Respirator usage must be in accordance with the OSHA regulations of 29 CFR 1910.134. IDLH or unknown concentrations require an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.
Other Equipment: Wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specific work environment to prevent skin contact. **Ventilation:** Install and operate general and local maximum explosion-proof ventilation systems of sufficient power to maintain airborne levels of naphthalene below the OSHA PEL standard cited in section 2. **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove and launder contaminated clothing before wearing it again; clean this material from shoes and equipment.
Comments: Practice good personal hygiene; always wash thoroughly after using this material. Keep this material off of your clothing and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Do *not* smoke, eat, or drink in any immediate work area. Avoid inhalation of vapor!

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage Segregation: Store naphthalene in a cool, dry, well-ventilated area away from chemical incompatibles (see sect. 5).
Special Handling/Storage: Protect containers from physical damage. All bulk storage facilities must be built with an explosion-proof design. All containers used in shipping/transferring operations must be electrically grounded to prevent static sparks. Use monitoring equipment to measure the extent of vapor present in any storage facility containing naphthalene because of potential fire and explosion hazards.
Comments: All operations with naphthalene must be done carefully to prevent accidental ignition of its flammable/explosive vapor. If the weather is warm, more naphthalene vapor forms and the potential for explosion increases. Do *not* smoke in any use or storage area!
Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Naphthalene	**DOT ID No.** UN1334
DOT Hazard Class: ORM-A	**IMO Label:** Flammable Solid
IMO Class: 4.1	**DOT Label:** None

References: 1, 2, 12, 13, 84-94, 103, PII

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GENIUM PUBLISHING CORP.

No. 7

NITRIC ACID
(Revision C)
Issued: October 1980
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION 26

Material Name: NITRIC ACID

Description (Origin/Uses): Used to dissolve noble metals, for etching and cleaning metals, to make organic nitrates and nitrocompounds, to destroy residues of organic matter, and in explosives.

Other Designations: Red Fuming Nitric Acid; HNO_3; CAS No. 7697-37-2

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 3 (H) 0 (F) 0 (R) OXY

HMIS	
H 3	R 1
F 0	I 4
R 1	S 4
PPG*	K 0
*See sect. 8	

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Nitric Acid, CAS No. 7697-37-2	*	**OSHA PEL** 8-Hr TWA: 2 ppm, 5 mg/m³ **ACGIH TLVs, 1987-88** TLV-TWA: 2 ppm, 5 mg/m³ TLV-STEL: 4 ppm, 10 mg/m³ **Toxicity Data**** Mouse, Inhalation, LC_{50}: 67 ppm/4 Hrs

*Contact your supplier to determine the percent by weight of nitric acid in the purchased product. Water is the other component of the product.
**See NIOSH, *RTECS* (QU5775000, QU5900000), for additional data with references to reproductive effects.

SECTION 3. PHYSICAL DATA

Boiling Point: Ca 251°F (122°C)*
Specific Gravity (H_2O = 1): 1.4*
pH: Very Acidic
Water Solubility (%): Complete
Molecular Weight: 63 Grams/Mole
Melting Point: Ca -30°F (-34°C)*

Appearance and Odor: A water white to slightly yellow liquid that darkens to a brownish color on aging and exposure to light; characteristic nitrogen dioxide (NO_2) odor.

*These properties are for the approximately 68%-by-weight nitric acid that is commercially available.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Nitric acid does not burn. Use extinguishing agents that will put out the surrounding fire. Use a water spray to dilute nitric acid during fires and to absorb liberated oxides of nitrogen.

Unusual Fire or Explosion Hazards: Although nitric acid does not burn, it is a strong oxidizing agent that can react with combustible materials to cause fires. Also, it can react with metals to liberate extremely flammable hydrogen gas. If this happens, direct fire-fighting procedures at this evolved hydrogen gas.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Choose protective equipment carefully (see sect. 5, Conditions to Avoid).

SECTION 5. REACTIVITY DATA

Nitric acid is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Nitric acid reacts explosively with metallic powders, carbides, hydrogen sulfide, and turpentine. Contact with organic materials such as wood, paper, sawdust, or alcohol, etc., may cause fires. Combustible materials can attain an increased flammability after being exposed to nitric acid even if they do not immediately catch fire.

Conditions to Avoid: Avoid any contact with incompatible chemicals. Because it is so reactive, always establish another material's compatibility with nitric acid before mixing the two materials. This applies to the selection of safety and handling equipment, because nitric acid can attack some forms of coatings, plastics, and rubber.

Hazardous Products of Decomposition: Various nitrogen oxides, including nitric oxide (NO), nitrogen dioxide (NO_2), nitrous oxide (N_2O), as well as nitric acid mist or vapor, can be produced by the decomposition reactions that can affect the nitric acid during fires.

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SECTION 6. HEALTH HAZARD INFORMATION

Nitric acid is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: This material is corrosive to any body tissue it contacts. Dental erosion is also reported.
Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** Skin, eyes, mucous membranes of the respiratory tract, teeth. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Irritation and/or corrosive burns of skin, eyes, and upper respiratory tract (URT), delayed pulmonary edema, pneumonitis, bronchitis, and dental erosion. **Chronic Effects:** None reported.

FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Treat for eye burns. **Skin.** Immediately wash the affected area with soap and water. Watch for chemical skin burns and treat them accordingly. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. If the exposure is severe, hospitilization with careful monitoring by trained medical personnel to detect the delayed onset of severe pulmonary edema (lungs filled with fluid) is recommended for at least 72 hours. **Ingestion.** Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. Do not induce vomiting. If the exposed person is responsive, give him or her one or two glasses of milk or water to drink as quickly as possible after exposure.
GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. **Seek prompt medical assistance for further treatment, observation, and support after first aid. NOTE TO PHYSICIAN: Wash affected skin areas with a 5% solution of sodium bicarbonate ($NaHCO_3$). If ingested, the risk versus the benefit of the passage of a naso-gastric tube is debatable. Activated charcoal is of *no* value. Do *not* give the exposed person bicarbonate to neutralize the material.**

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately in case contact with metals should produce highly flammable hydrogen gas. Cleanup personnel need protection against contact with and inhalation of nitric acid (see sect. 8). Contain large spills and collect waste. Use water sprays to direct nitric acid away from incompatible chemicals (see sect. 5). Neutralize the spilled nitric acid with soda ash or sodium bicarbonate. Use an absorbent such as sand, earth, or vermiculite on the resulting slurry and place the neutralized nitric acid material into containers suitable for eventual disposal, reclamation, or destruction.
Waste Disposal: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per Clean Water Act (CWA), Section 311 (b) (4)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of nitric acid solution is possible, wear a full face shield as a supplementary protective measure. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Consult the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for general recommendations on proper respiratory procedures. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent skin contact with nitric acid. Choose protective equipment carefully (see sect. 5, Conditions to Avoid).
Ventilation: Install and operate both general and local exhaust-ventilation systems powerful enough to maintain airborne concentrations of nitric acid below the OSHA PEL standard cited in section 2. Construct exhaust ducts and systems with material such as fiberglass, which resists attack by nitric acid. **Safety Stations:** Make emergency eyewash stations, washing facilities, and safety/quickdrench showers available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean nitric acid from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Provide preplacement and annual medical exams with emphasis on skin irritation to workers who are regularly exposed to nitric acid. Workers must receive training before handling this material in the workplace; even experienced workers should undergo refresher training periodically.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store nitric acid in a cool, dry, well-ventilated area away from incompatible chemicals (see sect. 5). Consider outside, isolated, or detached storage. Protect containers from direct sunlight.
Special Handling/Storage: Build all storage facilities of nonflammable materials that are resistant to chemical attack by nitric acid. Protect containers from physical damage. Preplan for routine use and emergency response.
Engineering Controls: Proper ventilation is essential in bulk storage areas; consider installing an automatic monitoring system to detect hazardous levels of nitrogen oxides that can develop from this material.
Comments: Separate nitric acid from hydrazine, diethylenetriamine, fluorides, and all other corrosives except sulfuric acid and sulfur trioxide when shipping or transferring it.
Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: (I) Nitric Acid, Fuming or (II) Nitric Acid, Over 40% or (III) Nitric Acid, 40% or Less
DOT Label: (I) Oxidizer and Poison or (II) Oxidizer and Corrosive or (III) Corrosive
DOT Hazard Class: (I) and (II) Oxidizer or (III) Corrosive Material
DOT ID Nos. (I) UN2032; (II) UN2031; (III) NA1760
IMO Class: 8 (All Types of Nitric Acid)
IMO Label: (I) Corrosive, Oxidizer, Poison; or (II) and (III) Corrosive
References: 1, 2, 26, 38, 84-94, 100, 112, 113, 114.

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Material Safety Data Sheet

From Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 313

PERCHLOROETHYLENE
(Revision D)
Issued: November 1978
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: PERCHLOROETHYLENE

Description (Origin/Uses): Used in commercial dry cleaning and metal-degreasing operations; used to a lesser extent in home products and in veterinary anthelmintics (worming).

Other Designations: Ethylene Tetrachloride; Tetrachloroethylene; C_2Cl_4; CAS No. 0127-18-4

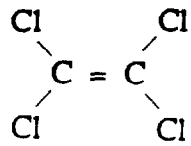
Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 2 / 0 / 0 / -

HMIS			
H	1		
F	0	R	1
R	1	I	3
PPG*		S	2
*See sect. 8		K	0

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Perchloroethylene, CAS No. 0127-18-4	Ca 100	**OSHA PEL** 8-Hr TWA: 100 ppm Ceiling: 200 ppm Maximum Peak above the Ceiling: 300 ppm for 5 min. in any 3 Hrs **ACGIH TLVs, 1987-88** TLV-TWA: 50 ppm, 340 mg/m³ TLV-STEL: 200 ppm, 1340 mg/m³ **Toxicity Data*** Human, Inhalation, TC_{Lo}: 96 ppm/7 Hrs



*See NIOSH, *RTECS* (No. KX3850000), for additional data with references to reproductive, irritative, tumorigenic, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 250°F (121°C)
Specific Gravity (H_2O = 1): 1.623
% Volatile by Volume: 100
Water Solubility (%): Insoluble
Molecular Weight: 166 Grams/Mole
Vapor Pressure: 19 Torrs at 77°F (25°C)
Vapor Density (Air = 1): 5.83

Appearance and Odor: A clear, colorless liquid; ethereal odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Perchloroethylene does not burn. Use extinguishing agents that will put out the surrounding fire.

Unusual Fire or Explosion Hazards: Perchloroethylene vapor is heavier than air and it collects in low-lying areas such as sumps, wells, and underground piping systems. Enter these low-lying areas with appropriate caution.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Use care in selecting safety equipment (see sect. 5, Conditons to Avoid).

SECTION 5. REACTIVITY DATA

Perchloroethylene is stable in closed containers during routine operations. It does not undergo hazardous polymerization.

Chemical Incompatibilities: Hazardous chemical reactions involving perchloroethylene and barium, beryllium, or lithium are reported in Genium reference 84, page 491M-208.

Conditions to Avoid: Prevent contact with incompatible chemicals. Avoid exposure to direct sunlight. Monitor the stabilizer level in the perchloroethylene product; get specifications from your supplier for the proper inhibitor levels. This material forms hydrochloric acid (HCl) if the inhibitor level becomes too low. Do not mix perchloroethylene with caustic soda or potash. This material may degrade or attack rubber and some plastics and coatings, so select protective gear and handling equipment carefully.

Hazardous Products of Decomposition: Although perchloroethylene itself does not burn, it can be very hazardous in fires because of thermooxidative degradation at high temperatures to very toxic phosgene and corrosive hydrogen chloride. Electric arcs and perchloroethylene vapor may also produce these products of hazardous decomposition.

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SECTION 6. HEALTH HAZARD INFORMATION

Perchloroethylene is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: Perchloroethylene affects the central nervous system (CNS), causing incoordination, headache, vertigo, light narcosis, dizziness, unconsciousness, and even death. All of these can occur as the level and duration of exposure continues.

Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** CNS, eyes, skin.
Primary Entry: Inhalation, skin. **Acute Effects:** Irritation of the skin, eyes, and upper respiratory tract (URT); CNS effects.
Chronic Effects: None reported.

FIRST AID
Eyes: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.
Skin: Immediately wash the affected area with soap and water.
Inhalation: Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.
Ingestion: Never give anything by mouth to someone who is unconscious or convulsing. Do not induce vomiting.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately. Cleanup personnel need protection against contact with and inhalation of vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U210
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per Clean Water Act (CWA), section 307 (a) and Resource Conservation and Recovery Act (RCRA), section 3001

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of perchloroethylene solution may occur, wear a full face shield/splash guard. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Consult the *NIOSH Pocket Guide to Chemical Hazards* for general recommendations on respirator protection. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with perchloroethylene. Suggested material includes polyvinyl alcohol, polyethylene, or neoprene. Leather shoes are also appropriate.
Ventilation: Install and operate general and local ventilation systems that are powerful enough to maintain airborne levels of perchloroethylene dust below the OSHA PEL standard cited in section 2. **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment.
Comments: Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Avoid inhaling perchloroethylene vapor. Select safety equipment carefully (see sect. 5, Conditions to Avoid).

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store perchloroethylene in a cool, dry, well-ventilated area away from barium, beryllium, and lithium.

Special Handling/Storage: Protect containers from physical damage. Fit all holding tanks with an air-drying venting system that prevents moist air from entering the tank and allows for perchloroethylene vapor expansion and contraction; airtight storage facilities are not recommended. Aluminum is not recommended for storage facilities.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Tetrachloroethylene	**DOT Label:** None	**IMO Label:** Saint Andrew's Cross (X)*
DOT ID No. UN1897	**DOT Hazard Class:** ORM-A	**IMO Class:** 6.1

*Harmful-Stow away from Foodstuffs (Materials of IMO Class 6.1, Packaging Group III).

References: 1, 12, 73, 84-94, 100, 103.

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GENIUM PUBLISHING CORP.

No. 683

POLYCHLORINATED BIPHENYLS (PCBs)

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION

27

Material Name: POLYCHLORINATED BIPHENYLS (PCBs)

Genium

Description (Origin/Uses): Commercial PCBs are mixtures that were once widely manufactured by combining chlorine gas, iron filings, and biphenyls. Their high stability contributes to their intended commercial applications and their accidental, long-term adverse environmental and health effects. PCBs are useful as insulators in electrical equipment because they are electrically nonconductive. Their distribution has been limited since 1976. The Aroclor PCB codes identify PCBs by type. The first two digits of a code indicate whether the PCB contains chlorinated biphenyls (12), chlorinated terphenyls, (54), or both (25, 44); the last two digits indicate the approximate percentage of chlorine. Found in insulating liquid, synthetic rubber, plasticizers, flame retardants, floor tile, printer's ink, paper and fabric coatings, brake linings, paints, automobile body sealants, asphalt, adhesives, electrical capacitors, electrical transformers, vacuum pumps, gas-transmission turbines, heat-transfer fluids, hydraulic fluids, lubricating and cutting oil, copying paper, carbonless copying paper, and fluorescent light ballasts.

Synonym: Chlorodiphenyls

Other Designations (Producer, Trade Name, Nation): Monsanto, Aroclor® (USA, Great Britain); Bayer, Clophen® (German Democratic Republic); Prodelec, Phenoclor®, Pyralene® (France); Kanegafuchi, Kanechlor®; Mitsubishi, Santotherm® (Japan); Caffaro, Fenclor® (Italy).

Trade Name	CAS No.	*RTECS* No.	Trade Name	CAS No.	*RTECS* No.
Aroclors	01336-36-3	TQ1350000	Aroclor 1242	53469-21-9	TQ1356000
Aroclor 1016	12674-11-2	TQ1351000	Aroclor 1248	12672-29-6	TQ1358000
Aroclor 1221	11104-28-2	TQ1352000	Aroclor 1254	11097-69-1	TQ1360000
Aroclor 1232	11141-16-5	TQ1354000	Aroclor 1260	11096-82-5	TQ1362000

HMIS			
H	1	R	1
F	1	I	3
R	0	S	1
PPG*		K	1

SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

PCB-42% Chlorine/Aroclor 1242
CAS No. 53469-21-9
OSHA PEL (Skin*)
8-Hr TWA: 1 mg/m³
ACGIH TLV (Skin*), 1988-89
TLV-TWA: 1 mg/m³

PCB-54% Chlorine/Aroclor 1254
CAS No. 11097-69-1
OSHA PEL (Skin*)
8-Hr TWA: 0.5 mg/m³
ACGIH TLV (Skin*), 1988-89
TLV-TWA: 0.5 mg/m³

All PCBs/Aroclors
CAS No. 1336-36-3
NIOSH REL 1977
10-Hour TWA: 0.001mg/m³
Toxicity Data**
Mouse, Oral, LD_{50}: 1900 mg/kg

*This material can be absorbed through intact skin, which contributes to overall exposure.
**See NIOSH, *RTECS* (Genium ref. 90), at the locations specified in section 1 for additional data with references to tumorigenic, reproductive, mutagenic, and irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: Ranges from 527°F (275°C) to 725°F (385°C)
Solubility in Water (%): Insoluble
Pour Point: Ranges from -31°F (-35°C) to 87.8°F (31°C)
% Volatile by Volume: Ranges from 1.2 to 1.6
Molecular Weight (Average): Aroclor 1242: 258 Grams/Mole
Aroclor 1254: 326 Grams/Mole

Appearance and Odor: Clear to light yellow mobile oil to a sticky resin; a sweet "aromatic" odor. As the percentage of chlorine increases, the PCB becomes thicker and heavier; e.g., Aroclor 1254 is more viscous than Aroclor 1242.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature: Not Found	LEL: Not Found	UEL: Not Found

Extinguishing Media: Use water spray/fog, carbon dioxide (CO_2), dry chemical, or "alcohol" foam to extinguish fires that involve polychlorinated biphenyls. Although it is very difficult to ignite PCBs, they are often mixed with more flammable materials (oils, solvents, etc.) **Unusual Fire or Explosion Hazards:** If a transformer containing PCBs is involved in a fire, its owner may be required to report the incident to appropriate authorities. Consult and follow all pertinent Federal, state, and local regulations. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode; fire fighters must also wear a complete set of protective clothing. **Comments:** The hazards of PCB fires are associated with the possibility of their being released into the environment where they and their products of degeneration can pose serious long-term health risks. These potential problems are heightened by the PCBs' resistance to biological and chemical degradation and by the possibility that they will contaminate underground water systems (see sect. 5)

*Ranges from 284°F (140°C) to 392°F (200°C).

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Polychlorinated biphenyls are very stable materials. Hazardous polymerization cannot occur.
Chemical Incompatibilities: PCBs can react dangerously with sodium or potassium. These reactions are part of an industrial process used to destroy PCBs; however, people have been killed by explosions at PCB treatment, storage, and disposal sites. **Conditions to Avoid:** Limit human exposure to PCBs to the lowest possible level; especially avoid contact with skin. **Hazardous Products of Decompositon:** Thermal-oxidative degradation of PCBs can produce toxic gases such as carbon monoxide, chlorine, chlorinated aromatic fragments, phenolics, aldehydes, and hydrogen chloride. Incomplete combustion of PCBs produces toxic compounds such as polychlorinated dibenzofuran (PCDF, the major product of combustion), and polychlorinated dibenzo-*p*-dioxin (PCDD or dioxin).

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: The EPA lists PCBs as carcinogens, and the IARC classifies them as probable human carcinogens (group 2B). **Summary of Risks:** Effects of accidental exposure to PCBs include acneform eruptions; eye discharge; swelling of the upper eyelids and hyperemia of the conjunctiva; hyperpigmentation of skin, nails, and mucous membrane; chloroacne; distinctive hair follicles; fever; hearing difficulties; limb spasms; headache; vomiting; and diarrhea. PCBs are potent liver toxins that can be absorbed through unbroken skin in hazardous amounts without immediately discernible pain or discomfort. Severe health effects can develop later. In experimental animals, prolonged or repeated exposure to PCBs by any route results in liver damage at levels that are less than those reported to have caused cancer in rodents. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, eyelids, blood, liver. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Skin and eye irritation, acneform dermatitis, nausea, vomiting, abdominal pain, jaundice, liver damage. **Chronic Effects:** Possible cancer (evidence of this is inconclusive); reproductive effects (jaundice, excessive secretion of tears, dermal chromopexy); and hepatitis. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for 15 minutes. **Skin.** Rinse exposed skin with flooding amounts of water; wash with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Induce vomiting by sticking your finger to the back of the exposed person's throat. Have him or her drink 1 to 2 glasses of milk or water. Get medical help (in plant, paramedic, community) for all exposures. Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** PCBs are poorly metabolized, soluble in lipids, and they accumulate in tissues or organs rich in lipids. Liver function tests can help to determine the extent of body damage in exposed persons. If electrical equipment containing PCBs arcs over, the PCBs or other hydrocarbon dielectric fluids may decompose and give off hydrochloric acid (HCl), a potent respiratory irritant.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat any accidental release of PCBs as an emergency. An SPCCP (spill-prevention control and countermeasure plan) must be formulated before spills or leaks occur.* PCBs are resistant to biodegradation, soluble in lipids, and chemically stable; as such they have become significant contaminants of global ecosystems. Releases of PCBs require immediate, competent, professional response from trained personnel. *Each release situation is unique and requires a specifically designed cleanup response.* General recommendations include adhering to Federal regulations (40 CFR Part 761). Notify safety personnel, evacuate nonessential personnel, ventilate the spill area, and contain the PCBs. All wastes, residues, and contaminated cleanup equipment from the incident are subject to EPA requirements (40 CFR 761). Consult your attorney or appropriate regulatory officials for information about reporting requirements and disposal procedures. **Waste Disposal:** Contact your hazardous waste disposal firm or a licensed contractor for detailed recommendations, especially when PCBs are unexpectedly discovered. Follow Federal, state, and local regulations. PCBs are biomagnified in the food chain; i.e., their concentration increases at each link. The disposal of PCBs or of PCB-contaminated materials is strictly regulated; violations of applicable laws can result in fines, lawsuits, and negative publicity. **Warning:** Accidental spills of PCBs that may affect water supplies must be reported to Coast Guard personnel at the National Response Center, telephone (202) 426-2675.

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
EPA Designations (40 CFR 302.4)
CERCLA Hazardous Substance, Reportable Quantity: 10 lbs (4.54 kg), per the Clean Water Act (CWA), §§ 311 (b) (4) and 307 (a).

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of PCBs is possible, wear a full face shield. Follow OSHA eye- and face-protections regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent any contact of PCBs with your skin. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standards cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contamination into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do not wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. Heavily soiled clothing must be properly discarded in a manner consistent with applicable regulations. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in work areas.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage Segregation: Store PCBs in closed containers in a cool, dry, well-ventilated area. Protect containers from physical damage. **Special Handling/Storage:** All storage facilities must have adequate containment systems (dikes; elevated, nonporous holding platforms; retaining walls) to prevent any major release of PCBs into the environment. Carefully design and implement these extra precautions now; do not wait until you have to respond to an accidental release of this material.

Transportation Data (49 CFR 172.101-2; PCBs were the first materials to be directly regulated by Congress by way of TSCA in 1976.)

DOT Shipping Name: Polychlorinated Biphenyls
DOT Hazard Class: ORM-E
ID No. UN 23115
DOT Packaging Requirements: 49 CFR 173.510

IMO Shipping Name: Polychlorinated Biphenyls
IMO Hazard Class: 9
IMDG Packaging Group: II

References: 1, 6, 26, 38, 84-94, 100, 101, 116, 117, 120, 122.

Prepared by PJ Igoe, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

Technical Review: Northeast Analytical, Inc. (PCB and VOC Specialists), Schenectady, New York, Telephone: (518) 346-4592

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GENIUM PUBLISHING CORP.

No. 181

SILVER

Issued: April 1986

SECTION 1. MATERIAL IDENTIFICATION

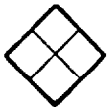
20

MATERIAL NAME: SILVER
DESCRIPTION: Elemental metal.
OTHER DESIGNATIONS: Ag, Argentum, CAS #7440-22-4.

MANUFACTURER/SUPPLIER: Available from many suppliers.

COMMENTS: Photography products account for 30% of industrial consumption. Additional uses include electrical conductors, coins, silverware, and jewelry.

HMIS
H:1
F:0
R:0
PPE*
*See sect. 8



Not Found

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Silver, Ag	99+	TWA 0.1 mg/m^3*
		TWA 0.01 mg/m^3**
		---
* Current (1985-86) ACGIH TLV for silver dust and fume.		Rat, Implant, TD: 2570 mg/kg
** Current (1985-86) ACGIH TLV for soluble silver compounds and OSHA exposure limit.		

SECTION 3. PHYSICAL DATA

Boiling Point ... 3833.6°F (2112°C)
Vapor Pressure ... Not Found
Water Solubility ... Insoluble
Vapor Density (Air = 1) ... Not Found
Evaporation Rate ... Not Found

Specific Gravity (H_2O = 1) ... 10.5
Melting Point ... 1763.4°F (961.9°C)
Percent Volatile by Volume ... Not Found
Molecular Weight ... 107.87

Appearance and odor: Ductile and malleable lustrous white metal.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Not Found	Not Found	Not Found	Not Applicable	Not Applicable

NFPA Classification: Noncombustible.

EXTINGUISHING MEDIA: Use proper extinguisher for surrounding fire.

UNUSUAL FIRE/EXPLOSION HAZARDS: None.

SPECIAL FIRE-FIGHTING PROCEDURES: None.

SECTION 5. REACTIVITY DATA

Silver is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES: Acetylene and silver form an insoluble, explosive acetylide. If silver is treated with nitric acid in the presence of ethyl alcohol, silver fulminate may be formed, which can be detonated.
Ethylenimine forms explosive compounds with silver. Finely divided silver and hydrogen peroxide solutions may explode.
This material is incompatible with oxalic and tartaric acid. Ammonia plus silver may form explosive compounds.
Bromoazide explodes on contact with silver foil.

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SECTION 6. HEALTH HAZARD INFORMATION | TLV

Silver is not considered a carcinogen by the NTP, IARC, or OSHA.

SUMMARY OF RISKS: Silver has no known physiological function in man and will accumulate in most tissues. Chronic accumulation (threshold in excess of 1 gram) in the body can result in argyria, a permanent condition associated with widespread bluish pigmentation of the skin and conjunctiva. TARGET ORGANS: Generally, where contact occurs. PRIMARY ENTRY: Inhalation, long-term handling (causes particles to become embedded in skin), or absorption through sweat glands. ACUTE EFFECTS are associated with soluble silver compounds that may be caustic, causing local irritations or destruction of tissue, depending upon strength of solution. CHRONIC EFFECTS: Argyria may be a local or general effect, depending upon previous exposure. FIRST AID: EYE CONTACT: Flush with water for 15 minutes. Get medical attention.* SKIN CONTACT: Wash skin with soap and water. Argyria from long-term exposure is permanent and cannot be washed away. INHALATION: Remove victim to fresh air. INGESTION: Dilute with water. Get medical attention.*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

COMMENTS: The original 0.01 mg/m^3 TLV was established to prevent a lifetime body accumulation exceeding 1 gram, where argyria would become evident. Evaluation of 25 years of data has shown 0.01 mg/m^3 to be too conservative; therefore, the ACGIH raised the TLV to 0.1 mg/m^3.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel; prevent entry into sewers or surface waters. Wear respirator where a dusting hazard is anticipated.

WASTE DISPOSAL: Reclaim or sell waste to a commercial reclaimer.

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES are not required unless metal is in the molten state.

GLOVES: Repeated handling may discolor the skin because of skin rubbing against the metal. Cotton gloves will prevent this cosmetic effect.

RESPIRATOR is required where metal dust or fumes are generated with inadequate exhaust ventilation. Air samples should be collected to quantify the exposure levels.

VENTILATION is required where air exposures exceed the TLV-TWA'S.

OTHER: Reclamation of silver from photographic or X-ray film may involve cyanide compounds. Proper precautions must be taken when working with cyanide compounds. See Genium MSDS #13, Potassium Cyanide, for further information.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Silver is usually stored in locked cabinets or safes to prevent theft.

ENGINEERING CONTROLS: Exhaust ventilation where TLV-TWA is exceeded.

EPA Hazardous Substance Designation: 40 CFR 260

Data Source(s) Code: 2, 4, 6, 14, 59, 82, 84, NFC 1983. DW

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Approvals	J.O. Aurocco, 11/86
Indust. Hygiene/Safety	DW 10-86
Medical Review	[illegible] 10/86

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GENIUM PUBLISHING CORP.

No. 136

SELENIUM

Issued: April 1988

SECTION 1. MATERIAL IDENTIFICATION

25

Material Name: SELENIUM

Description (Origin/Uses): Used to manufacture other selenium compounds; also used in photography and xerography and as a catalyst and pigment.

Other Designations: Elemental Selenium; Selenium Base; Selenium Dust; Selenium Metal; Selenium Metal Powder; Se; NIOSH *RTECS* No. VS7700000; CAS No. 7782-49-2

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: See Genium Industrial MSDS 152 (Selenium Dioxide).

HMIS		Not Found
H 3		
F 0	R 1	
R 1	I 4	
PPG*	S 2	
*See sect. 8	K 0	

SECTION 2. INGREDIENTS AND HAZARDS

	%	EXPOSURE LIMITS
Selenium, CAS No. 7782-49-2	ca 100	IDLH* Level: 100 mg/m³ **OSHA PEL**** 8-Hr TWA: 0.2 mg/m³ **ACGIH TLV,** 1987-88** TLV-TWA: 0.2 mg/m³ **Toxicity Data***** Rat, Oral, LD_{50}: 6700 mg/kg Rat, Inhalation, LD_{LO}: 33 mg/kg (8 Hrs)

*Immediately dangerous to life and health
**This exposure limit is defined for selenium compounds as Se.
***See NIOSH, *RTECS*, for additional data with references to reproductive, mutagenic, and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: ca 1263°F (684°C)
Water Solubility: Insoluble
Melting Point: ca 644°F (340°C)

Specific Gravity (H_2O = 1): Both amorphous and crystalline forms have specific gravities between 4 and 5.
Molecular Weight: 79 Grams/Mole

Appearance and Odor: A dark red to bluish black amorphous solid or dark red, grey, or black crystals appearing in two distinct forms, or allotropes, because of differences in crystalline structures; odorless.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air % by Volume	LOWER	UPPER
*	*		*	*

Extinguishing Media: *Selenium does not burn. Use agents such as dry chemical, "alcohol" foam, or carbon dioxide that will extinguish the surrounding fire.

Unusual Fire or Explosion Hazards: None.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Selenium is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

Chemical Incompatibilities: This material reacts dangerously with carbides, fluorine, oxygen, potassium, and many more materials (see Genium ref. 84).

Conditions to Avoid: Avoid direct contact with incompatible chemicals to prevent dangerous and violent reactions. Avoid the unintended contact of water with selenium in storage areas or reactor vessels.

Hazardous Products of Decomposition: When heated to decomposition, selenium readily emits toxic oxides of selenium (SeO_2). Selenium itself is a highly toxic and dangerous material.

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SECTION 6. HEALTH HAZARD INFORMATION

Selenium is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Direct exposure to selenium or inhalation of its dust causes severe irritation of the skin, eyes, and the upper respiratory tract (URT). **Caution:** Some symptoms of exposure to selenium (e.g., chemical pneumonia) may be delayed for several hours. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** URT, skin, eyes. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Skin and eye burns, contact dermatitis, intense irritation of the URT, and headache. Cases with flulike symptoms resembling metal-fume fever within 24 hours of exposure have been reported.
Chronic Effects: Odor of garlic on breath; fatigue; irritability; URT irritation; pallor; gastrointestinal distress; metallic taste; and an allergic eye reaction with red, sometimes puffy, eyelids.
FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water. **Skin.** Immediately wash the affected area with plenty of running water. Any worker who develops a rash or contact dermatitis must get medical attention and prevent any further contact with selenium metal or its compounds (e.g., selenium dioxide; see Genium Industrial MSDS 152). **Inhalation.** Remove exposed person to fresh air; restore and/or support his or her breathing as needed. Prompt administration of oxygen gas (O_2) by trained medical personnel may aid recovery. **Ingestion.** Give exposed person several glasses of water to dilute material. Do not induce vomiting. Never give anything by mouth to someone who is unconscious or convulsing.

Treat each exposure to selenium as an emergency! GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. *Seek prompt medical assistance for further treatment, observation, and support after first aid.* If chelation therapy to remove the metallic selenium is indicated, calcium disodium edetate ($CaNa_2$-EDTA) is the chelating agent of choice; do *not* use dimercaprol. Burns may require treatment with 10% sodium thiosulfate cream.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, evacuate all nonessential personnel, provide adequate ventilation, and do not add any water to the spill or leak area. *Cleanup personnel need protection against contact with and inhalation of dust (see sect. 8).* Scoop up spilled selenium into suitable containers for disposal. Carefully sweep or vacuum up small spills or residues without creating dust.
Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations for disposal. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste: Listed without a Number
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines in 29 CFR 1910.133. **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks) wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves; boots; aprons; and clean, impervious, body-covering clothing to prevent any possibility of skin contact.
Ventilation: Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne levels of selenium below the OSHA PEL standard cited in section 2. **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. Make the 10% sodium thiosulfate solution or cream and the $CaNa_2$-EDTA chelating agent formula (sect. 6) readily available to a trained safety specialist. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Particles can adhere to contact lenses and cause corneal damage. Do *not* wear contact lenses in any work area.
Comments: Practice good personal hygiene: always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store selenium in a cool, dry, well-ventilated area in tightly closed containers away from oxidizing agents, organic materials, water, metals, and incompatible chemicals (see sect. 5). **Special Handling/Storage:** Prevent moisture or water contamination in any storage facility. Consider installing an automatic monitoring system to detect selenium contamination; storage under an inert gas (e.g., a nitrogen blanket) may be warranted depending on the work environment. **Engineering Controls:** Use selenium in closed engineering systems because of its significant health and physical hazards (see sects. 4, 5, and 6). All engineering systems (production, transportation, etc.) should be of maximum explosion-proof design (i.e., they must be nonsparking, electrically grounded and bonded, etc.). **Comments:** Perform all work with selenium with a sustained, conscientious effort to prevent accidental contact with water. *Do not create a dusty working environment. Develop a sustained, conscientious program of working guidelines prior to any accidental exposure.*
Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Selenium Metal Powder	**DOT Label:** Poison	**IMO Label:** St. Andrew's Cross (X)*
DOT Class: Poison B	**DOT ID No.** UN2658	**IMO Class:** 6.1

*Harmful-Stow away from Foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III)
References: 1, 2, 12, 73, 84-94, 100, 103.

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Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
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GENIUM PUBLISHING CORP.

No. 9
SULFURIC ACID, CONCENTRATED
Revision C
Issued: October 1980
Revised: February 1986

SECTION 1. MATERIAL IDENTIFICATION

MATERIAL NAME: SULFURIC ACID, CONCENTRATED

OTHER DESIGNATIONS: Oil of Vitriol, Hydrogen Sulfate; H_2SO_4; CAS #7664-93-9

MANUFACTURER/SUPPLIER: Available from many suppliers, including:
Allied Corporation, PO Box 2064R, Morristown, NJ 07960; Telephone: 800 631-8050

HMIS
H:3
F: 0
R: 2
PPE: *
* See Sect. 8

R 1
I 3
S 4
K 0

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Hydrogen Sulfate (H_2SO_4) Water	93-98 Balance*	8-hr TWA: 1 mg/m^3 Human, Mist Inhalation, TCLo: 3 mg/m^3, 24 wk. (Toxic Mouth Effects) Rat, Oral, LD_{50}: 2140 mg/kg

* Material is obtained by the reaction of SO_3 and water. Can contain low impurity levels, such as 0.02% max of iron as Fe. Properties vary with H_2SO_4 content.

Current OSHA standard and ACGIH (1985-86) TLV. NIOSH has a 10-hr TWA, 40-hr. work week, of 1 mg/m^3.

SECTION 3. PHYSICAL DATA

	93.19% H_2SO_4	98.33% H_2SO_4	100% H_2SO_4
Boiling Point, 1 atm, deg C	ca 281	ca 338	ca 330 (dc)
Specific Gravity (60/60°F)	1.8354	1.84	1.84
Volatiles, % @ 340°C	ca 100	ca 100	ca 100
Melting Point, deg C	ca -34	ca 3	10.4

Water Solubility ... Complete Miscible
Vapor Pressure, mm Hg @ 100°F ... <1 (93.19% H_2SO_4); Deg. Baume ... 66 (93.19% H_2SO_4) - Density of H_2SO_4 is often reported in degrees Baume Be). Formula is Be=145 [145/sp gr for liquids heavier than water].

Appearance and odor: Clear, colorless, hygroscopic, oily liquid with no odor. Mists greater than 1 mg/m^3 are easily recognizable. Those at 5 mg/m^3 are distinctly objectionable.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
None - Nonflammable	NA	NA	NA	NA

Sulfuric acid is nonflammable; however, it is a strong oxidizing agent and may cause ignition by contact with combustible materials. Small fires may be smothered with suitable dry chemical. Cool exterior of storage tanks of H_2SO_4 with water to avoid rupture if exposed to fire. Do not add water or other liquid to the acid! The acid, especially when diluted with water, can react with metals to liberate flammable hydrogen gas.
Sulfuric acid mists and vapors from a fire area are corrosive (see sect. 5).
Fire fighters must wear self-contained breathing equipment and fully protective clothing.

SECTION 5. REACTIVITY DATA

Sulfuric acid is stable under normal conditions of use and storage. It does not undergo hazardous polymerization. It is a strong mineral acid reacting with bases and metals. The concentrated acid is also a dehydrating agent, picking up moisture readily from the air or other materials. Hydrogen gas may be generated within a H_2SO_4 container. Vent drums cautiously.

This material reacts exothermically with water. (Acid should always be added slowly to water. Water added to acid can cause boiling and uncontrolled splashing of the acid.) Sulfur oxides can result from decomposition and from oxidizing reactions of sulfuric acid.

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SECTION 6. HEALTH HAZARD INFORMATION | TLV

Concentrated sulfuric acid is a strong mineral acid, an oxidizing agent, and a dehydrating agent that is rapidly damaging to all human tissue with which it comes in contact. Ingestion may cause severe injury or death. Eye contact produces severe or permanent injury. Inhalation of mists can damage both the upper respiratory tract and the lungs. Sulfuric acid is not listed as a carcinogen by the NTP, IARC, or OSHA.

FIRST AID: EYE CONTACT: Immediately flush eyes (including under eyelids) with plenty of running water for at least 15 minutes. Speed in diluting and rinsing out acid with water is extremely important if permanent eye damage is to be avoided. Obtain medical help as soon as possible.* SKIN CONTACT: Immediately flush affected areas with water, removing contaminated clothing while under the safety shower. Continue washing with water and get medical attention.*

INHALATION: Remove to fresh air. Restore breathing. Call a physician immediately. INGESTION: Dilute acid immediately with large amounts of milk or water, then give milk of magnesia to neutralize. Never give anything by mouth to an unconscious person. Do not induce vomiting; if it occurs spontaneously, continue to administer fluid. Obtain medical attention as soon as possible.*

Maintain observation of patient for possible delayed onset of pulmonary edema.

* GET MEDICAL HELP = In plant, paramedic, community.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Handle major spills by a predetermined plan. Contact supplier for assistance in this planning, in meeting local regulations, and for disposing of large amounts. Notify safety personnel. Provide optimum ventilation; vapors are extremely irritating. Stop leak if you can do so without risk.

Cleanup personnel need protection against inhalation or contact. Keep upwind. Contain spill. Minor leaks or spills can be diluted with much water and neutralized with soda ash or lime. If water is not available, cover contaminated area with sand, ashes, or gravel and neutralize cautiously with soda ash or lime.

DISPOSAL: Follow Federal, state, and local regulations. Runoff to sewer may create hydrogen gas, which is a fire or explosion hazard. EPA (CWA) RQ 1000 lbs. (40 CFR 117).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general ventilation to meet current TLV requirements in the workplace. Where mists are up to 50 mg/m^3, a high-efficiency particulate respirator with full facepiece is warranted; a type-C supplier-air respirator with full facepiece operated in pressure-demand mode is used to 100 mg/m^3.

Avoid eye contact by use of chemical safety goggles or face shield where splashing may occur. Acid-resistant protective clothing, such as rubber gloves, aprons, boots, and suits, is recommended to avoid body contact.

Eyewash fountain and safety showers with deluge type of heads should be readily available where this material is handled or stored.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

Comprehensive preplacement and annual medical examinations with emphasis on dental erosion, cardiopulmonary system, and mucous membrane irritation and cough are indicated.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Sulfuric acid in carboys or drums should be stored in clean, ventilated storage areas having acid-resistant floors with good drainage. Keep out of direct sunlight, do not store above 89.6°F (32°C). Storage facilities are to be separate from organic materials, metallic powders, chromates, chlorates, nitrates, carbides, oxidizables, etc. Soda ash, sand, or lime should be kept in general storage or work areas for emergency use. Protect containers against physical damage. Glass bottles need extra protection. Sulfuric acid is highly corrosive to most metals, especially below 77% H_2SO_4. Avoid breathing mist or vapors. Avoid contact with skin or eyes. Do not ingest. Do not add water to concentrated acid. Drums may contain hydrogen gas, so open cautiously. Use nonsparking tools free of oil, dirt, and grit and vapor-proof electrical fixtures

DOT Classification: Corrosive Material. ID No.: UN1830 Label: Corrosive

Data Source(s) Code: 1-12, 19, 20, 24, 26, 31, 37-39, 42, 82. CK

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Approvals [illegible], 6/86.

Indust. Hygiene/Safety [illegible] 6/86

Medical Review [illegible] 86

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GENIUM PUBLISHING CORP.

No. 317
TOLUENE
(Revision D)

Issued: August 1979
Revised: April 1986

SECTION 1. MATERIAL IDENTIFICATION

20

MATERIAL NAME: TOLUENE

OTHER DESIGNATIONS: Methyl Benzene, Methyl Benzol, Phenylmethane, Toluol, C_7H_8, CAS #0108-88-3

MANUFACTURER/SUPPLIER: Available from many suppliers, including:
Allied Corp., PO Box 2064R, Morristown, NJ 07960; Telephone: (201) 455-4400
Ashland Chemical Co., Industrial Chemicals & Solvents Div., PO Box 2219, Columbus, OH; Telephone: (614) 889-3844

HMIS
H: 2
F: 3
R: 0
PPE*
*See sect. 8

R 1
I 3
S 2
K 4

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Toluene	ca 100	8-hr TLV: 100 ppm, or 375 mg/m^3* (Skin)**
		Man, Inhalation, TCLo: 100 ppm: Psychotropic***
		Rat, Oral, LD_{50}: 5000 mg/kg Rat, Inhalation, LCLo: 4000 ppm/4 hrs. Rabbit, Skin, LD_{50}: 14 gm/kg
		Human, Eye: 300 ppm

* Current (1985-86) ACGIH TLV. The OSHA PEL is 200 ppm with an acceptable ceiling concentration of 300 ppm and an acceptable maximum peak of 500 ppm/10 minutes.

** Skin designation indicates that toluene can be absorbed through intact skin and contribute to overall exposure.

*** Affects the mind.

SECTION 3. PHYSICAL DATA

Boiling Point ... 231°F (111°C)
Vapor Pressure @ 20°C, mm Hg ... 22
Water Solubility @ 20°C, wt. % ... 0.05
Vapor Density (Air = 1) ... 3.14

Evaporation Rate (BuAc = 1) ... 2.24
Specific Gravity (H_2O = 1) ... 0.866
Melting Point ... -139°F (-95°C)
Percent Volatile by Volume ... ca 100
Molecular Weight ... 92.15

Appearance and odor: Clear, colorless liquid with a characteristic aromatic odor. The odor is detectable to most individuals in the range of 10 to 15 ppm. Because olfactory fatigue occurs rapidly upon exposure to toluene, odor is not a good warning property.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
40°F (4°C) CC	896°F (480°C)	% by Volume	1.27	7.1

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, alcohol foam. Do not use a solid stream of water because the stream will scatter and spread the fire. Use water spray to cool tanks/containers that are exposed to fire and to disperse vapors.

UNUSUAL FIRE/EXPLOSION HAZARDS: This OSHA class IB flammable liquid is a dangerous fire hazard. It is a moderate fire hazard when exposed to oxidizers, heat, sparks, or open flame. Vapors are heavier than air and may travel a considerable distance to an ignition source and flash back.

SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters should wear self-contained breathing apparatus with full facepiece operated in a positive-pressure mode when fighting fires involving toluene.

SECTION 5. REACTIVITY DATA

CHEMICAL INCOMPATIBILITIES: Toluene is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. This material is incompatible with strong oxidizing agents, dinitrogen tetraoxide, silver perchlorate, tetranitromethane, and uranium hexafluoride. Contact with these materials may cause fire or explosion. Nitric acid and toluene, especially in the presence of sulfuric acid, will produce nitrated compounds that are dangerously explosive.

CONDITIONS TO AVOID: Avoid exposure to sparks, open flame, hot surfaces, and all sources of heat and ignition. Toluene will attack some forms of plastics, rubber, and coatings. Thermal decomposition or burning produces carbon dioxide and/or carbon monoxide.

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SECTION 6. HEALTH HAZARD INFORMATION | TLV

Toluene is not considered a carcinogen by the NTP, IARC, or OSHA. SUMMARY OF RISKS: Vapors of toluene may cause irritation of the eyes, nose, upper respiratory tract, and skin. Exposure to 200 ppm for 8 hours causes mild fatigue, weakness, confusion, lacrimation (tearing) and paresthesia (a sensation of prickling, tingling, or creeping on the skin that has no objective cause). Exposure to higher concentrations may cause headache, nausea, dizziness, dilated pupils, and euphoria, and, in severe cases, may cause unconsciousness and death. The liquid is irritating to the eyes and skin. Contact with the eyes may cause transient corneal damage, conjunctival irritation, and burns if not promptly removed. Repeated and/or prolonged contact with the skin may cause drying and cracking. It may be absorbed through the skin in toxic amounts. Ingestion causes irritation of the gastrointestinal tract and may cause effects resembling those from inhalation of the vapor. Chronic overexposure to toluene may cause reversible kidney and liver injury. FIRST AID: EYE CONTACT: Immediately flush eyes, including under eyelids, with running water for at least 15 minutes. Get medical attention if irritation persists.* SKIN CONTACT: Immediately flush skin (for at least 15 minutes) while removing contaminated shoes and clothing. Wash exposed area with soap and water. Get medical attention if irritation persists or if a large area has been exposed.* INHALATION: Remove victim to fresh air. Restore and/or support breathing as required. Keep victim warm and quiet. Get medical help.* INGESTION: Give victim 1 to 2 glasses of water or milk. Contact a poison control center. Do not induce vomiting unless directed to do so. Transport victim to a medical facility. Never give anything by mouth to a person who is unconscious or convulsing. * GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Limit access to spill area to necessary personnel only. Remove leaking containers to safe place if feasible. Cleanup personnel need protection against contact with liquid and inhalation of vapor (see sect. 8).
WASTE DISPOSAL: Absorb small spills with paper towel or vermiculite. Contain large spills and collect if feasible, or absorb with vermiculite or sand. Place waste solvent or absorbent into closed containers for disposal using nonsparking tools. Liquid can be flushed with water to an open holding area for handling. Do not flush to sewer, watershed, or waterway.
COMMENTS: Place in suitable container for disposal by a licensed contractor or burn in an approved incinerator. Consider reclaiming by distillation. Contaminated absorbent can be buried in a sanitary landfill. Follow all Federal, state, and local regulations. TLm 96: 100-10 ppm. Toluene is designated as a hazardous waste by the EPA. The EPA (RCRA) HW No. is U220 (40 CFR 261). The reportable quantity (RQ) is 1000 lbs/454 kg (40 CFR 117).

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical service must be nonsparking and have an explosion-proof design. Exhaust hoods should have a face velocity of at least 100 lfm (linear feet per minute) and be designed to capture heavy vapor. For emergency or nonroutine exposures where the TLV may be exceeded, use an organic chemical cartridge respirator if concentration is less than 200 ppm and an approved canister gas mask or self-contained breathing apparatus with full facepiece if concentration is greater than 200 ppm.
Safety glasses or splash goggles should be worn in all work areas. Neoprene gloves, apron, face shield, boots, and other appropriate protective clothing and equipment should be available and worn as necessary to prevent skin and eye contact. Remove contaminated clothing immediately and do not wear it until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks, or open flame. Storage areas must meet OSHA requirements for class IB flammable liquids. Use metal safety cans for handling small amounts. Protect containers from physical damage. Use only with adequate ventilation. Avoid contact with eyes, skin, or clothing. Do not inhale or ingest. Use caution when handling this compound because it can be absorbed through intact skin in toxic amounts. SPECIAL HANDLING/STORAGE: Ground and bond metal containers and equipment to prevent static sparks when making transfers. Do not smoke in use or storage areas. Use nonsparking tools. ENGINEERING CONTROLS: Preplacement and periodic medical exams emphasizing the liver, kidneys, nervous system, lungs, heart, and blood should be provided. Workers exposed to concentrations greater than the action level (50 ppm) should be examined at least once a year. Use of alcohol can aggravate the toxic effects of toluene.
COMMENTS: Emptied containers contain product residues. Handle accordingly!
Toluene is designated as a hazardous substance by the EPA (40 CFR 116). DOT Classification: Flammable liquid. UN1294.
Data Source(s) Code: 1-9, 12, 16, 20, 21, 24, 26, 34, 81, 82. CR

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Approvals J.O. Rodocco, 11/86.
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GENIUM PUBLISHING CORP

No. 312
TRICHLOROETHYLENE
(Revision E)

Issued: July 1979
Revised: August 1987

SECTION 1. MATERIAL IDENTIFICATION

23

MATERIAL NAME: TRICHLOROETHYLENE

DESCRIPTION (Origin/Uses): Prepared from *sym*-tetrachloroethane by way of eliminating HCl by boiling with lime. Used to manufacture organic chemicals, pharmaceuticals; in degreasing and dry cleaning; and as a solvent for fats, waxes, rubbers, oils, paints, varnishes, ethers, and cellulose esters.

OTHER DESIGNATIONS: Ethylene Trichloride; TCE; Trichloroethene; 1,1,2-Trichloroethylene; C_2HCl_3; NIOSH *RTECS* #KX4550000; CAS #0079-01-6

MANUFACTURER/SUPPLIER: Available from several suppliers, including:
Dow Chemical USA, 2020 Dow Center, Midland, MI 48640;
Telephone: (517) 636-1000; (800) 258-CHEM

COMMENTS: Trichloroethylene is a toxic solvent and a suspected occupational carcinogen.

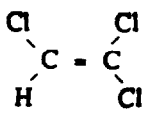
HMIS

H	2	R	1
F	1	I	3
R	1	S	1
PPE*		K	0

* See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

Ingredients	%	HAZARD DATA
Trichloroethylene, CAS #0079-01-6; NIOSH *RTECS* #KX4550000	100	ACGIH Values 1987-88 TLV-TWA*: 50 ppm, 270 mg/m^3 TLV-STEL**: 200 ppm, 1080 mg/m^3 OSHA PEL 1986*** 8-Hr TWA: 100 ppm Ceiling: 200 ppm NIOSH REL 1986 10-Hr TWA: 25 ppm TOXICITY DATA Human, Oral, LD_{Lo}: 7 g/kg Human, Inhalation, TC_{Lo}: 6900 mg/m^3 (10 Min) Human, Inhalation, TC_{Lo}: 160 ppm/83 Min Human, Inhalation, TD_{Lo}: 812 mg/kg



- * The TLV-TWA is set to control subjective complaints such as headache, fatigue, and irritability.
- ** The TLV-STEL is set to prevent incoordination and other beginning anesthetic effects from TCE. These levels should provide a wide margin of safety in preventing liver injury.
- *** The OSHA PEL is 300 ppm for 5 minutes in any 2 hours.

SECTION 3. PHYSICAL DATA

Boiling Point ... 188.6°F (87°C)
Vapor Pressure ... 58 Torr at 68°F (20°C)
Water Solubility ... Insoluble
Vapor Density (Air = 1) ... 4.53
Evaporation Rate ... Not Listed
Specific Gravity ... 1.4649 at 68°F (20°C)
Melting Point ... -120.64°F (-84.8°C)
Molecular Weight ... 131.40 Grams/Mole

Appearance and odor: Colorless, nonflammable mobile liquid; sweetish odor like chloroform.

COMMENTS: TCE is highly soluble in lipids. A high vapor pressure at room temperature provides the potential for TCE vapors to contaminate use areas.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
Not Listed	770°F (410°C)	% by Volume	8%	10.5%

EXTINGUISHING MEDIA: TCE has no flash point in a conventional closed tester at room temperature, but it is moderately flammable at higher temperatures. Use dry chemical, carbon dioxide, alcohol foam, or other extinguishing agents suitable for the surrounding fire.

OSHA Flammability Class (29 CFR 1910.106): Not Regulated

UNUSUAL FIRE/EXPLOSION HAZARDS: During fire conditions TCE emits highly toxic and irritating fumes, including hydrochloric acid and phosgene. SPECIAL FIRE-FIGHTING PROCEDURES: Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode. At TCE vapor levels of 300-1000 ppm, fire fighters who lack the proper respiratory equipment may experience incoordination and impaired judgment.

DOT Flammability Class (49 CFR 173.115): Not Regulated

SECTION 5. REACTIVITY DATA

Trichloroethylene is stable. Hazardous polymerization can occur under certain circumstances (see Conditions to Avoid and Comments, below).

CHEMICAL INCOMPATIBILITIES include magnesium or aluminum powder, NaOH, KOH, or other strong alkaline materials. Reactions with alkaline materials may lead to the formation of dangerous explosive mixtures of chloroacetylenes.

CONDITIONS TO AVOID: When TCE is heated (as in the case with vapor degreasers) or exposed to sunlight, it requires extra stabilization against oxidation, degradation, and polymerization. It is slowly decomposed by light when moist.

PRODUCTS OF HAZARDOUS DECOMPOSITION include hydrochloric acid and phosgene under certain conditions at elevated temperatures.

COMMENTS: TCE is stable under normal handling and storage conditions, and hazardous polymerization is not expected to occur. However, failure of the stabilizer at elevated temperatures or other extreme conditions may allow polymerization to take place..

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SECTION 6. HEALTH HAZARD INFORMATION

Trichloroethylene is listed as a carcinogen by the NTP, IARC, and OSHA. NIOSH recommends that trichloroethylene be treated as an occupational carcinogen. IARC carcinogenic results are animal suspect, animal positive, and human indefinite. SUMMARY OF RISKS: Moderate exposures to TCE cause symptoms similar to those of alcohol inebriation. Higher concentrations cause narcotic effects. Ventricular fibrillation has been cited as the cause of death following heavy exposures. TCE-induced hepato cellular carcinomas have been detected in mice during tests conducted by the National Cancer Institute (*Chem & Eng News* 54 [April 5, 1976]:4). Organ systems affected by overexposure to TCE are the central nervous system (euphoria, analgesia, anesthesia), degeneration of the liver and kidneys, the lungs (tachypnea), heart (arrhythmia) and skin (irritation, vesication, and paralysis of fingers when immersed in liquid TCE). Contact with the liquid defats the skin, causing topical dermatitis. Certain people appear to experience synergistic effects from TCE exposure concomitant with exposure to caffeine, alcohol, and other drugs. When combined with alcohol intake, toxic effects are increased and may cause a red, blotchy facial and upper body rash commonly called "degreaser's flush." Other reported symptoms of TCE exposure include abnormal fatigue, headache, irritability, gastric disturbances, and intolerance to alcohol. Toxic effects from testing of TCE on humans include hallucination, distorted perception, somnolence (general depressed activity), and jaundice. TARGET ORGANS: Respiratory system, central nervous system, heart, liver, kidneys, and skin. PRIMARY ENTRY: Ingestion, inhalation, skin contact. ACUTE EFFECTS: Headache, vertigo, visual disturbance, tremors, nausea, vomiting, dermatitis, dizziness, drowsiness, and irritation to the eyes, nose, and throat. CHRONIC EFFECTS: None Reported. MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE: Diseases of the liver, kidneys, lungs, and central nervous system. FIRST AID: EYE CONTACT: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help.* INHALATION: Remove victim to fresh air; restore and/or support his breathing as needed. Do not give adrenalin to the victim. Get medical help.* INGESTION: Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. A professional decision regarding whether or not to induce vomiting is required. Do not give adrenalin to the victim. Get medical help.*

*GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Get prompt medical assistance for further treatment, observation, and support after first aid.

COMMENTS: Workers' responses to TCE vary significantly because of many factors, including age, health status, nutrition, and intake of alcohol, caffeine, and medicines. Do not use these substances before, during, or after exposure to TCE. If a worker displays any of the symptoms of exposure to TCE, thoroughly investigate all the possible contributing factors to determine, if possible, how much the work environment levels of TCE are responsible.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Inform safety personnel of any trichloroethylene spill or leak and evacuate the area for large spills. Cleanup personnel must use respiratory and liquid contact protection. Adequate ventilation must be provided. Confine the spilled TCE to as small an area as possible. Do not allow it to run off to sewers or open waterways. Pick up spilled TCE with a vacuum cleaner or an absorbent such as vermaculite.

DISPOSAL: Consider reclamation, recycling, or destruction rather than disposal in a landfill.

Trichloroethylene is designated as a hazardous substance by the EPA (40 CFR 116.4).

Trichloroethylene is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U228

EPA Reportable Quantity (40 CFR 117.3): 1000 lbs (454 kgs)

Aquatic Toxicity Rating, TLm 96: Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety goggles. Follow the eye and face protection guidelines of 29 CFR 1910.133. GLOVES: Wear impervious gloves. RESPIRATOR: Use a NIOSH-approved respirator per the *NIOSH Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of TCE requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. WARNING: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. OTHER EQUIPMENT: Wear rubber boots, aprons, and other suitable body protection appropriate to the existing work environment. VENTILATION: Install and operate general and local exhaust ventilation systems of sufficient power to maintain airborne concentrations of TCE below the OSHA PEL standards cited in section 2. SAFETY STATIONS: Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. OTHER SPECIAL MODIFICATIONS IN THE WORKPLACE: Because of the unresolved controversy about the carcinogenic status of TCE, all existing personal protective equipment and engineering technology should be used to prevent any possibility of worker contact with this material.

COMMENTS: Practice good personal hygiene. Keep material off of your clothes and equipment. Avoid transfer of material from hands to mouth while eating, drinking, or smoking. Adhere to the sanitation requirements of 29 CFR 1910.141 and 29 CFR 1910.142.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Prevent TCE from coming into contact with strong caustics such as NaOH; KOH; chemically active metal like Ba, Li, Na, Mg, Ti; and powdered aluminum or magnesium in acidic solutions. SPECIAL HANDLING/STORAGE: Store this material in a cool, dry, well-ventilated area. Avoid elevated temperatures because products of toxic and corrosive decomposition from TCE may form. Monitor the level of any stabilizer component that may be added to the TCE. (Consult the technical data from the supplier to determine the specifics of any added stabilizer.) If applicable, follow the supplier's recommendation concerning proper rotation of stock, shelf-life requirements, and levels of stabilizers.

ENGINEERING CONTROLS IN THE WORKPLACE: Avoid collecting aluminum fines (very small particles) or chips in a TCE vapor degreaser. Monitor TCE stabilizer levels regularly. Only trained personnel should operate vapor degreasers.

TRANSPORTATION DATA (per 49 CFR 172.101-2):

DOT Hazard Class: ORM-A	DOT ID No. UN1710	IMO Class: 6.1
IMO Label: St. Andrew's Cross (X)*	DOT Shipping Name: Trichloroethylene	DOT Label: None

* Harmful - Stow away from foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

References: 1-9, 12, 14, 21, 73, 87-94. PI

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Approvals JO Recchello

Indust. Hygiene/Safety 11-19-87

Medical Review M. D. Harbison

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GENIUM PUBLISHING CORP.

No. 382

VINYL CHLORIDE
(Revision A)
Issued: August 1978
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION 26

Material Name: VINYL CHLORIDE

Description (Origin/Uses): Widely used to make PVC resins and plastics; also used in organic synthesis.

Other Designations: VCM; Vinyl Chloride Monomer; Chloroethylene; Chloroethene; C_2H_3Cl; CAS No. 0075-01-4

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

NFPA: 4 / 2 / 1 / -

HMIS			
H	2	R	1
F	4	I	4
R	1	S	3
PPG*		K	4

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Vinyl Chloride, CAS No. 0075-01-4	Ca 100	**OSHA PEL** 8-Hr TWA: 1 ppm* **ACGIH TLV, 1987-88** TLV-TWA: 5 ppm, 10 mg/m³ **Toxicity Data**** Rat, Oral, LD_{50}: 500 mg/kg

*The action level set by OSHA in 29 CFR 1910.1017 is 0.5 ppm. Exposures above this level are strictly regulated by extensive medical record keeping, reporting, surveillance, and other requirements. Consult 29 CFR 1910.1017 for details.

**See NIOSH, *RTECS* (No. KU9625000), for additional data with references to mutagenic, reproductive, and tumorigenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 61°F (16°C)
Water Solubility (%): Insoluble
Molecular Weight: 107 Grams/Mole
Vapor Density (Air = 1): 2.2

Appearance and Odor: A colorless gas; mild, sweet odor at high concentrations.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
-108.4°F (-78°C)	882°F (472°C)	% by Volume	3.6%	33%

Extinguishing Media: Vinyl chloride gas is a severe fire and explosion hazard; treat any fire involving it as an emergency. Try to shut off the flow of gas. Use a water spray to protect the personnel attempting this and to cool fire-exposed cylinders/containers of vinyl chloride.

Unusual Fire or Explosion Hazards: This heavier-than-air gas can flow along surfaces, reach distant sources of ignition, and flash back. Eliminate sources of ignition in the workplace, particularly in low-lying areas such as sumps, cellars, basement utility rooms, and underground piping systems.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Vinyl chloride is stable in closed, airtight, pressurized containers at room temperature under normal storage and handling conditions. It can undergo hazardous polymerization if it is heated or reacted with a polymerization catalyst, or if the concentration/activity of the added inhibitor becomes too low.

Chemical Incompatibilities: This material is incompatible with copper, aluminum, and other polymerization catalysts or free radical initiators like hydroquinone.

Conditions to Avoid: Do not allow sources of ignition such as open flame, unprotected heaters, lighted tobacco products, electric sparks, or excessive heat in work areas. Avoid prolonged exposure to air, especially in the presence of certain contaminants, because dangerous levels of polyperoxides may accumulate. Avoid exposure to sunlight; if the proper catalytic conditions occur, the vinyl chloride monomer may react with itself and undergo an explosive polymerization reaction. Violent ruptures of containers of this gas can occur.

Hazardous Products of Decomposition: During fires, vinyl chloride may decompose into toxic gases such as hydrogen chloride, carbon monoxide, and phosgene.

SECTION 6. HEALTH HAZARD INFORMATION

Vinyl chloride is listed as a carcinogen by the ACGIH, NTP, and IARC with sufficient epidemiological evidence from human studies.
Summary of Risks: Vinyl chloride depresses the central nervous system (CNS), causing effects that resemble mild alcohol intoxication; however, these effects can progress to narcosis, eventual collapse, and even death as the intensity and/or duration of the exposure continues. Thrombocytopenia (decrease in blood platelets) has been reported following exposures.
Medical Conditions Aggravated by Long-Term Exposure: Possible liver effects. **Target Organs:** Respiratory system, skin, eyes, kidneys, hematopoietic (blood) system, and musculoskeletal system. **Primary Entry:** Inhalation. **Acute Effects:** Headache, dizziness, lightheadedness, skin and eye irritation. **Chronic Effects:** Cancer, especially angiosarcoma of the liver.
FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Skin contact with liquid vinyl chloride causes frostbite (cryogenic injury). Treat this accordingly.
Inhalation. Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.
Ingestion. Unlikely.
GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat any vinyl chloride gas leak as an emergency.* Preplan emergency responses and make sure all personnel know about them. Notify safety personnel, evacuate all nonessential personnel, provide maximum explosion-proof ventilation, and eliminate all sources of ignition immediately. Make sure cleanup personnel have protection against contact with this material and inhalation of its vapor (see sect. 8). **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations for disposal. Follow Federal, state, and local regulations.
OSHA Designations
Air Contaminant (29 CFR 1910.1000 Subpart Z)
Vinyl chloride is specifically regulated by OSHA at 29 CFR 1910.1017 as a suspected carcinogenic agent.
EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. U043
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per Clean Water Act (CWA), section 307 (a); Clean Air Act (CAA), section 112; and Resource Conservation and Recovery Act (RCRA), section 3001.

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Consult the *NIOSH Pocket Guide to Chemical Hazards* for general recommendations on respirators. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves; boots; aprons; head covers; and clean, impervious, body-covering clothing to prevent any possibility of skin contact with vinyl chloride. All clothing must be flame resistant. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of vinyl chloride below the OSHA PEL standard cited in section 2. All ventilation systems must be of maximum explosion-proof design, e.g., nonsparking, electrically grounded and bonded. **Safety Stations:** Make eyewash stations, safety showers, and washing facilities available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. **Other:** Design all engineering systems to be explosion-proof in areas where vinyl chloride gas may occur. Pressure check all pipes and equipment used with this gas and make sure that all connections are leak tight. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store vinyl chloride in a cool, dry, well-ventilated area away from sources of ignition and incompatible chemicals. Outside or detached storage is recommended. Shade containers from radiant heat and direct sunlight. **Special Handling/Storage:** Vinyl chloride is shipped/stored as a pressurized gas in cylinders or tank cars. Protect these containers against physical damage and regularly inspect them for cracks, leaks, or faulty valves. Ground and bond all containers used in shipping/transferring operations. Store cylinders upright; secure them tightly; do not drag or slide them; move them in a carefully supervised manner with a suitable hand truck. Monitor the activity and concentration of the added inhibitor to the vinyl chloride product. Follow your supplier's recommendations concerning proper shelf life, rotation of inventory, and maintenance of purity. **Engineering Controls:** Make all engineering systems (ventilation, production, etc.) of maximum explosion-proof design. **Comments:** Perform all operations with vinyl chloride carefully to prevent accidental ignition. Do not smoke in any use or storage area. Maintain the valve protection cap in place until immediately before using vinyl chloride. Insert a check valve or trap into the transferral line to prevent a dangerous backflow into the original container. Use pressure-reducing regulators when connecting cylinders to lower-pressure piping systems. Obtain detailed handling, shipping, and storage information from your supplier. A trained chemist or safety specialist familiar with the physical and chemical properties of this material should be present during all work operations.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Vinyl Chloride	**DOT Label:** Flammable Gas	**IMO Label:** Flammable Gas
DOT ID No. UN1086	**DOT Hazard Class:** Flammable Gas	**IMO Class:** 2.1

References: 1, 2, 12, 73, 84-94.

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GENIUM PUBLISHING CORP.

No. 318

XYLENE (Mixed Isomers)
(Revision D)
Issued: November 1980
Revised: August 1988

SECTION 1. MATERIAL IDENTIFICATION

26

Material Name: XYLENE (Mixed Isomers)

Description (Origin/Uses): Used as a raw material for the production of benzoic acid, phthalic anhydride, isophthalic and terephthalic acids and their dimethyl esters in the manufacture of polyester fibers; in sterilizing catgut; with Canadian balsam as oil-immersion in microscopy; and as a cleaning agent in microscopic techniques.

Other Designations: Dimethylbenzene; Xylol; C_8H_{10}; CAS No. 1330-20-7

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Comments: Although there are three different isomers of xylene (*ortho*, *meta*, and *para*), the health and physical hazards of all three isomers are very similar. This MSDS is written for a xylene mixture of all three isomers, which is usually commercial xylene.

NFPA: 3 / 2 / 0 / -

HMIS			
H	2	R	1
F	3	I	3
R	0	S	2
PPG*		K	3

*See sect. 8

SECTION 2. INGREDIENTS AND HAZARDS / % / EXPOSURE LIMITS

INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Xylene (Mixed Isomers), CAS No. 1330-20-7* *o-Xylene, CAS No. 0095-47-6 *m*-Xylene, CAS No. 0108-38-3 *p*-Xylene, CAS No. 0106-42-3 **Check with your supplier to determine if there are additions, contaminants, or impurities (such as benzene) that are present in reportable quantities per 29 CFR 1910. ***Immediately dangerous to life and health. **** See NIOSH, *RTECS* (No. ZE2100000), for additional data with references to reproductive, irritative, and mutagenic effects.	**	IDLH*** Level: 1000 ppm **OSHA PEL** 8-Hr TWA: 100 ppm, 435 mg/m³ **ACGIH TLVs, 1987-88** TLV-TWA: 100 ppm, 435 mg/m³ TLV-STEL: 150 ppm, 655 mg/m³ **Toxicity Data**** Human, Inhalation, TC_{Lo}: 200 ppm Man, Inhalation, LC_{Lo}: 10000 ppm/6 Hrs Rat, Oral, LD_{50}: 4300 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point: 275°F to 293°F (135°C to 145°C)*
Melting Point: -13°F (-25°C)
Evaporation Rate: 0.6 Relative to BuAc = 1
Specific Gravity (H_2O = 1): 0.86

Water Solubility (%): Insoluble
Molecular Weight: 106 Grams/Mole
% Volatile by Volume: Ca 100
Vapor Pressure: 7 to 9 Torrs at 68°F (20°C)
Vapor Density (Air = 1): 3.7

Appearance and Odor: A clear liquid; aromatic hydrocarbon odor.

*Materials with wider and narrower boiling ranges are commercially available.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
81°F to 90°F (27°C to 32°C)	867°F (464°C)	% by Volume	1%	7%

Extinguishing Media: Use foam, dry chemical, or carbon dioxide. Use water sprays to reduce the rate of burning and to cool containers.

Unusual Fire or Explosion Hazards: Xylene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

SECTION 5. REACTIVITY DATA

Xylene is stable in closed containers during routine operations. It does not undergo hazardous polymerization.

Chemical Incompatibilities: This material may react dangerously with strong oxidizers.

Conditions to Avoid: Avoid any exposure to sources of ignition and to strong oxidizers.

Hazardous Products of Decomposition: Carbon monoxide (CO) may be evolved during xylene fires.

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SECTION 6. HEALTH HAZARD INFORMATION

Xylene is not listed as a carcinogen by the IARC, NTP, or OSHA.

Summary of Risks: Liquid xylene is a skin irritant and causes erythema, dryness, and defatting; prolonged contact may cause blistering. Inhaling xylene can depress the central nervous system (CNS), and ingesting it can result in gastrointestinal disturbance; and possibly hematemesis (vomiting blood). Effects on the eyes, kidneys, liver, lungs, and the CNS are also reported. **Medical Conditions Aggravated by Long-Term Exposure:** Problems with eyes, skin, central nervous system, kidneys, and liver may be worsened by exposure to xylene. **Target Organs:** CNS, eyes, gastrointestinal tract, blood, liver, kidneys, skin. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Dizziness; excitement; drowsiness; incoordination; staggering gait; irritation of eyes, nose, and throat; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; and dermatitis. **Chronic Effects:** Reversible eye damage, headache, loss of appetite, nervousness, pale skin, and skin rash.

FIRST AID: Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have a trained person administer oxygen. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Vomiting may occur spontaneously, but do not induce it. If vomiting should occur, keep exposed person's head below his or her hips to prevent aspiration (breathing the liquid xylene into the lungs). Severe hemorrhagic pneumonitis with grave, possibly fatal, pulmonary injury can occur from aspiring very small quantities of xylene.

GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. If exposure is severe, hospitilization for at least 72 hours with careful monitoring for delayed onset of pulmonary edema is recommended.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately. Cleanup personnel need protection against contact with and inhalation of xylene vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.

Waste Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

OSHA Designations

Air Contaminant (29 CFR 1910.1000 Subpart Z)

EPA Designations (40 CFR 302.4)

RCRA Hazardous Waste, No. U239

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), section 311 (b) (9)

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield as a supplementary protective measure. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specifics of the work operation to prevent prolonged or repeated skin contact with xylene. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of xylene below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of xylene into general work areas by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make eyewash stations, safety/quick-drench showers, and washing facilities available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean xylene from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale xylene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store xylene in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage.

Special Handling/Storage: Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Xylene
DOT ID No. UN1307

DOT Label: Flammable Liquid
DOT Hazard Class: Flammable Liquid

IMO Label: Flammable Liquid
IMO Class: 3.2 or 3.3

References: 1, 2, 12, 73, 84-94, 100, 103.

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