CORNHUSKER ARMY AMMUNITION PLANT LONGTERM GROUNDWATER MONITORING HEALTH AND SAFETY PLAN

Prepared for
U.S. Army Environmental Center

June 1997

Woodward-Clyde

Woodward-Clyde Federal Services
10975 El Monte, Suite 100
Overland Park, Kansas 66211
Project Number K9642

Woodward-Clyde
Engineering & sciences applied to the earth & its environment

June 10, 1997
WCFS Project K9642

Ms. Heather Black
Project Manager
U.S. Army Environmental Center
Installation Restoration Division, Building E4480
Aberdeen Proving Ground, Maryland 21010-5401

Re: Cornhusker Army Ammunition Plant
Long Term Ground Water Monitoring
Health and Safety Plan

Dear Ms. Black:

Enclosed please find fifteen copies of the final Health and Safety Plan for the long term ground water monitoring at the Cornhusker Army Ammunitions Plant. Enclosed within the plan is a letter dated June 6, 1997 containing responses to the comments received from William Houser. The responses to Mr. Houser's comments have also been incorporated into the document as appropriate. I look forward to receiving your thoughts and comments on the document.

If you have any questions, please contact me at (913) 344-1153.

Sincerely,

David C. Convy
Project Manager

enclosure

cc: Bob Lanza (w/o enclosure)

K9642/hspltrfin/ 06/10/97 7:46 AM

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June 6, 1997

Ms. Heather Black
Project Manager
U.S. Army Environmental Center
Installation Restoration Division, Building E4480
Aberdeen Proving Ground, Maryland 21010-5401

Re: Response to Comments and Revised Health and Safety Plan
Cornhusker Army Ammunition Plant
Longterm Groundwater Monitoring

Dear Ms. Black:

Woodward-Clyde Federal Services (WCFS) received comments from Mr. William Houser on the Cornhusker Army Ammunition (CHAAP) Longterm Groundwater Monitoring Health and Safety Plan. This letter presents our response to those comments. Following each comment (retyped in bold), is our response to the comment. If changes have been made to the safety plan, this is noted in the response. Enclosed with the response to comments is a revised safety plan for the work at CHAAP.

a. **Page 5-1, Section 5.1, first paragraph, first sentence. Recommend including asbestos in Table 2, since discussed in this sentence.**

Disagree. The second paragraph in Section 5.1 discusses that the asbestos material has been removed and is no longer a hazard to personnel, especially those performing tasks under the current scope of services (groundwater sampling).

b. **Page 5-1, Section 5.1, third paragraph. Material Safety Data Sheets must also be included for hazardous materials brought on site by contractors (i.e., preservatives, bentonite, calibration gases, etc.). Also a MSDS needs to be included for Methanol.**

Agree. The text will be changed to include language referring to MSDS's for products brought onto the jobsite. A MSDS for methanol will be added to Attachment A.

Contractors are required to coordinate with the following installation facilities prior to starting field activities:

1. **Emergency medical facilities- for emergency support**

2. **Environmental office- for environmental support**
3. **Safety office- for installation safety and security requirements and support, and**
4. **Fire department- contractors must furnish the fire department with a list of all chemicals (to include quantities and storage location) brought on the installation (i.e., preservatives, calibration gases, etc.)**

Agree. The text of the safety plan will be changed to include this information in Section 11.4.

The contractor should not store more than 10 gallons of flammable/combustible chemicals on site at one time. If larger quantities are needed then the contractor will be required to obtain a flammable storage cabinet for the chemicals. Ensure that only compatible chemicals are stored together. Ensure that calibration gases and chemicals are stored in an area were there is limited traffic.

Agree. It is anticipated that only small quantities of chemicals will be stored and used at the jobsite at any particular time. The text will be modified to add language on the storage of chemical products in Section 11.12, Housekeeping.

c. **Page 5-2, Section 5.2.3, second paragraph, first sentence. Recommend stating that no drilling will be conducted within 30 feet or height of boom of overhead electrical lines. All personnel working in and around the drill rig must be informed of the location of the kill switch in case of an emergency. The kill switch must be tested daily prior to beginning of scheduled activities. A log (including dates and tested by) must be maintained on site. Recommend incorporating in the health and safety plan.**

Agree. The text will be modified in Section 5.2.3 regarding minimum distances from electrical lines and heavy equipment. The table in the section will also be modified. Information regarding the kill switch on the drill rig and daily testing of this equipment will be incorporated into Section 5.2.4.

d. **Page 6-2, Section 6.2.3, first paragraph, last sentence. Recommend referring to appropriate document in Attachment C and state all personnel attending safety briefings will be required to sign this document.**

Agree. Section 6.2.3 will be modified appropriately.

e. **Page 6-2, Section 6.2.4. Accidents resulting in any fatality, lost-time injury or illness, hospitalization of 3 or more personnel, or property damage to government or contractor property (which occurred during the performance of the contract) equal to or exceeding $2000.00 must be telephonically reported to U.S. Army Environmental Center (USAEC), SFIM-AEC-ETP, (410) 671-4811, as soon as possible, but not later than 2 hours after occurrence and reported in writing within 5 days of occurrence on DA Form 285 (encl). All other accidents/incidents must be telephonically reported to USAEC, SFIM-AEC-ETP, (410) 671-4811, within 8 hours of occurrence. Recommend incorporating this requirement.**

Agree. The USAEC requirements will be incorporated into the safety plan.

f. **Page 7-1, Section 6.2.4, Exclusion Zone, first sentence. Same comment as C above.**

Agree. No change required to text of the safety plan.

g. **Page 10-2, Section 10.2. Recommend incorporating the personal protective equipment requirements to be worn during equipment decontamination procedures.**

Agree. The appropriate language will be added to this section.

h. **Page 11-3, Section 11.9, Exclusion Zone. Recommend incorporating what actions will be taken should an unauthorized entry into the exclusion zone occur (i.e., stop work, document, notify, etc.).**

Agree. The appropriate language will be added to this section.

i. **Page 12-5, Section 12.2, Fire extinguishers. Recommend stating that a minimum 20 lb. ABC types will be used.**

Agree. The fire extinguishers will be changed to 20 lb. ABC type.

j. **Page 12-5, Section 12.2, First aid kit. CPR shields and protective gloves are required for first-aid kits to limit the potential for infection of first-aid responder (29 CFR 1910.1030(c)(3)(i).**

Agree. This equipment is required in the Woodward-Clyde safety procedure for Bloodborne pathogens, HS-211, and will be added to the first aid list of supplies.

k. **Page 12-5, Section 12.2. Recommend referring to Table six for emergency points of contacts and telephone numbers.**

Agree. References to Table 6 will be added to Section 12.

l. **Tables, table six. Recommend replacing Vivian Graham with William Houser as USAEC Safety Officer.**

Agree. The name change will be made.

Please contact the undersigned if you have questions regarding the response to comments and the revised Longterm Groundwater Monitoring Health and Safety Plan for the Cornhusker Army Ammunition Plant.

Sincerely,

Carla J. Dods

Carla J. Dods
Health and Safety Officer

David C. Convy
Project Manager

Enclosure

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Tables

Figures

Attachments

Project Name:	Cornhusker Army Ammunition Plant
WCFS Project Number:	K9642
Project Location:	Grand Island, Nebraska
Client:	U.S. Army Environmental Center
Contract Number:	DACA31-94-D-0059
WCFS Project Manager:	David C. Convy
W-C Health and Safety Officer:	Carla J. Dods
Site Contact:	Tom Jamieson

Effective Dates: June 9, 1997 through December 31, 1998

APPROVALS

David C Convy

Project Manager

5 June 1997

Date

Carla J. Dods

Health and Safety Officer

June 5, 1997

Date

Corporate Health and Safety Officer

Date

SECTIONONE **Administrative Information**

Project Name:	Cornhusker Army Ammunition Plant
WCFS Project Number:	K9642
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David C Convy
Project Manager

5 June 1997
Date

Carla J. Dods
Health and Safety Officer

June 5, 1997
Date

Corporate Health and Safety Officer

June 6, 1997
Date

2.1 PLAN OBJECTIVES

This Health and Safety Plan (HSP) defines procedures and protocol to be followed during the field activities portion of the Longterm Groundwater Monitoring at the Cornhusker Army Ammunition Plant (CAAP). Its primary function is to establish requirements for protecting the health and safety of the field sampling team throughout the field activities. Woodward-Clyde (W-C) requires that all personnel performing field work as part of this delivery order understand, use, and document health and safety procedures specified in this plan.

Specifically, this plan presents the following:

- Identification and evaluation of the physical, chemical, and biological hazards associated with the site and work activities
- Specifies levels of protection, protective equipment, and air monitoring
- Outlines emergency response procedures for the types of incidence that may occur
- Identifies key project personnel and specifies their safety responsibilities
- Specifies decontamination procedures for personnel and equipment

This HSP is in compliance with OSHA regulations and the activities conducted under this HSP will be performed in compliance with OSHA regulations and W-C safety policy and procedures. It is in compliance with applicable sections of 29 CFR 1910.120 and was prepared exclusively for use by employees of W-C and its subcontractors. Use of this HSP by firms or persons not under contract to W-C shall be at that persons sole risk.

This plan shall not be modified or used after the expiration date without written approval by the Project Manager (PM) and Health and Safety Officer (HSO) or their representatives. This plan is not valid until it is signed and dated by the PM, HSO and Corporate Health and Safety Officer (CHSO).

Woodward-Clyde will provide health and safety oversight of all field activities. Any subcontractors will be responsible for providing their personnel with appropriate medical surveillance and OSHA training. All W-C subcontractors will be responsible for providing competent operators for heavy equipment who will conduct daily equipment inspections and complete equipment maintenance, as appropriate.

2.2 SITE DESCRIPTION

CAAP is located on an 11,936-acre tract approximately 2 miles west of Grand Island, Nebraska. The site also includes off-post areas (to the northeast) which have groundwater contaminated with explosives compounds originating from CAAP.

CAAP was constructed and became fully operational in 1942 as a U.S. Government-owned, contractor-operated facility, for the production of artillery shells, mines, bombs, and rockets for World War II and Korean and Vietnam conflicts. The plant was operated intermittently for 30 years with the most recent operations ending in 1973. Explosives wastes and residues associated with munitions loading, assembly, and packing operations at CAAP have resulted in a large groundwater plume that originates at waste leachpits and cesspools of the CAAP Load Lines and extends east-northeastward to the City of Grand Island. From 1942-1945, various bombs, shells, boosters, and supplementary charges were produced at CAAP using primarily 2,4,6-TNT. From 1950-1955, artillery shells and rockets were produced using a mixture of 2,4,6-TNT, RDX, and HMX. From 1965-1973, the plant was activated again to produce bombs, projectiles, and small gravel mines.

The explosive compounds have migrated with the prevailing direction of groundwater flow. Relatively nonsorbing compounds, including RDX and HMX, have migrated the greatest distance. More highly sorbing compounds, such as 2,4,6-TNT, have migrated shorter distances. The Site Characterization Document (SCD) provides the most comprehensive description available of the nature and extent of groundwater contamination at CAAP (USAEC, 1993a).

Evaluation and remediation of explosives contaminated at CAAP has been an on-going process. During the early and middle 1980s, the U.S. army conducted an incineration project designed to excavate and treat soils beneath leachpits and cesspools of the CAAP Load Lines. The purpose of this project was to remove the source of explosives contamination. The project reduced the sources of contamination, but was unable to remove all contaminated soil. At many locations, remediation action levels could not be achieved before groundwater was encountered. Water quality sampling of on- and off-post wells has been conducted repeatedly since the middle 1980s to identify domestic users of water with elevated concentrations of RDX and other explosives. Where affected water users have been identified, the U.S. Army and the City of Grand Island have worked together to provide an alternative water supply.

CAAP was listed as a site on the National Priorities List on July 22, 1987. A federal Facilities Agreement (FFA), effective April 1990, set forth the terms for the RI/FS effort. This agreement provides the terms, the listing of documents to be generated, and the target dates for delivery of reports. Numerous studies had been conducted at CAAP and in the surrounding area prior to this agreement, to assess and delineate the extent of contamination. These studies are summarized in detail in the SCD.

After completion of the SCD, data gaps and concerns were identified by USEPA and NDEQ necessitating additional site investigation in order to fully characterize the nature and extent of contamination associated with the site and to complete a Remedial Investigation. In accordance with the terms of the FFA; USAEC, NDEQ, and USEPA decided to divide the site into three Operable Units (OU1, OU2 and OU3).

OU1: Background areas, the explosives groundwater plume, and off-post areas.

OU2: The LAP facilities (Loadlines 1-5) and the Gravel and Clay Pit Area.

OU3: All other on-post areas. These include:

- Burning Grounds
- Sanitary Landfill
- Pistol Range
- Shop Area
- Nitrate Area

- Pesticide and Fertilizer Storage Areas
- Magazine Areas
- Sewage Treatment Areas
- Administration Area
- Recreation

2.3 PREVIOUS INVESTIGATIONS AND FIELD WORK

Work Plan Addendum documents were prepared for OU1, (USAEC, 1993b) and for OU2 and OU3 (USAEC, 1993c) to address the data gaps identified in the SCD. The Work Plan Addendum for OU1 was implemented in 1994 and involved the installation and sampling of 109 miniwells in the LAP areas to evaluate the current conditions at previously excavated explosives, wastewater cesspools, and leachpits. The miniwells were installed in the water-table aquifer immediately upgradient and downgradient of these cesspools and leachpits and were sampled twice. In addition, aquifer tests were performed and additional soil, groundwater, and surface water/sediment samples were collected.

In addition, an Interim Remedial Action (IRA) was conducted in November and December 1994 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) by USACE where explosives contaminated soils were removed from 25 sites. Using information contained in the SCD, a Focused Feasibility Study was prepared that evaluated various options for groundwater extraction and treatment. A three-dimensional groundwater flow model was developed as an aid to evaluating effects of the various groundwater extraction options. A preferred option was presented to the public that included extraction wells near the CAAP Load Lines to minimize the effects of additional sources, and off-post extraction wells to prevent further migration of the explosives plume. A Record of Decision (ROD) for this action was signed on November 11, 1994.

This section describes the roles of the various positions as they pertain to health and safety. The responsibilities and authority of each individual are presented in Table 1. Key personnel who may be involved in field activities at the CAAP include:

Project Manager - David Convy
Field Team Leader - To be named
Site Safety Officer (SSO) - To be named

Personnel to be assigned to field activities must be approved by the Project Manager and Health and Safety Officer (HSO) before they begin any field work on this project.

The anticipated field activities of current and future investigations at the Site are described briefly in the following sections. These activities are expected to include Site management, non-intrusive, and intrusive activities. It is noted that not all activities described in this section will be conducted during each phase of field work. The detailed sampling plans and objectives will be included in the Technical Plan and associated supporting documents.

4.1 SITE MANAGEMENT

This activity covers general management of activities and personnel during field events and includes general activities at the field office such as receipt of deliveries, shipment of samples, radio and telephone communications, documentation of field activities, maintaining field supplies, and meetings. Transport of project personnel and visitors to various Site locations is also included in this activity.

4.2 SITE RECONNAISSANCE

A site reconnaissance of individual work sites at the CAAP may be conducted during the planning of field work and as part of field activities. This activity may include walk-throughs to familiarize the field team with site conditions, utility clearance for intrusive work, and air quality surveys.

4.3 SURVEYING

Surveying is a non-intrusive activity that will occur during certain field activities. Monitoring wells, sampling locations, and important Site features may be surveyed for vertical and horizontal control to provide accurate location data to be used to produce multi-purpose maps. Surveying is likely to be conducted in many areas of the Site.

4.4 PIEZOMETER AND MONITORING WELL INSTALLATION AND DEVELOPMENT

Piezometers and monitoring wells will be installed at various locations on Site to investigate groundwater contamination and monitor the performance of the groundwater remediation system. The monitoring well borings will be drilled using auger or rotary drilling techniques.

As part of the logging of monitoring well borings, downhole geophysical surveys of individual borings may be conducted to better define the stratigraphy of the Site and assist with the interpretation of subsurface materials at individual boring locations.

Following monitoring well installation, each piezometer and monitoring well will be developed to remove any materials introduced into the formation during drilling operations. Development activities will consist of surging, pumping, bailing, or other well development methods.

4.5 PIEZOMETER AND MONITORING WELL MEASUREMENTS AND SAMPLING

Water level measurements, aquifer testing, and groundwater sampling will be conducted at existing and new piezometers and monitoring wells. Aquifer testing may include installation of data loggers and aquifer pump tests. Monitoring well samples typically will be collected using submersible pumps and non-dedicated, stainless-steel bailers. Each well will be purged prior to sampling.

In addition, private water supply wells may be sampled at the well head or a separate tap.

A qualitative evaluation of the conditions at the site has been made to determine the known hazards at the site and evaluate the risks associated with site activities. This evaluation is based on:

- Nature of known contaminants and hazards
- The potential presence of contaminants and hazards at specific work areas
- Potential for personnel and public exposure during various site activities
- Effects of contaminants and hazards on human health
- Concentrations of chemical contaminants and products

The potential hazards associated with exposure varies directly with the concentration of contamination to which an individual is exposed and the length of exposure. Exposure potential is defined as the probability of an individual receiving a harmful exposure.

5.1 CHEMICAL HAZARDS

Three classes of chemicals have been used and detected at the CAAP: heavy metals, various nitrogen compounds used in the manufacture of explosives, and asbestos. Most of the compounds detected are irritating to the skin, mucous membranes and eyes, and affect the central nervous system, lungs, liver, and kidney. In addition, many of the nitrogen compounds can be highly flammable and explosive if present in significant concentrations.

A list of known chemicals which may be expected at CAAP is found in Table 2. Potentially hazardous materials which will be used during site investigation activities are also given in Table 2. Asbestos containing building materials (ACBM) have been used throughout CAAP. ACBM has been removed and remediated during past operations. No known personnel hazards posed by ACBM are currently known to exist.

MSDSs are provided for the chemicals anticipated to be used during groundwater monitoring activities, as well as those known to have been used at CAAP. These are provided in Attachment A. A MSDS will be obtained and kept with the safety plan for any other chemical products used on-site.

Although the chemicals detected on site have the potential to adversely impact human health, based on the activities approved under this Health and Safety Plan, and the relative concentrations of the known contaminants, the overall chemical hazards are characterized as **low**. A summary of the chemical hazards is presented in Table 3.

5.2 PHYSICAL HAZARDS

Personnel should be aware that the protective equipment worn may limit manual dexterity, hearing, visibility, and may increase the difficulty of performing some tasks. Personnel should be aware of wind directions and attempt to coordinate field activities and gasoline powered equipment so that exhaust fumes and chemical vapors are located downwind from work areas.

5.2.1 Heat Stress

Personal protective equipment places an additional strain on the wearer when performing work that requires physical activity. Heat exhaustion or heat stroke are possible, especially during warm weather and have the following characteristic symptoms:

- **Heat Exhaustion** - nausea, headache, weakness, dizziness, or extreme perspiration; pale, cool, moist skin.
- **Heat Stroke** - a sudden lack of perspiration; dry, pale to red skin; and strong rapid pulse. **This condition requires immediate medical attention.**

All field personnel shall be monitored for heat stress following the procedures in HS-201 provided in Attachment B when air temperatures exceed 75°F.

All personnel should be aware of the physical condition of themselves and their fellow workers. One or more of the following control measures may be implemented:

- **Adequate Liquids** - Provide sufficient cool (not cold) liquids to replace lost body fluids. Employees must replace water and electrolytes lost from sweating. Employees will be encouraged to drink more than the amount required to satisfy thirst since thirst satisfaction is not an accurate indicator of adequate fluid replacement. Replacement fluids can be commercial mixes such as Gatorade or Quick Kick, fruit juices, or water.
- **Work/Rest Regimens** - Implementation of a work-rest regimen that will provide adequate break periods for cooling down. This may require additional shifts of workers or suspending work during the hottest parts of the day.
- **Breaks** - All breaks are to be taken in a cool and shaded rest area. Impermeable protective garments are to be removed during rest periods. Employees shall not be assigned other tasks during rest periods.
- **Cooling Devices** - Equipment such as cooling vests can be worn beneath protective garments.

5.2.2 Cold Stress

Exposure to cold or wet and cold environments can result in cold stress (hypothermia) or cold injury (frostbite). In the event field activities are conducted during cold weather, W-C procedure HS-202 and the American Conference of Governmental Industrial Hygienist (ACGIH) cold stress TLVs will be followed (Attachment B). Appropriate first-aid treatment for cold stress will be provided until medical care is available.

5.2.3 Electricity and Utilities

Known underground facilities, structures, and utilities must be located from available record information prior to initiating intrusive work. The locations must be considered as approximate. Be aware and always suspect the existence of underground utilities such as electrical power, gas, petroleum, telephone, sewer, and water.

Special precaution must be taken when operating machinery (i.e., drill rigs) in the vicinity of overhead electrical power lines. Contact with electricity can shock, burn, and result in death. All overhead electrical power lines are to be considered energized and dangerous. Walk completely around the machine and look up before beginning work at a site in the vicinity of power lines. Determine what the minimum distance from any point on the machine to the nearest power line or trees near power lines will be when operating. Do not raise a mast or boom, or operate the machine if the distance is less than 30 feet. Remember that electricity can arc from energized sources to heavy equipment. Standard procedures for drilling safety (HS-203) are included in Attachment B. Minimum clearance distances are listed below:

System Voltage	Minimum Clearance
0-500 kV	30 feet
501-750 kV	35 feet
751-1,000 kV	45 feet

5.2.4 Heavy/Large Equipment

The activities to be performed under the provisions of this plan involve the potential-exposure to large machinery, particularly drilling equipment. This equipment poses a variety of hazards, in particular physical injury from inadvertent contact with the equipment. Personnel will stand clear of equipment and within eyesight of the equipment operator at all times. All large and heavy machinery will be equipped with backup alarms. All large equipment will be inspected daily to check that all parts are in good working condition, in particular the kill switch on drilling rigs. Field personnel working with a drill rig crew will be informed of the location of the kill switch in the event of an emergency. Daily inspections of drill rigs and other large equipment will be documented on separate inspection forms or recorded in the field book associated with those activities. Special precautions for drilling equipment are identified in the Woodward-Clyde SOP HS-203 included in Attachment B.

Working around heavy machinery can pose a noise hazard for site personnel. Hearing protection is required for personnel working where a noise-producing source (i.e., drill rig, steam cleaner) forces a person to raise their voice to communicate with someone 3 feet away.

5.2.5 Slip, Trip, and Fall

Many of the field activities involve the potential for slip, trip, and fall hazards. This includes the numerous prairie dog holes present throughout the site. The wearing of PPE can also increase the potential for slips, trips, and falls. Alertness and good housekeeping practices are vital to reducing the hazards.

5.3 BIOLOGICAL HAZARDS

Assume that all animals are potentially dangerous. A person who is bitten by an animal may become infected by tetanus or rabies. Warm-blooded animals, such as dogs, cats, rats, and prairie dogs can transmit rabies. Rabies can be transmitted when the saliva from an infected animal contacts an open wound (even a scratch) or any normal body opening, such as the mouth or eye.

Poisonous snakes and insects may also pose a hazard to field personnel. Extra precaution will be taken in suspect environments to avoid exposure. Insects may also be carriers of infectious disease. Personnel sensitive or allergic to insect bites should be cautious and alert to their working environment.

Ticks and tickborne diseases are a possible hazard. Information on ticks is provided in Woodward-Clyde SOP HS-213 (Attachment B).

Potential exposure also exists for exposure to microbiological hazards such as viruses, bacteria, and molds. Personnel shall avoid disturbing small rodent nesting areas and shall keep eating and work area free of food supplies that would attract mice. For example, the hanta virus can be carried by the liquid and solid excrement of field mice. The hanta virus is known to be present in Nebraska and exposure occurs through inhalation of dusts associated with mice droppings. Prairie dogs have also been documented carriers of the Bubonic plague virus. Personnel shall avoid contact with wild animals.

Table 4 presents an assessment of the biological hazards associated with each type of activity based on the information above.

5.4 UNEXPLODED ORDNANCE AND EXPLOSIVES

Previous unexploded ordnance (UXO) clearance surveys conducted by Army and UXO subcontractors have identified only a small portion of CAAP where UXO may be located at or near the ground surface. This area, identified as the Burning Ground, has been enclosed by a fence and is excluded from the scope of this investigation. WCFS and subcontractor personnel are expressly forbidden to enter this area. The location of the fence is such that personnel outside the fence are unlikely to be hurt if a spontaneous detonation occurs within one of the former ordnance disposal trenches.

All other areas of CAAP have either been extensively cultivated, mown, or swept for unexploded ordnance, and, as a result are believed to be free of UXO hazards at or near the ground surface.

Loadlines 1, 2, 3, and 4

Explosive compounds have previously been used in these areas and it is considered likely that spills involving these compounds may have occurred on the concrete floor inside of the buildings. The majority of this material was flushed off the floors and into drains and directed to outside sumps. Over time, residual quantities of these compounds may have leaked through fractures in the concrete and entered the underlying soils and groundwater. It is not anticipated that sufficient quantities of explosives sufficient to pose any explosive hazard will be encountered. Intrusive work is not anticipated in these areas. However, in the event future work is conducted in these areas and as an added precaution, the concrete floor will be continually wetted during drilling to penetrate it. Soil will be sampled directly beneath the slab and screened for explosives. If explosives compounds are found to exceed 10%, the location will be abandoned. Additionally, dust monitoring will be performed during intrusive operations so that workers can be appropriately protected from contaminated dust that could possibly be generated during penetration of the concrete floor.

Burning Ground Area (outside of Restricted Zone Fence)

Explosive hazards have been repeatedly surveyed by Huntsville USACE UXO and EHS UXO personnel. Information developed during the surveys was used by the Army to build a fence around all known or suspected ordnance and/or explosive burial sites. Based on review of aerial photographs and records, no pits exist outside the fence-line. Currently, the areas to the west of the Burning Ground have been leased for crop production. However, as a conservative precaution, UXO surface clearance will be conducted at boring locations directly outside of the perimeter fence.

Burning Ground Area (Abandoned Burning Area)

Although disposal (burning) operations may have occurred at this location, no pits or other burial operations are suspected. Therefore, UXO surface clearance (with clearance capability up to 2 feet) will be followed by a focused EM survey at soil boring locations. Any metallic anomaly will be avoided by at least 10 feet.

Pistol Range

Since this area has been previously inspected as part of the SCD Investigation (USACE 1993) and has been extensively cultivated, the surface is not suspected of having explosive hazards. Therefore, surface clearance will not be required prior to surface activities.

In the event intrusive work is performed at the Pistol Range, an EM survey will be performed across the site to identify anomalies due to metal or other soil disturbances. Based on EM results, intrusive work will be performed in areas at least 10 feet from detected metallic anomalies.

Sanitary Landfill (Fuse Destructor Area)

Due to the presence of suspected buried objects in the first few feet of soil, UXO surface clearance and geophysical (EM) survey (with clearance capabilities of up to 2 feet) will be performed prior to intrusive work at any selected location. Boring locations will be at least 10 feet away from any detected metallic anomaly.

5.5 HAZARD EVALUATION

Although the chemicals detected on site have the potential to adversely impact human health, based on the activities approved under this Health and Safety Plan, and the relative concentrations of the known contaminants, the overall chemical hazards are characterized as **low**. A summary of the hazards for each activity is presented in Table 4.

6.1 TRAINING AND MEDICAL EXAMINATION

All personnel participating in site work with the potential for incurring exposure to hazardous substances shall have successfully completed a pre-placement or periodic/update physical examination in accordance with 29 CFR 1910.120. All site personnel also shall have completed minimum training in compliance with 1910.120, as appropriate, and requirements as specified by other regulations.

All site personnel will attend an initial safety briefing conducted by the SHSO to become familiar with the overall site conditions and hazards, emergency procedures, site communication and to review the contents of this HSP relating to the safe conduct of work prior to performing any on-site activities. Daily safety meetings will be attended to ensure safe work practices are used and personnel are familiar with any changes in the site conditions or field procedures.

The initial safety briefing will inform all site personnel of the location of the nearest telephone, the emergency phone numbers, and how emergency assistance can be summoned. If a pay telephone is used as a primary or secondary means of emergency communications, sufficient change shall be available in the command post. The list of emergency phone numbers will be conspicuously posted at the command post at the worksite.

6.2 LOGS, REPORTS, AND RECORDKEEPING

6.2.1 General

The Project Manager is responsible for ensuring that implementation of the safety program for the long term groundwater monitoring is documented. A project and/or site file of health and safety related records and activity reports will contain the following:

- Visitor and site personnel registers
- Signed copies of the Compliance Agreement
- Copies of safety meetings
- Records of usage and calibration of environmental monitoring equipment
- Employee injury/exposure incident reports
- Records of safety violations and remedial actions taken
- Safety inspection reports, including daily inspections of drill rigs and other large equipment

A separate health and safety field logbook may be maintained on-site and should contain information such as: weather conditions, employees on-site, level of personal protection worn, monitoring instrumentation readings (average, peak, and background), subjects discussed during site health and safety briefings, and safety violations.

Periodic audits will be conducted to verify that the HSP and appropriate amendments are being implemented. Audits will follow W-C SOP HS-105.

6.2.2 Air Monitoring

A bound logbook will be used by the SSO and field personnel to record results of each environmental monitoring event within the exclusion zone. Monitoring will be conducted in the breathing zone or near the point of potential exposure. The following instruments will be used:

- PID/FID for intrusive activities and decontamination
- Respirable dust meter for subsurface soil sampling and drilling activities
- Noise meter during drilling activities

Monitoring with a PID/FID is not required for groundwater sampling at off-site locations. All monitoring equipment used for health and safety purposes will be calibrated as recommended by the manufacturer and, records of calibration will be maintained.

6.2.3 Safety Meetings And Inspections

The HSP and safety briefings serve the purpose of informing personnel of the hazards associated with the site and activities to be conducted. Safety briefings will be conducted by the Site Safety Officer (SSO) or Health and Safety Officer (HSO) at the beginning of each new activity or phase of work. Tail gate safety meetings will be conducted on a daily basis for on-site personnel and visitors to the site. All safety briefings and meetings will be documented in a field logbook or the forms included in Attachment C. All personnel working on the site will be required to sign a Compliance Agreement (Attachment C).

Safety inspections will be conducted periodically and documented in a field logbook or a separate form developed for this purpose (see Attachment C).

6.2.4 Accident/Incident Reporting

In the event of an accident or incident, the SSO will immediately notify the WCFS Project Manager and Health and Safety Officer. Types of accidents or incidents that are considered reportable are:

- Illness resulting from chemical exposure or unknown causes
- Physical injury, including an injury that does not require medical attention
- Fire, explosions, and flashes resulting from activities performed by W-C and its subcontractors
- Infractions of safety rules and requirements
- Unexpected chemical/radiological exposures
- Occurrence involving damage to equipment
- Threat of injury or near miss

Work will be suspended to correct the cause of the accident/incident and to modify this plan as necessary.

A W-C accident/incident report form (Attachment C) must be submitted to the PM and CHSO within 24 hours of occurrence.

Accidents resulting in any lost-time injury or illness, hospitalization of three or more people, or property damage of $2,000.00 or more, must be reported to the USACE, SFIM-AEC-ETP, within two hours by telephone and within five days in writing. All other accidents or incidents must be reported within eight hours of occurrence by telephone. Reportable accidents will be documented on DA Form 285 which is included in Attachment C. Telephone numbers for reporting accidents is listed in Table 6.

The provisions of 29 CFR 1910.120 requires the establishment of work zones for hazardous waste site activities to ensure the greatest possible degree of protection for all workers and to minimize the spread of contamination beyond hazard zones. The three basic work zones that will be established, based on work activity requirements, are:

- The exclusion zone
- The contamination reduction zone
- The support zone

Exclusion Zone

The exclusion zone for intrusive activities (such as monitoring well drilling and installation) is the area where contaminants could or do occur and will normally encompass a 30 foot radius around the point of intrusive activities. The boundary of the exclusion zone will be marked with either pin flags, caution tape, or similar materials. Personnel and equipment decontamination is required when exiting the exclusion zone after an intrusive activity. All individuals entering this area must be approved by the SSO.

An exclusion zone will not normally be established around non-intrusive activities (such as surveying) and personal/equipment decontamination will not normally be required.

Contamination Reduction Zone (CRZ)

In general, the CRZ is established immediately outside the exclusion zone to minimize the migration of contaminants from the exclusion zone to clean or support areas and to reduce the exposure potential of individuals leaving the exclusion zone.

Support Zone

The support zone is located in a clean area, preferably upwind and immediately outside of the CRZ, or in the on-site vehicles. Supplies, emergency equipment, and support personnel are located in the support zone or in the on-site vehicles.

The following tasks are area-wide by nature and do not require the establishment of work zones specific to each site or activity:

- Surface Reconnaissance survey
- Surveying
- Groundwater sampling of off-site locations

The following tasks require the establishment of work zones:

- Hollow-stem auger drilling and monitoring well installation
- Surface/subsurface soil sampling where UXO is suspected
- Rig/drilling equipment decontamination
- Groundwater sampling at on-site locations

8.1 LEVELS OF PROTECTION

Level D

Level D may be used when the atmosphere contains no known chemical hazard and when work functions preclude splashes, immersion, or the potential for unexpected inhalation of, or contact with hazardous materials. Level D consists of:

- Steel-toed boots (with disposable boot covers, if required by the SSO)
- Hard-hats (if an overhead hazard exists)
- Hearing protection (if needed)
- Safety glasses

Modified Level D

Modified Level D may be used in areas that can normally qualify for Level D, but where there is a potential for contact with contaminated materials. Modified Level D consists of:

- Uncoated Tyvek or equivalent disposable coverall. Saranex or polycoated coveralls must be worn instead of the uncoated Tyvek when corrosive product is handled.
- Disposable chemical-resistant inner gloves, latex or nitrile (worn over disposable cotton liners, if desired).
- Chemical-resistant neoprene gloves.
- Steel-toed boots with chemical-resistant boot covers, or steel-toed chemical resistant boots.
- Hard-hats.
- Splash shield when using corrosive chemicals.
- Hearing protection (if needed)
- Safety goggles or glasses.
- Additional seasonal items may be required. Any such items will be worn under the coverall.

During intrusive activities coverall sleeves will be worn over the cuff of protective gloves and coverall legs will be worn over the upper portion of disposable boot covers. Wrists and ankles will be taped.

Level C

Personnel shall upgrade to Level C (don respiratory protection) in the event that any monitoring indicates a higher level of PPE is required. Respirators will be stored inside sealed plastic bags until needed.

Level C consists of Modified Level D gear plus a full-face or half-face air purifying respirator, donned. The following constitutes Level C:

- Uncoated Tyvek or equivalent disposable hooded coverall. Saranex or polycoated coveralls must be worn instead of the uncoated Tyvek when corrosive product is handled.

- Disposable chemical-resistant inner gloves, latex or nitrile (worn over disposable cotton liners, if desired).
- Chemical-resistant neoprene outer gloves.
- Boots, chemical resistant with steel toe and shank.
- Disposable chemical-resistant boot covers, optional.
- Full-face or half-face respirator
- NIOSH approved combination organic vapor, acid gases, and HEPA filter cartridges.
- Hard-hats.
- Hearing protection (if needed).
- Safety goggles, with half-face respirator.
- Additional seasonal items may be required. Any such items will be worn under the coverall.

During intrusive activities coverall sleeves will be worn over the cuff of protective gloves and coverall legs will be worn over the upper portion of disposable boot covers. Wrists and ankles will be taped.

8.2 INITIAL PROTECTION LEVELS AND UPGRADES

Initial levels of PPE for each activity are listed below. The level of PPE will be upgraded to a higher specified levels if any action levels are reached according to set action levels outlined in Table 4.

- Site Reconnaissance - Level D
- Piezometer and Monitoring Well Installation - Modified Level D
- Groundwater Sampling, off-site and background wells - Level D
- Groundwater Sampling, on-site - Modified Level D
- Waste Handling - Modified Level D
- Decontamination - Level D or Modified Level D

Team members responsible for conducting equipment decontamination will wear the same level of PPE as was worn to accomplish the work.

Direct-reading real-time monitoring will be conducted for certain activities.

- A photoionization detector (PID) with a 11.7 lamp or flame ionization detector (FID) will be used to monitor for chemical substances during drilling activities subsurface soil sampling, groundwater sampling at on-site monitoring wells, groundwater sampling at new monitoring wells and piezometers, and decontamination of drilling equipment.
- A respirable dust monitor will be used during drilling and subsurface soil sampling.
- Noise meter will be used to monitor noise levels during drilling activities.

Real-time monitoring will be conducted to provide an indication of the presence of potential hazards. During drilling and on-site groundwater sampling activities, the SSO or designated person will monitor the work site for organic vapors using a PID or FID. Readings will be taken from background and breathing zone areas at least once every 30 minutes. Samples may also be screened with monitoring instruments. Table 4 outlines the action guidelines for each instrument.

Noise monitoring will be conducted in compliance with OSHA regulation and W-C procedures.

Decontamination of equipment and personnel will be performed to limit the migration of contaminants off-site and between work zones at the site. Decontamination will generally occur at the edge of the exclusion zone. Additionally, centrally-located decontamination stations may be established as project activities and needs warrant.

10.1 PERSONNEL DECONTAMINATION PROCEDURES

Personnel decontamination will consist primarily of soap and water washing and water rinse of exterior protective gear followed by doffing of the gear. The general decontamination sequence for activities conducted at modified Level D are as follows:

1. Wash outer gloves and boots
2. Rinse outer gloves and boots
3. Remove tape at wrists and boot interface
4. Remove outer gloves and boot covers
5. Remove coveralls
6. Remove and rinse goggles and hard hat
7. Remove inner gloves

The general decontamination sequence for activities conducted at Level C are as follows:

1. Wash outer gloves and boots
2. Rinse outer gloves and boots
3. Remove tape at wrist, boot, and hood interface
4. Remove outer gloves and boot covers
5. Remove and rinse hard hat
6. Remove coveralls
7. Remove APR, discard cartridges (if necessary), clean APR
8. Remove inner gloves

Gloves and coveralls will be removed by turning inside out. Ground cloths, gloves, coveralls, and APR cartridges will be placed into plastic trash bags and stored at the contamination-reduction zone for disposal in a municipal trash receptacle.

Respirators will be cleaned with potable water in the field after each use and will be washed at the end of the day using a soap and water wash followed by a potable water rinse. Respirators will be inspected daily for damage, missing parts, and proper function. Other reusable protective equipment worn by personnel performing field activities will be rinsed with potable water after each use and will be cleaned at the end of each day in the manner described by the manufacturer. Reusable items will be air-dried and placed in plastic bags for storage.

Decontamination equipment and supplies consist of, but are not limited to, the following:

- Potable water
- Washtubs
- Alconox detergent, follow mixing instructions
- Brushes, hand sprayers
- Plastic sheeting
- 5-gallon buckets with lids

- Garbage bags
- Methanol

10.2 EQUIPMENT DECONTAMINATION PROCEDURES

Heavy equipment will be decontaminated with a high pressure steam cleaner. Equipment and other tools will be cleaned prior to the site entry to remove grease, oil, encrusted dirt, or other materials. The SSO or Field Team Leader will inspect all equipment prior to use on-site. Reusable sampling equipment and any other tools used for intrusive work will be decontaminated between sampling locations.

At the conclusion of work at the site, all equipment will be thoroughly cleaned using the methods previously described. The SSO will inspect all equipment leaving the site for adequacy of decontamination.

Large equipment decontamination will be conducted at the exclusion zone or the decontamination station at the Shop Area. The general decontamination for large equipment is usually conducted with a high pressure sprayer following the sequence below:

1. Lay down plastic ground cloth (if appropriate)
2. Rinse with potable water to remove soils
3. Wash with potable water and Alconox (or equivalent) solution
4. Rinse with potable water

Decontamination of small sampling equipment will be conducted at the edge of the exclusion zone or an established decontamination station. The general decontamination sequence is as follows:

1. Lay down plastic ground cloth (if appropriate)
2. Wash and scrub with potable water
3. Wash and scrub with Alconox and potable water
4. Rinse with potable water
5. Rinse with distilled water
6. Air dry

Personnel performing equipment decontamination will wear the same level of protective clothing as was worn to conduct the work. Levels of protection are summarized in Table 5.

All work shall be performed in compliance with W-C and USAEC policies and procedures, in addition to OSHA General Industry and Construction regulations. General items that apply to the CAAP site and field work are described in the following sections.

11.1 GENERAL SAFETY PROVISIONS

The following general provisions will be in effect during all site activities:

- There will be no activities conducted on-site without sufficient backup personnel. At a minimum, two persons ("buddy system") must be present at the site during all site activities.
- No employee may be allowed on-site without the prior knowledge and consent of the Site Safety Officer.
- No loose jewelry, clothing, or long hair shall be permitted on or near equipment with moving parts.
- Employees shall avoid unnecessary contamination by walking around pools of liquids, discolored areas, or any area that shows obvious evidence of contamination.
- Personnel shall not enter a contaminated area unless it is necessary.
- Field personnel must observe each other for signs of toxic exposures (changes in skin color, coordination, pupil size, etc.) and inform each other of non-visual effects (headaches, nausea, dizziness, etc.).
- Drilling operations will be suspended during high winds and electrical storms.
- Field activities will be suspended during severe weather such as thunderstorms, tornado warnings, and winter storm warnings.
- Damaged personal protective equipment or clothing will be immediately repaired or replaced, as appropriate.
- Smoking, eating, drinking, chewing gum or any other activity involving hand-to-mouth contact while in the exclusion and contamination-reduction zones is prohibited.
- Personnel must thoroughly wash their hands and face before eating, smoking, or drinking.
- Facial hair that could interfere with proper respirator fit is not allowed for activities that may require respiratory protection.
- Unauthorized removal of materials from the site is prohibited.
- Possession of controlled substances and items while working on-site is strictly prohibited.

11.2 SANITATION

The Project Manager will ensure that adequate sanitation facilities are provided for field personnel in compliance with OSHA regulations 29 CFR 1910.120 and 29 CFR 1926.51.

The Site Safety Officer shall ensure that all on-site personnel have ready access to soap and clean water or equivalent for washing before exiting any contaminated areas and proceeding to support facilities. Potable water shall be maintained for drinking purposes, and common drinking cups shall not be used. Toilet facilities shall be provided for all field activities. These facilities shall be maintained in the Support Zone, not in areas known or suspected to be contaminated.

11.3 ILLUMINATION

Most project operations will occur during daylight hours, between sunrise and sunset, as determined locally. Some specific work tasks may require 24-hour operations. Where sufficient illumination is not naturally occurring, supplementary lighting will be provided in compliance with OSHA regulations, 29 CFR 1910.120, 29 CFR 1926.56, and USAEC requirements.

11.4 COMMUNICATIONS

On and off site communications will be established for the CAAP site. Communications to off-site emergency contacts will be via telephone established at the field office. Communications with remote field crews will be established using two-way radios or cellular telephones. Each remote field crew shall be provided a means to communicate with the field office and/or off-site emergency contacts.

All communication devices used in a potentially explosive atmosphere must be intrinsically or extrinsically safe, and not capable of sparking. This equipment should be checked daily to ensure that they are operating properly.

Hand signals will be established for work tasks in high noise areas. Specific hand signals will be described during safety briefings and shall include, but not be limited to the following:

- Everything is OK/not OK: Thumbs up/Thumbs down
- Stop work and leave the area: Hand moves across throat in cutting motion or gram person's upper arm and gently tug
- I need assistance/help: Hands placed around throat in choking signal

Prior to initiating field activities, WCFS will notify the appropriate CAAP and off-site agencies of the work to be performed, the chemical, physical, and biological hazards that may be encountered, and response procedures described in this safety plan. These agencies include, but are not limited to, the following:

- CAAP medical clinic
- St. Francis Medical Center, Grand Island
- CAAP safety office
- CAAP firefighting unit
- Grand Island Fire Department

Copies of this safety plan and MSDS's will be provided to the agency, as appropriate. The CAAP firefighting unit will be notified of the names, quantities, and storage location of chemical products brought onto the facility.

11.5 CONFINED SPACE ENTRY

Confined space entry will not be required for the stated scope of work.

11.6 ENERGY ISOLATION

Machinery with moving parts pose a hazard to site workers and maintenance personnel. Equipment of particular concern are drilling rigs, grout mixers, and remediation process equipment such as blowers. Moving parts will be guarded and shielded. Warning labels will be posted as required by the OSHA hazard communication standard, 29 CFR 1910.1200 and 29 CFR 1926.

11.7 SAMPLE HANDLING

All sample containers collected during the site characterization that are to be submitted to a laboratory for analysis will be decontaminated prior to packaging for shipment. Procedures for sample container decontamination will be as follows:

- Place clear plastic tape over label to protect the sample label
- Rinse or spray the containers with distilled water; containers with encrusted soil shall be cleaned by scrubbing with soap and water followed by a distilled water rinse
- Dry sample containers
- Prepare for shipment

In order to protect laboratory personnel from potentially contaminated samples and broken containers, the following precautions will be taken:

- The shipping container will be lined with bubble wrap or foam packaging material to protect containers from breakage
- All samples will be placed in a plastic bag lining the cooler (excluding specially designed coolers provided by a laboratory
- Individual sample containers may be wrapped in foam or bubble warp to prevent breakage
- The plastic trash bag will be tied or sealed with packaging tape
- Any drain hole on shipping cooler will be taped shut

11.8 CONTROL OF FIELD WORK-GENERATED WASTE MATERIALS

Control and management of field -derived or investigation-derived waste materials is described below:

- Used uncontaminated protective clothing: Double bag and dispose of as sanitary waste as directed by the CAAP Commander's Representative.
- Soil samples/cuttings: Cuttings generated from auger borings, if any, will be containerized in 55 gallon steel drum and temporarily staged at the drill site pending sampling analytical results (NDEQ 1995, USAEC 1994b).

- Decontamination water: Dispose on ground in neat manner as directed by the Task Manager.
- Well development/purge water: Discharge to the ground at a minimum of 15 feet downgradient from the well as per NDEQ and USAEC correspondence (NDEQ 1994, USAEC 1994b).
- Other samples will be packaged in accordance with DOT regulations as appropriate.

11.9 SITE SECURITY

Site security is necessary to:

- Prevent the exposure of unauthorized and/or unprotected people to site hazards
- Avoid interference with safe working procedures

To maintain site security during working hours, the following methods will be used:

- Require escorts for visitors
- Establishment of work zones with caution tape and/or traffic cone/barriers.

Site security is maintained by a locked area and perimeter gates during off-duty hours. Field materials and equipment may be secured in the field support area, Shop Area Building S-5.

In the event unauthorized persons enter the exclusion zone, they will be asked to leave and escorted out of the exclusion zone by the sample team leader. Should the persons refuse to leave the exclusion zone, work will be stopped, the site manager and CAAP representative notified, and CAAP security called as appropriate. All unauthorized entries into the exclusion zone will be documented in the field log book.

11.10 HEAVY MATERIAL HANDLING SAFETY

Below are guidelines to follow when working with heavy materials:

- Be aware of footing at all times
- Use chains, hoists, straps, and any other equipment to safely aid in the moving or lifting of heavy objects/material
- Use your legs, not your back
- Get help whenever in doubt about material's weight
- Use the buddy system

11.11 SAFETY PRECAUTIONS WHEN USING HEAVY EQUIPMENT

All personnel engaged in heavy equipment operations shall wear eye protection, hard hats, steel-toed boots and hearing protection (if required). Because tools and heavy equipment can create major hazards at sites, only trained, competent individuals will operate these items.

11.12 HOUSEKEEPING

Housekeeping is an important aspect of a field program and will be strongly stressed in all aspects of field work. Good housekeeping plays a key role in occupational health protection and is a way of preventing accidents and dispersion of dangerous contaminants. All work areas will be kept as clean as possible at all times, and spills will be cleaned up immediately. Housekeeping will be the responsibility of all employees.

W-C will implement a housekeeping program for the field activities to minimize the potential for slips, trips, and falls in the work zones. The program will include:

- Daily scheduling to police the area of debris, including paper products, cans, and other material brought on site.
- Periodic (daily minimum) removal of all garbage bags and containers used to dispose of food products, plastic inner gloves, and contaminated disposal clothing.
- Any object capable of being blown away by high winds will not normally be left out-of-doors unless the object is secured to a fixed object.
- Store chemical products in a specific area, with compatible materials, and out of traffic areas. Compressed gas cylinders for instrument calibration will be stored according to the manufacturer's directions.

12.1 SITE EMERGENCY PROCEDURES

12.1.1 Emergency Medical Procedures

For severe injuries, illnesses, or overexposures:

- Remove the injured or exposed person(s) from immediate danger.
- If the incident is life-threatening, perform appropriate first aid and call for medical assistance.
- If possible, at least partial decontamination should be completed. Wash, rinse, and/or cut off protective clothing and equipment.
- If decontamination cannot be done, wrap the victim in blankets or plastic sheeting to reduce contamination of other personnel.
- Render emergency first aid and call an ambulance for transport to local hospital immediately. Notify emergency personnel of contaminants on-site. See Table 6 for a list of emergency telephone numbers.
- Evacuate other personnel on site to a safe place until the SSO determines that it is safe to resume work.
- Report the accident to the PM, HSO, and USAEC representative immediately and complete an incident report. See Table 6 for the list of telephone numbers and Attachment C for incident report forms.

For minor injuries or illnesses:

- Complete a full decontamination.
- Administer first aid. Minor injuries may be treated on site, but all injuries will be examined by trained medical personnel. Victims of bites or stings will be taken to the Midwest City Regional Hospital.
- Notify the PM, HSO, and USAEC representative. Complete an incident report. See Table 6 for a list of telephone numbers and Attachment C for incident report forms.

12.1.2 First-Aid - Chemical Injury

If the injury to the worker is chemical in nature (e.g., overexposure), the following first aid procedures are to be instituted as soon as possible:

Eye Exposure	If contaminated solid or liquid gets into the eyes, wash eyes immediately with sterile saline solution or potable water by lifting the lower and upper lids occasionally. Continue eye wash for 15 minutes. Cover the eye with a dry pad and obtain medical attention immediately.
Skin Exposure	If contaminated solid or liquid gets on the skin, promptly wash contaminated skin using soap or mild detergent and water. If solids or liquid penetrate through the clothing,

	remove the clothing immediately and wash the skin using soap or mild detergent and water. Obtain medical attention immediately if symptoms warrant.
Breathing	If a person breathes in large amounts of organic vapor, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Obtain medical attention immediately.
Swallowing	If contaminated solid or liquid has been swallowed **and the person is conscious**, follow procedures listed on the MSDS. Obtain medical attention immediately.

12.1.3 First Aid - Physical Injury

When performing first aid, wear PPE as designated in W-C procedure HS-211, Bloodborne Pathogens, and follow universal precautions. Treat all blood and biohazards as being contaminated with pathogens.

Animal Bites	Thoroughly wash the wound with soap and water. Flush the area with running water and apply a sterile dressing. Immobilize affected part until the victim has been attended by a physician. See that the animal is kept alive and in quarantine. Obtain name and address of the owner of the animal.
Burns (minor)	Do not apply Vaseline or grease of any kind. Apply cold water applications until pain subsides. Cover with a wet sterile gauze dressing. Do not break blisters or remove tissue. Seek medical attention.
Burns (severe)	Do not remove adhered particles of clothing. Do not apply ice or immerse in cold water. Do not apply ointment, grease or Vaseline. Cover burns with thick sterile dressings. Keep burned feet or legs elevated. Seek medical attention immediately.
Cramps	Treat as heat exhaustion
Cuts	Apply pressure with sterile gauze dressing, and elevate the area until bleeding stops. Apply a bandage and seek medical attention.
Eyes	Keep the victim from rubbing the eye. Flush foreign objects from the eye with water. If flushing fails to remove the object, apply a dry, protective dressing and consult a physician.
Fainting	Keep the victim lying down with feet elevated. Loosen tight clothing. If victim vomits, roll him onto his side or turn his

	head to the side. If necessary wipe out his mouth. Maintain an open airway. Bathe his face gently with cool water. Unless recovery is prompt, seek medical attention.
Fracture	Deformity of an injured part usually means a fracture. If fracture is suspected, splint the part as it lies. Do not attempt to move the injured part of the person. Seek medical attention immediately.
Snake Bites	Keep the bite area as low as possible. Transport the victim immediately to a medical facility.
Insect Bites	Remove "stinger" if present. Keep affected part below the level of the heart. Apply ice bag. For minor bites and stings apply soothing lotions, such as calamine.
Puncture Wounds	If puncture wound is deeper than skin surface, seek medical attention. Serious infection can arise unless proper treatment is received. Follow procedures for cuts.
Sprains	Elevate injured part and apply ice bag or cold packs. Do not soak in hot water. If pain and swelling persists, seek medical attention.
Unconsciousness	Never attempt to give anything by mouth. Keep victim flat, maintain an open airway. If victim is not breathing, provide artificial respiration and call for an ambulance immediately.

12.1.4 Injury Due to Heat and Cold

Working in conditions of extreme heat and cold require special precautions. Procedures in HS-201 and HS-202 (Attachment B) will be followed. These are summarized below.

If a person is suffering from heat exhaustion (profuse perspiration, normal body temperature), the following procedures will be taken:

- Remove the person to a cooler, shaded area
- Give 8 ounces of water or Gatorade every 15 minutes for three or four doses
- Allow the person to rest
- If the person is suffering from camps, press warm, wet towels over the cramped area

If a person is suffering from heat stroke (skin hot and dry, very high body temperature), the following procedures will be taken:

- Decontaminate the victim
- Cool the victim quickly by soaking the person in cool but not cold water, sponging the body with rubbing alcohol or cool water, or pouring water on the body to reduce the body temperature to a safe level (about 102 to 105°F)

- Transport to hospital for medical attention as soon as possible

If a person is suffering from frostbite (white or gray skin that is numb), the following procedures will be taken:

- Move the person to a warm environment and out of the elements
- Slowly warm the affected body parts (hands, feet, face) by placing in warm water and covering with warm clothing. **Do not rub the affected areas.** Do not use ice, snow, gasoline, or anything cold on affected areas.
- Transport to a hospital for medical attention.

If a person is suffering from hypothermia (reduced body temperature, shivering, loss of coordination, glassy stare, confused, incoherent, sleepy, slow pulse and respiration, or unconscious), the following procedures will be taken:

- Move the person to a warm environment and out of the elements
- Quickly warm the body with indirect heat sources. Remove wet and sweat-soaked clothing; dress in dry clothes or wrap the person in a blanket.
- Give warm drinks if person is conscious; **no** alcohol or caffeinated beverages.
- **Transport to a hospital for medical attention** as soon as possible. This is a life-threatening situation

12.1.5 Fire/Explosion

In the event of a fire or explosion, the local fire department should be summoned immediately. Upon their arrival, the SSO or Field Team Leader will advise the fire commander of the location, nature, and identification of the hazardous materials on-site.

If it is safe to do so, site personnel may:

- Use fire fighting equipment available on site to control or extinguish the fire
- Remove or isolate flammable or other hazardous materials which may contribute to the fire

Otherwise, immediate evacuation of the area is indicated. In the event of an explosion, all personnel shall be evacuated and the fire department notified. No one shall re-enter the area until it has been cleared by explosives safety personnel.

12.1.6 Natural Disasters

Natural disasters may occur at the site due to weather. These include lightning, high winds, tornadoes, winter storms.

- Lightning - Persons should not work in open areas, near trees or other equipment outside during lightning storms. Stop work until the storm passes.
- High Winds - If high winds are forecast, then the site should be cleared before the winds become hazardous. Workers should be instructed to go to an appropriate shelter.

- Tornadoes - If a tornado warning or watch has been issued, work will stop until the storm and threat of a tornado has passed.
- Winter Storms - If a winter storm warning or watch has been issued, work will stop until the storm has passed. If a wind-chill warning has been issued, the SSO and Field Team Leader will decide if field work should proceed.
- If an evacuation is called, account for all persons before leaving the site.
- Notify the PM of any work stoppage (Table 6).

12.1.7 Spill Control

Spills are not anticipated during field activities due to the quantities of chemicals on-site. In the event of a small spill, sorbent will be applied to the spill which will then be cleaned up and disposed following procedures on the MSDS (Attachment A).

12.1.8 Evacuation Route

The Field Team Leader will designate primary and secondary evacuation routes from the specific work areas. A safe meeting place will be identified. These routes will be discussed during the safety briefing and bi-weekly safety meetings.

12.1.9 Unexploded Ordnance

In the event a known or suspected ordnance is encountered, the following procedures will be implemented:

- Evacuate all personnel to a safe location upwind of the ordnance.
- Contact the Field Team Leader and SSO.
- Secure the area against trespassers.
- The Field Team Leader will notify USAEC and CAAP personnel, and emergency personnel. Table 6 lists the emergency telephone numbers. The field crew will take any further instruction from the Field Team Leader or SSO.
- The work area will remain evacuated until clearance has been received from the USAEC and CAAP that it is safe to proceed.

12.2 EMERGENCY EQUIPMENT

This equipment will be stored at appropriate locations selected during site mobilization. Emergency response equipment shall be moved from one site to another based on changing locations of field activities in order to ensure that emergency equipment is available in the work area.

- Telephone to call for assistance (see Table 6 for the list of emergency telephone numbers).
- Fire Extinguishers. (20 lb ABC)

- First Aid Kit: At least one industrial first aid kit will be provided and maintained fully stocked in the support zone. The first aid kit will include a CPR shield and protective clothing to protect against bloodborne pathogens (see HS-211 in Attachment B).
- Drinking water, Gatorade, or the equivalent
- Extra full set of PPE
- Emergency eye wash stations
- Spill control materials such as vermiculite or clay absorbent
- Bloodborne pathogen spill control kit.

Tables

TABLE 1
RESPONSIBILITIES AND AUTHORITY OF HEALTH AND SAFETY PERSONNEL

Person	Responsibilities	Authorities
W-C Project Manager David Convy	• Assure that the project is performed in a manner consistent with the W-C Health and Safety Program • Assure that the Health and Safety Plan (HSP) is prepared, approved, and properly implemented • Assure that adequate funds are allocated to fully implement project health and safety • Coordinate with the HSO on health and safety matters	• Assign HSO approved SSO to the project and, if necessary, assign a suitably qualified replacement • Suspend field activities if health and safety of personnel are endangered, pending further consideration by the HSO and/or CHSO. • Suspend a W-C individual from field activities for infractions of the HSP, pending an evaluation by the HSO, CHSO and/or WCGI Health and Safety Manager.
WCGI Health and Safety Manager Phil Jones	• Administer the Health and Safety Program • Track health and safety regulations that affect W-C • Maintain W-C records pertaining to medical surveillance, training, fit testing, chemical exposure, and incidents • Update the W-C Health and Safety Manual • Manage the W-C employee medical surveillance program • Audit key aspects of the W-C Health and Safety Program • Supervise CHSOs	• Implement improvements to the W-C Health and Safety Program • Approve the health and safety qualifications of employees • Establish employee training and medical surveillance procedures • Approve or disapprove Health and Safety Plans • Suspend work on any project that jeopardizes the health and safety of personnel.
W-C Corporate Health and Safety Officer (CHSO) Charles Self, CIH	• Direct the implementation and coordination of the Health and Safety Program of the Operating Group (or responsibility area) and provide recommendations for improvement of the program • Determine the need for project Health and Safety Plans • Maintain a high level of understanding regarding health and safety regulations affecting W-C • Review and approve Health and Safety Plans • Monitor implementation of Health and Safety Plans	• Approve or disapprove Health and Safety Plans • Direct Operating Unit HSO to prepare project Health and Safety Plans • Access and review W-C project files • Direct changes in personnel work practices to improve health and safety of employees • Remove individuals from project, if their conduct jeopardizes their health and safety or that of coworkers • Suspend work on any project that jeopardizes the health and safety of personnel involved.

TABLE 1
RESPONSIBILITIES AND AUTHORITY OF HEALTH AND SAFETY PERSONNEL

Person	Responsibilities	Authorities
W-C Corporate Health and Safety Officer (CHSO) (Continued)	• Investigate reports of incidents or accidents and report to Health and Safety Manager • Provide W-C employee health and safety training in the Operating Group, particularly refresher training • Determine whether an accidental exposure or injury merits a change in the affected individual's work assignments and whether changes in work practices are required • Coordinate Operating Units with regard to health and safety equipment needs • Supervise HSOs through the matrix management system in cooperation with the Operating Unit Manager	
W-C Operating Unit Health and Safety Officer (HSO) Carla Dods	• Administer the Health and Safety Program within the Operating Unit • Maintain a working understanding of key government health and safety regulations and W-C health and safety policies • Interface with project managers concerning health and safety • Report to CHSO on health and safety matters • Develop or review, approve or disapprove project Health and Safety Plans prior to submittal to the CHSO for review • Conduct W-C staff training and orientation on health and safety-related activities • Appoint or approve SSOs • Monitor compliance with Health and Safety Plans and conduct site audits • Assist project managers in obtaining required health and safety equipment • Approve personnel to work on hazardous waste management projects with regard to medical examinations and health and safety training • Answer employee questions and concerns regarding health and safety	• Suspend work or otherwise limit exposures to personnel, if health and safety risks are unacceptable • Direct personnel to change work practices, if existing practices are deemed to be hazardous to health and safety of personnel • Remove personnel from projects, if their actions or conditions endanger their health and safety, or the health and safety of co-workers.

TABLE 1
RESPONSIBILITIES AND AUTHORITY OF HEALTH AND SAFETY PERSONNEL

Person	Responsibilities	Authorities
W-C Site Safety Officer (SSO) To be named	• Direct health and safety activities on site • Immediately report all safety-related incidents or accidents to the HSO and the Project Manager. • Assist Project Managers in all aspects of implementing Health and Safety Plans • Maintain health and safety equipment on site • Implement emergency procedures, as required. • Review certifications/medical surveillance status of all site personnel prior to site access • Maintain health and safety records for W-C and subcontractor personnel on site (including medical examinations, training, compliance agreements, and incident/accident reports).	• Temporarily suspend field activities if health and safety of personnel are endangered, pending further consideration by the HSO and/or CHSO • Temporarily suspend a W-C individual from field activities for infractions of the Safety and Health Plan, pending an evaluation by the HSO and/or CHSO

TABLE 2

KNOWN CHEMICAL HAZARDS
PROCESS/WASTE/BYPRODUCT CHEMICALS THAT MAY BE PRESENT ON SITE

Process Explosives
Cyclotetramethylenetetranitramine (HMX)
Cyclotrimethylenetrinitramine (RDX0
2,4,6-Trinitrotoluene (2,4,6-TNT)
Lead azide

Explosive Degradation Products
2,4-Dinitrotoluene (2,4-DNT)
2,6-Dinitrotoluene (2,6-DNT)
Nitrobenzene (NB)
1,3-Dinitrobenzene (1,3-DNB)
1,3,5-Trinitrobenzene (1,3,5-TNB)

Other Process/Waste/Byproducts
Aluminum (Al)
Cadmium (Cd)
Chromium (Cr)
Iron (Fe)
Lead (Pb)
Silver (Ag)
Freon 113 (TCLTFE)
Trichlorodifluoroethane (TCLDFE)
Nitrate

PESTICIDES/HERBICIDES/FERTILIZERS KNOWN TO HAVE BEEN USED ON SITE

Malathion
Chlordane, 8E
Aldrin, 4#
Urox Liquid
Ded-Weed ME-6 (2,4-D)
Ded Weed (2,4-D and/or 2,4,5-T)
Benzabor (2,3,6-Trichlorobenzoic acid)
DDT
Cyanogen
Anhydrous ammonia
Dry Ammonium nitrate

TABLE 2
KNOWN CHEMICAL HAZARDS
PROCESS/WASTE/BYPRODUCT CHEMICALS THAT MAY BE PRESENT ON SITE
(Continued)

OTHER CHEMICALS KNOWN TO HAVE BEEN PRESENT ON SITE

Diesel Fuel
Heating Oil
Lead Paint
PCBs
Asbestos
Coal

CHEMICALS CURRENTLY IN USE IN NITRATE AREA

Motor Oils
Hydraulic Oils
Solvents
PCBs
Gasoline
Silica Sand
Oil- and water-based paints

HAZARDOUS MATERIALS USED IN SITE INVESTIGATION ACTIVITIES

<u>PID/FID Related Substances</u>
Isobutylene
Methane

<u>Preservatives</u>
Nitric Acid
Hydrochloric Acid
Sulfuric Acid

<u>Other Materials</u>
Cement
Bentonite Grout

TABLE 3
SUMMARY OF CHEMICAL AND PHYSICAL HAZARDS

Compound	PEL/TLV[1]	IDLH[2]	Warning Concentration	IP[3] (Ev)	LEL[4] (%)	UEL[5] (%)	Vapor Pressure (mmHg)
Organics							
Trichloroethylene	25 ppm	Ca/1,000 ppm	21.4	9.45	8	10.5	58
Carbon Tetrachloride	2 ppm	Ca/300 ppm	21.4 ppm	11.47	NA	NA	58
1,1,1-Trichlorethane	350 ppm	1,000 ppm	20 ppm	11.0	7.5	12.5	100
1,1-Dichloroethane	100 ppm	4,000 ppm	120 ppm	11.06	5.6	NA	230
1,1-Dichloroethene	1 ppm	NA	0.085 - 500 ppm	9.46	5.6	11.4	500
1,1,2-Trichloroethane	10 ppm	Ca/500 ppm	NA	11.0	NA	NA	19
1,2-Dichloroethene	200 ppm	4,000 ppm	0.085 - 500 ppm	9.65	5.6	12.8	180-264
Tetrachloroethene	25 ppm	Ca/500 ppm	4.68 ppm	9.32	NA	NA	14
Toluene	100 ppm	2,000 ppm	0.17 ppm	8.82	1.2	7.1	20
Benzene	0.1 ppm	Ca/3,000 ppm	4.68 ppm	9.25	1.3	7.1	75
Fuel Oil No. 1	5 mg/m^3						
Fuel Oil No. 2	5 mg/m^3						
Gasoline							
Explosives							
2,4-DNT and 2,6-DNT	1.5 mg/m^3 (skin)	Ca/200 mg/m^3	inadequate	NA	NA	NA	1
TNT	0.5 mg/m^3	NE	NA	11.78	NA	NA	0.05
Dinitrobenzene (all isomers)	1 mg/m^3; 0.15 ppm (skin)	2-- mg/m^3	NA	10.43-10.71	NA	NA	NA
Trinitrobenzene	NA	NA	NA	NA	NA	NA	≤1
RDX	1.5 mg/m^3	NA	NA	NA	NA	NA	NA
HMX	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	1 ppm (skin)	200 ppm		9.92	1.8	NE	1
Lead azide							
2-amino-4,6-DNT							
Metals/Inorganics							
Aluminum	5 mg/m^3	NE	NE	NA	NA	NA	0
Iron (oxide)	5 mg/m^3	2,500 mg/m^3	NE	NA	NA	NA	0
Cadmium	0.05 mg/m^3	Ca/50 mg/m^3	inadequate	NA	NA	NA	0
Chromium III	0.5 mg/m^3	NE	NA	NA	NA	NA	0
Chromium IV	0.05 mg/m^3	NE	NA	NA	NA	NA	0

TABLE 3
SUMMARY OF CHEMICAL AND PHYSICAL HAZARDS
(Continued)

Compound	PEL/TLV[1]	IDLH[2]	Warning Concentration	IP[3] (Ev)	LEL[4] (%)	UEL[5] (%)	Vapor Pressure (mmHg)
Lead	0.05 mg/m^3	700 mg/m^3	NA	NA	NA	NA	0
Silver	0.01 mg/m^3	10 mg/m^3		NA	NA	NA	0
Site Investigation Materials							
Isobutylene							
Methane							
Nitric Acid	2 ppm	100 ppm		11.95	NA	NA	48
Hydrochloric Acid	5 ppm	100 ppm		12.74	NA	NA	> 1
Sulfuric Acid	1 mg/m^3	80 mg/m^3		NE	NE	NE	1
Cement							
Physical Agents							
Noise	Varies: 8 hrs = 85 dB 2 hrs = 91 dB						
Heat Stress	80°F WBGT Continuous work, Moderate workload	104° body Core temperature					
Cold Stress	98.6° body Core temperature	95° body Core Temperature					

Notes:

Ca = Carcinogen
dB = Decibels
NA = Not Available
NE = Not Established
(skin) = Exposure By Skin Absorption may contribute to overall exposure
WBGT = Wet Bulb Globe Thermometer
1 = Permissible Exposure Limit/Threshold Limit Value
2 = Immediately Dangerous to Life and Health
3 = Ionization Potential
4 = Lower Explosive Limit
5 = Upper Explosive Limit

TABLE 4

HAZARD ASSESSMENT SUMMARY

	Chemical Hazards			Physical Hazards								Biological Hazards	Hazard Assessment			Overall Hazard Rating
	Contamination		Hazardous Products													
Activity	Surface	Subsurface		Noise	Slip, Trip and Fall	Heat	Cold	Excavation	Drilling, Large Equipment, Machinery	UXO	Lifting		Chemical	Physical	Biological	
Site Management/ Reconnaissance					X	X	X					X	Low	Low	Low	Low
Surveying	X				X	X	x					X	Low	Low	Low	Low
Shallow Soil Borings	X	X		X	X	X	X		X		X	X	Medium	High	Low	Medium-High
Piezometer/ Monitoring Well Installation and Development	X	X	X	X	X	X	X		X			X	Medium	High	Low	Medium-High
Piezometer/ Monitoring Well Measurements and Sampling		X	X		X	X	X				X	X	Low	Low	Low	Low
Decontamination	X			X	X	X	X		X		X		Low	Low	Low	Low

Notes: Low - potential for exposures is small.
Medium - potential for exposures is likely; anticipated hazards less than or at exposure limits; Includes physical agents.
High - potential for exposure above exposure limits or dangerous activities

TABLE 5
PERSONAL PROTECTIVE EQUIPMENT, AIR MONITORING AND ACTION LEVEL SUMMARY

Activity	Levels of Protection		Air Monitoring		Action Levels		Special Precautions
	Standard^2	Upgrade	Instruments	Detector Tubes	Upgrade^3	Stop Work	
Management	D	None	None	None	None	None	
Site Reconnaissance	D	None	None	None	None	None	
Surveying	D	Modified D	None	None	Observed Contamination	None	
Subsurface Soil Sampling^1	D/Modified D	C	PID/FID and Dust		5 ppm 0.5 mg/m^3 dust	25 ppm/ 10 ppm 0.5 mg/m^3 dust	Drilling, Dust
Piezometer/Monitoring Well Installation and Development	D/Modified D	Modified D/C	PID/FID and Dust		5 ppm 0.5 mg/m^3 dust	25 ppm/ 10 ppm 0.5 mg/m^3 dust	Splash, Drilling
Piezometer/Monitoring Well Measurements and Sampling^1	D/Modified D	C	PID/FID	None	5 ppm	25 ppm/ 10 ppm	Splash
Decontamination^1	D/Modified D	Modified D/C	PID/FID	None	5 ppm	25 ppm/ 10 ppm	Splash

Notes:

Action Level = 50 ppm for full-face respirator
10 ppm for half-face respirator

[1] These intrusive activities can be performed in Level D protection at off-site background locations only

[2] Upgrade from Level D to Modified D will be based on visible contamination, odors, or air monitoring results

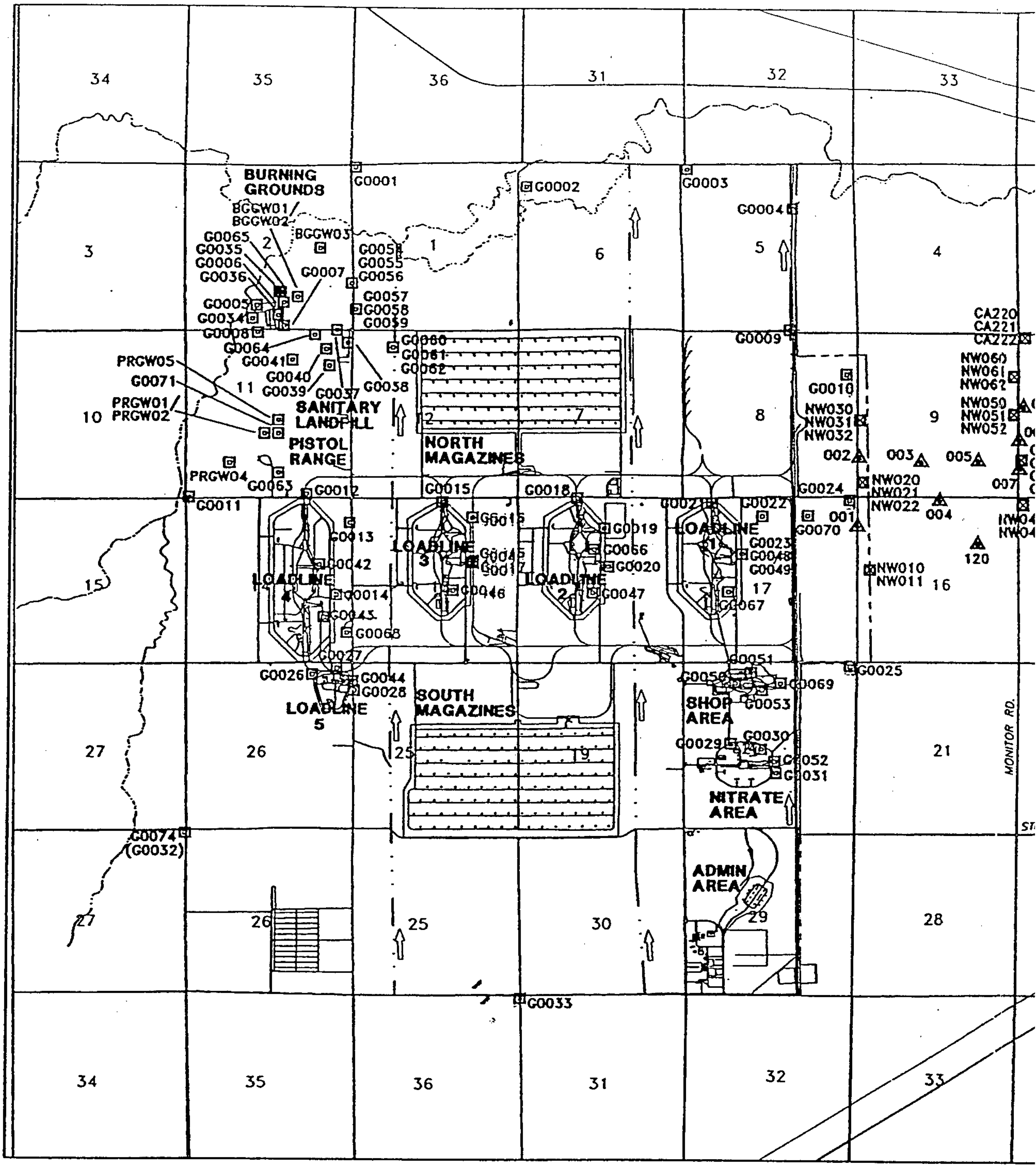
[3] Consistent readings of greater than 2 minutes in the breathing zone. Upgrade based on nitrobenzene and TNT

TABLE 6
EMERGENCY CONTACTS

Local Emergency Contact:	
Fire/Rescue:	911
Ambulance:	911
Police:	911
Sheriff (Hall County)	911
Poison Control Center:	St. Francis Medical Center Emergency Room 308-389-0313
Off-Site Medical Facility:	St. Francis Medical Center 2620 W. Faidley St. Grand Island, Nebraska 308-384-4600
Directions to Off-Site Hospital:	From the East Gate of CAAP, proceed east on Old Potash Highway approximately 4 miles. At Highway 281, turn left and go north about 1/4 mile to W. Faidley St. At W. Faidley St. turn right and proceed east. St. Francis Medical Center is on the left about 1/2 mile. (See Hospital Location map, Exhibit 3-2)
WCFS Project Manager:	David C. Convy 913-344-1153 (Work) 913-642-5505 (Home)
Woodward-Clyde Corporate Health and Safety Officer:	Charles Self 318-478-5532 (Work)
Woodward-Clyde Health and Safety Officer:	Carla J. Dods 913-344-1021 (Work) 816-746-9351 (Home)
CAAP Commander's Representative:	Tom Jamieson 308-381-0313 (Work) 308-384-0634 (Home)
USAEC Safety Officer:	William Houser 410-612-6869
USAEC SFIM-AEC-ETP	Incident reporting 410-671-4811

This list will be posted in the support area and in all vehicles

Figures



LEGEND:

——-·-·—— FACILITY BOUNDARY

——-··—— GRAND ISLAND CITY LIMITS

—— ⇨ —— DRAINAGE DITCH FLOW DIRECTION

·················· SURFACE DRAINAGE

(281) STATE ROUTE

[30] U.S. ROUTE

G0001 ⊡ ON-POST GROUNDWATER MONITORING

NW082 OR CA211 ⊠ OFF-POST GROUNDWATER MONITORING

⊚ CITY OF GRAND ISLAND PIEZOMETER

▲ OFF-POST IRRIGATION WELL

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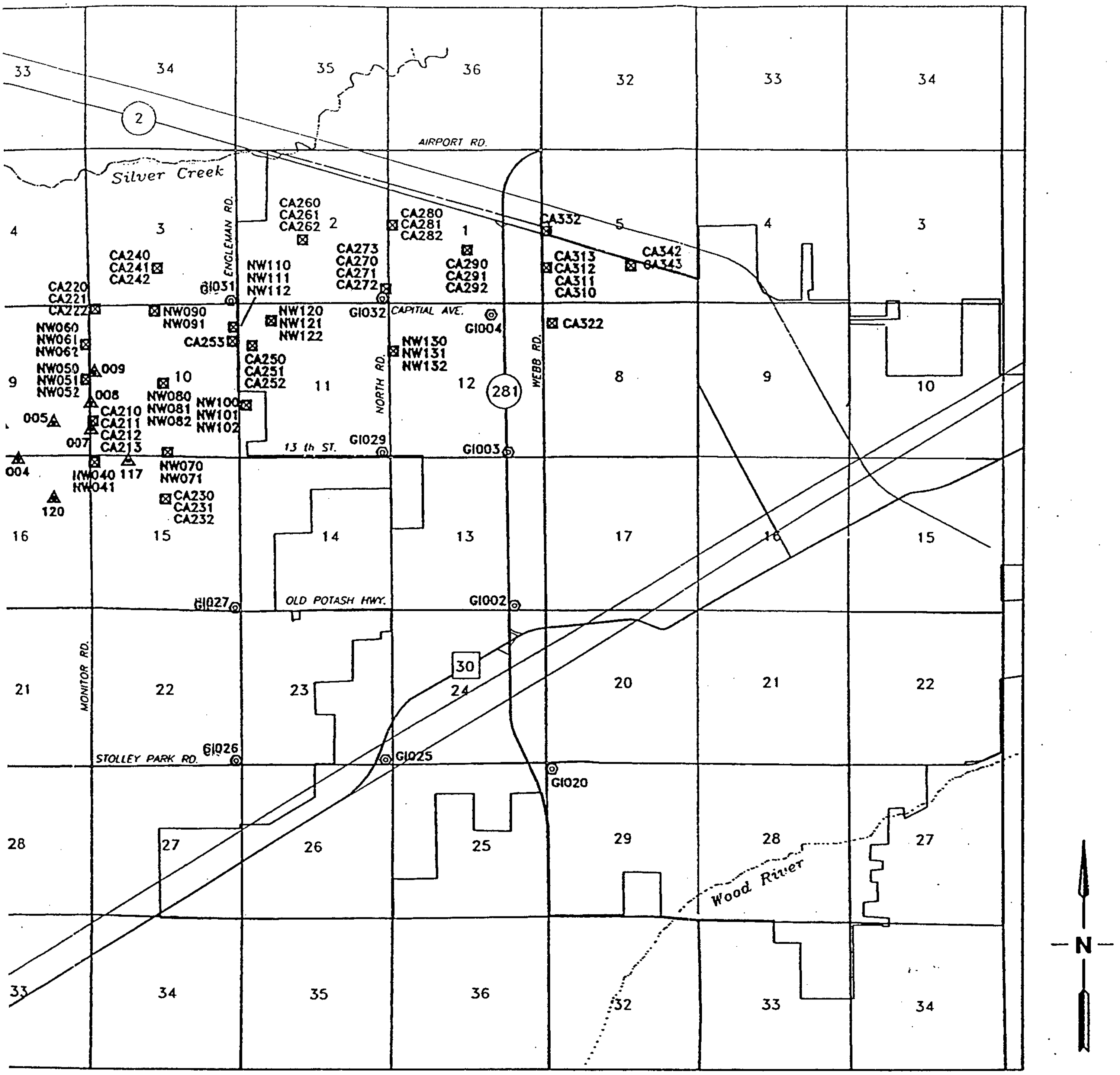

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SCALE FEET

ITORING WELL

NITORING WELL

OMETER

SOURCE: ICF KAISER

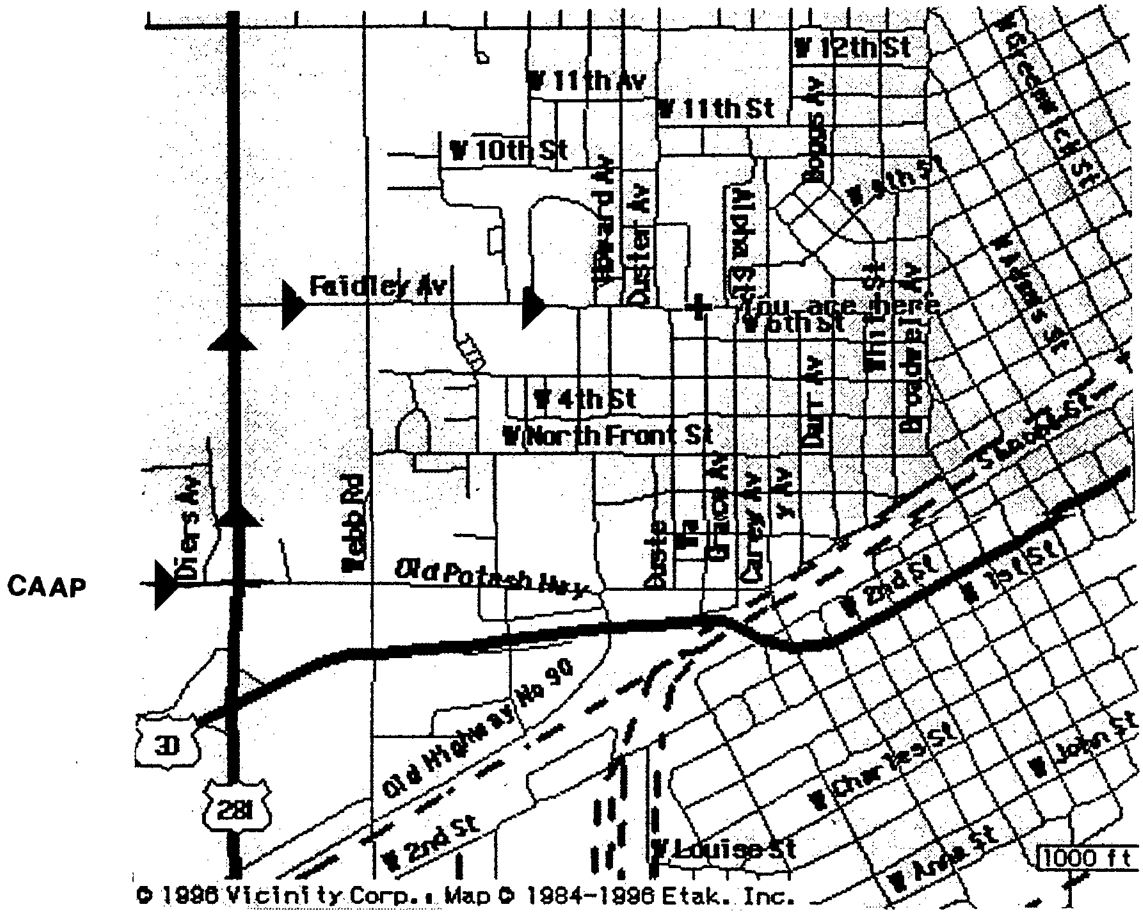
Woodward-Clyde Federal Services

Engineering & sciences applied to the earth and its environment

10975 El Monte, Suite 100
Overland Park, Kansas 66211

CLIENT:	U.S. ARMY ENVIRONMENTAL CENTER
LOCATION:	CORNHUSKER AAP
TITLE:	FACILITY MAP

PROJ. NO.	CHK'D. BY	DATE	FIG. NO
K9642		04/09/97	1-1



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N

Source: Infoseek Maps

Woodward-Clyde Consultants
Engineering & sciences applied to the earth and its environment
10975 El Monte, Suite 100
Overland Park, Kansas 66211

CLIENT: **U.S. Army Environmental Center**

LOCATION: **Grand Island, Nebraska**

TITLE:
ROUTE TO HOSPITAL

ACAD FILE:

PROJ. NO.	CHK'D. BY	DATE	DWG. NO.
K9642	CJD	4/4/97	2

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Attachments

ATTACHMENT A

Material Safety Data Sheets

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 79
Ammonium Nitrate

Issued: 7/81 Revision: A, 8/90

Section 1. Material Identification 32

Ammonium Nitrate (NH_4NO_3) Description: Derived by the reaction of nitric acid and ammonia in the presence of water. Used in fertilizers, herbicides and insecticides, explosives (prills/oil mixture of 94% NH_4NO_3 and 6% oil), pyrotechnics, cosmetic preparation (hair dyes, tints, and colorings), and in manufacturing nitrous oxide; as an ingredient of freezing mixtures, an oxidizer in solid rocket propellents, a dessicant for cotton, a nutrient for antibiotics and yeast, a catalyst, and an absorbent for nitrogen oxides.

Other Designations: CAS No. 6484-52-2; nitric acid, ammonium salt; norway saltpeter.

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

Cautions: A powerful oxidizer and an allergen, ammonium nitrate is irritating to the eyes, nose, throat, and mucous membranes.

R 1
I -
S 2
K 0

NFPA

Nonfire: 0 / 0 3 / oxy

Fire: 0 / 2 3 / oxy

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

Section 2. Ingredients and Occupational Exposure Limits

Ammonium nitrate, ca 100%

1989 OSHA PEL	**1990 ACGIH TLV**	**1988 NIOSH REL**	**1985-86 Toxicity Data***
None established	None established	None established	Rat, oral, LD_{50} : 4820 mg/kg

* Monitor NIOSH, *RTECS* (BR9050000), for future toxicity data.

Section 3. Physical Data

Boiling Point: 410 °F (210 °C)

Melting Point: 337.3 °F (169.6 °C)

pH: (0.1 M solution in water): 5.43

Molecular Weight: 80.06

Specific Gravity (H_2O = 1 at 4 °C): 1.725 at 25 °C

Water Solubility: 118.3 g/100 cc of H_20 at 32 °F (0 °C)

Appearance and Odor: A hygroscopic, colorless, crystalline solid; odorless. Prill form is needle-shaped (acicular) lumps.

Section 4. Fire and Explosion Data

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

Extinguishing Media: Use flooding amounts of water in early stages of fire. When applying water to fused or molten material, use extreme caution to avoid eruptive scattering and spread of fire.

Unusual Fire or Explosion Hazards: This material is an oxidizing agent which supports combustion and an explosive hazard if heated under confinement that allows high pressure buildup. Prevent contamination of NH_4NO_3 with other combustible materials that may cause possible explosion of the entire mass. A mixture of diesel oil with NH_4NO_3 is used as an industrial explosive.

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. Approach fires from upwind. If large quantities of ammonium nitrate are involved, fight fire with unmanned hoseholders and withdraw to a safe area. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Ammonium nitrate is stable when stored and used under proper storage and handling conditions (Sec. 9). Hazardous polymerization cannot occur.

Chemical Incompatibilities: Ammonium nitrate is a strong oxidizing agent that reacts with strong alkalies to liberate ammonia. It can also react vigorously with reducing materials. Ignites on contact with ammonium dichromate, potassium dichromate, potassium chromate, chromium (VI) salts, barium chloride, sodium chloride, and potassium nitrate. Violent or explosive spontaneous reactions occur with hot water, urea, sawdust, barium nitrate, copper iron (II) sulfide, acetic anhydride + nitric acid, ammonium chloride + water + zinc, and ammonium sulfate + potassium. Many powdered metals react violently or explosively with fused NH_4NO_3 below 392 °F (200 °C): aluminum, antimony, bismuth, cadmium, chromium, cobalt, copper, iron, lead, magnesium, manganese, nickel, tin, zinc, and brass. This material forms heat- or shock-sensitive explosive mixtures with hydrocarbon oils, nonmetals (e.g. charcoal), organic fuels (e.g. wax), sugar, potassium permanganate, sulfur, trinitroanisole, acetic acid, aluminum + calcium nitrate + formamide (a blasting explosive), chloride salts, and charcoal + metal oxides.

Conditions to Avoid: Avoid contaminating ammonium nitrate with oil, charcoal, or other organic substance. If contaminated with these combustible materials, ammonium nitrate can be considered an explosive capable of detonation by combustion or by shock from adjacent explosions. Sensitivity to detonation increases when heated.

Hazardous Products of Decomposition: Thermal oxidative decomposition of ammonium nitrate can produce toxic gases of nitrogen oxides.

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list ammonium nitrate as a carcinogen.
Summary of Risks: Ammonium nitrate is a powerful oxidizer and allergen. It is irritating to the eyes, nose, throat, and mucous membranes. Individuals may be exposed to nitrogen oxides due to decomposition of NH_4NO_3 at high temperatures. Nitrogen oxides are toxic gases that can quickly cause acute respiratory problems.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Eyes, skin, and mucous membranes.
Primary Entry Routes: Inhalation (for nitrogen oxides), ingestion (for ammonium nitrate salts).
Acute Effects: Inhalation causes mucous membrane and respiratory tract irritation, severe lung congestion, difficult breathing, and urination and acid urine. Inhalation of large amounts causes systemic acidosis and abnormal hemoglobin. Contact with skin may cause mild skin irritations. Any tissue changes are readily reversible and disappear after exposure stops. There is some discomfort. There are also reports of faintness and low blood pressure in workers exposed to ammonium nitrate.
Chronic Effects: None reported.

FIRST AID

Eyes: Gently lifting the eyelids, flush immediately and continuously with flooding amounts of running water until medical help arrives. Transport immediately to an emergency medical facility.
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 that *conscious* person drink 1 to 2 glasses of water. Treat as a strong oxidant ingestion. *Do not induce vomiting in the field!* Call Poison Control. Transport to an emergency medical facility.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Ammonium nitrate is very quickly soluble in water. Supportive measures for methemoglobinemia are the most important treatment.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate the hazard area, and issue an "Oxidizer" warning. Remove heat and ignition sources and provide adequate ventilation. Cleanup personnel should protect against skin and eye contact and vapor inhalation. Sweep spill into a noncombustible container and dissolve in a large amount of water. Add soda ash. Mix and neutralize with 6M-HCl (acid gas hazard). Do not release to sewers or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Neutralized sludge may be buried in an approved landfill. Incineration requires scrubbers for NO_2 and oxidation or reduction process for NO. 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
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
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

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 prolonged or repeated skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at a level that promotes worker safety and productivity. 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 separate from other chemicals and combustible materials in tightly closed, multi-ply paper or plastic bags in a cool, dry, well-ventilated area in a building made of noncombustible materials and equipped with an automatic sprinkler system. Protect plastic bags from physical damage. Store on clean concrete floors or wooden pallets. If stored directly on the floor, first cover the floor with a moisture insulator such as a polyethylene sheet. Prevent NH_4NO_3 entrapment by eliminating floor drains and depressions. Do not store above 130 °F (54.5 °C).

Engineering Controls: Avoid vapor inhalation and contact with skin or eyes. Use only with appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Provide general exhaust ventilation in the workplace and storage area. Store ammonium nitrate under cool and dry conditions. Prevent contamination of ammonium nitrate since it is a potential explosive hazard when contaminated.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Ammonium nitrate (no organic coating)
DOT Hazard Class: Oxidizer
ID No.: UN1942
DOT Label: Oxidize
DOT Packaging Requirements: 173.182
DOT Packaging Exceptions: 173.153

IMO Shipping Name: Ammonium nitrate, with not more than 0.2% of combustible substance including any organic substance calculated as carbon, to the exclusion of any other add substance
IMO Hazard Class: 5.1
IMO Label: Oxidizer
IMDG Packaging Group: III
ID No.: UN1942

MSDS Collection **References:** 4-11, 25, 73, 84, 85, 103, 109, 124, 126, 127, 132, 133, 136
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** DJ Seeley, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

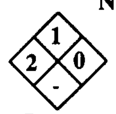
Sheet No. 1
Anhydrous Ammonia

Issued: 8/85 Revision: D, 4/90

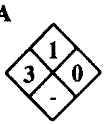
Section 1. Material Identification

Anhydrous Ammonia Description: Manufactured primarily by using atmospheric nitrogen and a hydrogen source at high temperatures (752 °F/400 °C to 11,732 °F/6500 °C) and pressures (100 to 900 atm) in the presence of an iron catalyst (a modified Haber reduction process). Used as a refrigerant, a fertilizer, a cleaning and bleaching agent, a household cleaner, a condensation catalyst, a neutralizing agent in the petroleum industry, and a yeast nutrient; in nitriding of steel, developing diazo films, manufacturing nitric acid, synthetic fibers, and explosives; and in latex preservatives, dyeing, ureaformaldehyde, nitrocellulose, nitroparaffins, melamine, ethylenediamine, fuel cells, sulfite cooking liquors, and rocket fuel.
Other Designations: CAS No. 7664-41-7; NH_3; ammonia (ACGIH); ammonia anhydrous.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

NFPA



Gaseous



Liquified

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

* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Anhydrous ammonia, ca 100%

OSHA PEL
15-min STEL: 35 ppm, 27 mg/m³
ACGIH TLVs, 1989-90
TLV-TWA: 25 ppm, 17 mg/m³
TLV-STEL: 35 ppm, 24 mg/m³

NIOSH REL, 1987
50 ppm
5-min ceiling: 35 mg/m³

Toxicity Data*
Human, eye: 700 ppm
Human, inhalation: 20 ppm inhaled affects the sense organs, special senses (conjunctiva irritation, ulcerated nasal septum), and the lungs, thorax, and respiration (change in trachea or bronchi)

* See NIOSH, *RTECS* (BO0875000), for additional irritative, mutative, and toxicity data.

Section 3. Physical Data

Boiling Point: -28.03 °F/-33.35 °C
Melting Point: -107.9 °F/-77.7 °C
Vapor Pressure: 10 atm at 78.3 °F/25.7 °C
Vapor Density (Air = 1): 0.6
Molecular Weight: 17.03 g/mol
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 0.77 at 32 °F/0 °C (liquid), 0.7 at -27 °F/-33 °C (gas)
Water Solubility: 47% at 32 °F/0 °C, 34% at 68 °F/20 °C

Appearance and Odor: Colorless liquid or gas with a strong, pungent, and irritating odor. Their low and high odor thresholds are 0.0266 mg/m³ and 39.6000 mg/m³, respectively.

Section 4. Fire and Explosion Data

Flash Point: Gas at room temperature	**Autoignition Temperature:** 1204 °F/ 651 °C (iron catalyzed)*	**LEL:** 16% v/v	**UEL:** 25% v/v

Extinguishing Media: An explosive mixture may form in air if this gas continues to flow while the flame is extinguished. Thus the best procedure is first to stop the flow of gas. It may be necessary to use carbon dioxide or dry chemical to extinguish the flame surrounding the valve that controls the gas supply. Use water to cool fire-exposed containers and to protect personnel shutting off gas. The water reduces gas concentration due to its solubility in water. For fires involving liquified anhydrous ammonia, use dry chemical or CO_2.
Unusual Fire or Explosion Hazards: This material is a moderate fire and explosion hazard when exposed to heat and/or flame. The presence of oil and other combustible materials increases the fire 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. If gas is leaking or tanks are exposed to intense heat, evacuate the area and the area downwind. Tanks should be equipped with appropriate pressure-relief devices. Violent rupture can occur if relief valves fail. Stay clear of tank heads. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

* 850 °C/1562 °F (uncatalyzed).

Section 5. Reactivity Data

Stability/Polymerization: Anhydrous ammonia is stable at room temperature in closed containers under normal storage and handling conditions. Its decomposition to flammable hydrogen and nitrogen gas begins above 840 °F/450 °C. Hazardous polymerization cannot occur.
Chemical Incompatibilities: This material is an alkaline gas that gives off heat when it reacts with acids. Contact with interhalogens, boron halides, 1,2-dichloroethane (with liquid NH_3), ethylene oxide (polymerization reaction), chloroformamidnium nitrate, oxygen + platinum, magnesium perchlorate, nitrogen trichloride, and strong oxidants can cause potentially violent or explosive reactions. Contact with heavy metals and their compounds, chlorine azide, bromine, iodine, iodine + potassium, tellurium halides, pentaborane (9), silver oxide, silver chloride, silver nitrate, silver azide, and hypochlorites yield explosive products. Contact with chlorine or chlorine bleach can cause the evolution of hazardous chloramine gas. Ammonia forms sensitive explosive mixtures with air + hydrocarbons, germanium derivatives, stibine, 1-chloro-2,4-dinitrobenzene, ethanol + silver nitrate, and 2-, or 4-chloronitrobenzene (above 160 °C/30 bar). This material is also incompatible with acetaldehyde, acrolein, boron, chlorosilane, hexachloromelamine, sulfur, hydrazine + alkali metals, potassium ferricyanide, potassium mercuric cyanide, nitrogen dioxide, phosphorus pentoxide, and tetramethylammonium amide.
Hazardous Products of Decomposition: Thermal oxidative decomposition of anhydrous ammonia can produce toxic fumes of ammonia (NH_3) and nitrogen oxides (NO_x).

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists anhydrous ammonia as a carcinogen.
Summary of Risks: Ammonia gas can be suffocating and extremely irritating to the eyes, throat, and respiratory tract. Depending on exposure level and time, effects range from mild irritation to severe corrosion of body tissue due to ammonia's alkalinity. Exposures to increasing concentrations may be hazardous since persons acclimated to its odors may suffer overexposure and adverse health effects. Intense exposure can be fatal. Fatalities may occur from exposure to ammonia concentrations of 2500 to 4500 ppm for 30 min. 700 ppm causes eye irritation. High gas concentrations can burn and blister skin and cause severe eye irritation with permanent corneal damage. Contact with liquid anhydrous ammonia can also severely burn the eyes and skin. Extensive burns can be fatal.
Medical Conditions Aggravated by Long-Term Exposure: Permanent eye damage, scars, and pulmonary impairment.
Target Organs: Respiratory system, eyes.
Primary Entry Routes: Inhalation, ingestion, skin and eye contact.
Acute Effects: Inhalation can cause dyspnea; bronchospasm; mucosal burns of the nose, pharnyx, and larynx (throat irritation at 408 ppm and laryngospasm at 1700 ppm); chest pain; pulmonary edema; saliva secretion; pink, frothy sputum; and urine retention. Ingestion causes nausea, vomiting, and swelling of the lips, mouth, and larynx. Skin contact with concentrated ammonia produces liquefaction necrosis (tissue death) and deep penetrating burns. Eye exposure results in lacrimation, conjunctivitis, iritis, corneal irritation, and temporary or permanent blindness.
Chronic Effects: Chronic bronchiectasis with small airway obliteration may occur. Interstitial fibrosis has been observed 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. Time is the most important consideration! *The first 10 seconds are critical to preventing blindness.*
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, neither induce vomiting nor attempt to neutralize. Have the conscious person drink about 4 oz of water or milk to dilute. Caution! Excessive amounts may cause vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Serum ammonia levels are not clinically useful in managing exposures; instead, evaluate clinically for pulmonary edema and respiratory distress, with treatment as appropriate. Consider esophagoscopy if the patient has oral or pharyngeal burns. Do not induce gastric lavage. Steroid treatment is controversial and of questionable benefit. If ingestion is significant, observe for development of esophageal stricture. For eye exposures, irrigate until conjunctival sac pH is <8.5.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice an anhydrous ammonia spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate area to disperse gas. Cleanup personnel should protect against vapor inhalation and skin contact. Before fixing a leak, use a water spray to reduce the concentration of gaseous ammonia around a leaking vessel. If a cylinder is the source of a leak, remove it to a safe place in open air. Then, either repair the leak or allow the cylinder to empty. If ammonia is liquified, isolate the hazard area and allow it to vaporize. Rapid neutralization of large amounts of ammonia is not advised since the heat generated may increase exposure of personnel. Do not release the water used during cleanup into sewers, drains, or surface water. 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): 100 lb (45.4 kg) [* per Clean Water Act, Sec. 311(b)(4)]
Listed as a SARA Extremely Hazardous Substance (40 CFR 355), Reportable Quantity: 100 lb; Threshold Planning Quantity (TPQ): 500 lb
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

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 any skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL, 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 cylinders or tanks in a cool, well-ventilated, fire-resistant location away from oxidizing agents, combustible materials, incompatible materials (especially chlorine, bromine, iodine, and acids), heat and ignition sources, and exit points. Special outside storage out of direct sunlight is preferred. Protect containers from physical damage. Follow good practice for handling compressed gas in cylinders.
Engineering Controls: Work practices and equipment must be designed to prevent skin and contact with ammonia or ammonia solutions and inhalation of gaseous vapor. Provide workers with training on safe handling. Do not use ammonia near heat and ignition sources. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Cylinders in use should be in enclosed cabinets equipped with an individual air ventilation source to control accidental leaks. Do not use copper, brass, bronze, or galvanized steel in contact with ammonia. Welded, not threaded, joints are preferred in ammonia service. Do not use brazed joints. Iron and steel construction is preferred. Piping should be of rigid steel. Follow OSHA regulations (29 CFR 1910.11).

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Ammonia, anhydrous
DOT Hazard Class: Nonflammable gas
ID No.: UN1005
DOT Label: Nonflammable gas
DOT Packaging Requirements: 173.304, 173.314
DOT Packaging Exceptions: 173.306

IMO Shipping Name: Ammonia, anhydrous, liquified, or ammonia solutions, density (specific gravity) less than 0.880 at 15 °C, in water, containing more than 50% ammonia
IMO Hazard Class: 2.3
IMO Label: Poison gas
IMDG Packaging Group: -
ID No.: UN1005

MSDS Collection **References:** 1, 2-9, 12, 17, 19, 20, 24, 26, 27, 31, 38, 73, 84, 85, 87, 88, 103, 109, 123, 124, 126, 127, 129, 133, 134, 136
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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Material Safety Data Sheets Collection:
Sheet No. 23
Cadmium Metal/Powder
Issued: 9/77 Revision: D, 5/93

Section 1. Material Identification

Cadmium Metal/Powder (Cd) Description: Occurs naturally in the mineral greenockite (cadmium sulfide). This form is rare and most cadmium is obtained by extraction from other ores containing it as a mineral (lead, copper, and zinc). Zinc sulfide ores are the main source; by direct distillation or recovery from the electrolytic process. Used in electroplating other metals, fire protection systems, nickel-cadmium storage batteries, power transmission wire, TV phosphors, pigments for ceramic glazes, machinery enamels, baking enamels, photography and lithography, selenium rectifiers, electrodes for cadmium-vapor lamps, and photoelectric cells; as a fungicide and a Weston standard cell control of atomic fission in nuclear reactors.

Other Designations: CAS No. 7440-43-9, colloidal cadmium.

Manufacturer: Contact your supplier/distributor. Consult latest *Chemical Week Buyers' Guide*(73) for suppliers list.

Cautions: Cadmium is a highly toxic metal. Symptoms may be delayed several hours and include pulmonary edema (fluid in lungs) which can be fatal. Chronic effects include kidney damage. Cd is considered a carcinogen by several government agencies. The powder is pyrophoric and presents a significant fire/explosion hazard.

Powder

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

Genium

Solid

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

*Chronic effects PPE-Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Cadmium, ca 100%

1992 OSHA PEL
8-hr TWA: 5 $\mu g/m^3$

1992 OSHA SECAL*
TWA: 15 or 50 $\mu g/m^3$

1990 IDLH Level
50 mg/m^3

1993-94 ACGIH TLVs
TWA: 0.01 mg/m^3 (total dust), Class A2 carcinogen
TWA: 0.002 mg/m^3 (respirable fraction)

1991 DFG (Germany) MAK
None established

1992 NIOSH REL
Carcinogen, keep as low as possible

1992 Toxicity Data†
Human, inhalation, LC_{Lo}: 39 mg/m^3/20 min caused cardiac changes, thrombosis, and respiratory depression.
Rat, oral, LD_{50}: 225 mg/kg; details not reported.
Woman, inhalation, LC_{Lo}: 129 $\mu g/m^3$ for 20 continuous years produced lung tumors.
Man, TC_{Lo}: 88 $\mu g/m^3$/8.6 years caused kidney and ureter toxicity with protein in the urine.

* Separate engineering control limit: to be achieved in processes and work places where it is not possible to achieve the PEL through engineering and work practices alone. The SECAL for Cd is 15 or 50 $\mu g/m^3$ depending on the processes involved. See Federal Register 57 (178): 42222, Table VIII-B1, 9/14/92.
†See NIOSH, *RTECS* (EU9800000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 1409 °F (765 °C)
Melting Point: 610 °F (321 °C)
Vapor Pressure: 0.095 mm Hg at 609.6 °F (320.9 °C)
Refraction Index: 1.13
Mohs Hardness: 2.0
Molecular Weight: 112.4

Density: 8.642
Water Solubility: Insoluble
Other Solubilities: Soluble in nitric (rapidly), hydrochloric (slowly), and other acids. The solid is soluble in ammonium nitrate solution, but the powdered form undergoes an explosive reaction.

Appearance and Odor: Silver-white, blue-tinged, lustrous, odorless, soft metal that is easily cut with a knife. The powder is grayish-white.

Section 4. Fire and Explosion Data

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

Extinguishing Media: The solid metal is not flammable, but the finely divided powder is pyrophoric. As a rule, the more finely divided the powder is, the greater the potential for explosion. Use carbon dioxide, dry chemical, or sand. **Unusual Fire or Explosion Hazards:** Processes that create cadmium dust such as cutting, grinding, or welding present a serious explosion hazard in presence of ignition sources. Avoid creation of cadmium dust clouds. **Special Fire-fighting Procedures:** Because 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. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: Cadmium easily tarnishes in moist air as it is oxidized to cadmium oxide. The solid is stable in dry air. The powder is pyrophoric. Cd becomes brittle at 176 °F (80 °C). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include ammonium nitrate (powdered Cd), hydrazoic acid, tellurium, zinc, ammonia, sulfur, selenium, nitryl fluoride, and oxidizing agents. **Conditions to Avoid:** Creation of Cd dust clouds, exposure to heat and ignition sources, and contact with incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of Cd can produce toxic cadmium oxide (CdO) fumes.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies list Cd as a carcinogen: IARC Class 2A (probably carcinogenic in humans),(183) NTP Class 2 (reasonably anticipated to be a carcinogen),(169) and NIOSH Class X (carcinogen defined without further categorization),(183) ACGIH TLV-A2 (suspected human carcinogen),(183) EPA-B1 (Probable human carcinogen) and DFG MAK-A2 (unmistakably carcinogenic in animal experimentation only).(183) **Summary of Risks:** Dust or fume inhalation generally results in acute symptoms delayed up to 24 hr. Effects include a flu-like syndrome similar to metal fume fever with chills, fever, and muscle pain in the back and limbs. Pulmonary edema (fluid in lungs) can develop after severe exposure and may result in death. If victim recovers, residual changes may include lung fibrosis (thickening) and vascular changes. Long-term exposure to Cd damages the liver and kidneys (accumulates, half-life = 7 to 30 yr). Proteinuria (protein in urine) of low molecular weight is the first sign of tubular dysfunction. Excess urinary glucose is also seen. Bone demineralization similar to osteoporosis (decreased bone density)...

Continue on next page

Section 6. Health Hazard Data, *continued*

occurs *not* as a direct effect of Cd exposure, but indirectly by altering kidney regulation of calcium and phosphorus which are needed for strong, healthy bones. Some studies show a correlation between anemia (low hemoglobin in blood) and high Cd levels. Selenium (Se) and zinc (Zn) appear to suppress Cd toxicity; Se binds up Cd, preventing it from entering body tissue and Zn may compete for the same metabolic site. **Medical Conditions Aggravated by Long-Term Exposure:** Kidney, blood, or respiratory disorders. **Target Organs:** Blood, kidney, liver, respiratory system. **Primary Entry Routes:** Inhalation, ingestion. **Acute Effects:** Inhalation may cause irritation of the eyes, nose, and throat, nausea and vomiting, abdominal colic, diarrhea, chest tightness, cough, headache, and weakness. Pulmonary edema could develop up to 24 hr post exposure. Kidney damage may occur after acute exposures, but is more likely with chronic exposure. **Chronic Effects:** Symptoms may be delayed several years after last exposure and include perforation of the nasal septum (tissue between the nostrils), loss of smell, chronic bronchitis, severe progressive emphysema, anorexia, insomnia, fatigue, pallor, anemia, kidney damage, bone demineralization, lung fibrosis and possible cancer of the respiratory tract.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift 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. Wash exposed 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. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of cadmium's irritating nature.

Note to Physicians: β-2 microglobulin excretion of > 200 µg/g creatinine indicates kidney dysfunction as does a renal cortex [Cd] of 180 to 220 µg/g of wet kidney cortex. Blood Cd levels are *not* indicative of exposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against inhalation. Carefully scoop up small spills and place in sealed impermeable containers. *Do not* disperse dust by sweeping. Remember that Cd powder can be pyrophoric and must be handled carefully. Prevent entry into sewers, drains, and 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

Listed as a RCRA Hazardous Waste (40 CFR 261.24): D006, Characteristic of Toxicity; regulatory level = 1.0 mg/L
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 10 lb (4.54 kg)† [* per CWA, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1027)

† No reporting of releases of this substance is required if the diameter of the pieces of the solid metal is equal to or exceeds 100 µm (0.004 in.)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because 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 MSHA/NIOSH-approved respirator. For any detectable concentration, use a SCBA or supplied air respirator (with auxiliary SCBA) with a full facepiece operated in pressure-demand or other positive-pressure mode. 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.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear gloves, boots, aprons, and gauntlets to prevent Cd dust from contacting skin. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL or SECAL (Sec. 2). Lunchroom facilities should not have concentrations above 2.5 $\mu g/m^3$ at any time. Local exhaust ventilation is preferred because 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 before reuse. Remove Cd from shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using Cd, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles. Do not allow cadmium dust to build up in storage area.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level.

Administrative Controls: Prohibit workers from removing Cd from protective clothing and equipment by blowing, shaking, or any other means that disperses Cd into the air. Employees must not enter eating facilities while wearing PPE unless it is vacuumed with a HEPA. Consider preplacement and periodic medical exams of exposed workers emphasizing the blood, kidneys, liver, and respiratory system. Educate workers on Cadmium's carcinogenicity.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Poisonous solids, n.o.s.*, Pyrophoric metals, n.o.s.†
DOT Hazard Class: 6.1*, 4.2†
ID No.: UN2811*, UN1383†
DOT Packing Group: III*, I†
DOT Label: Keep away from food*, Spontaneously Combustible†
Special Provisions (172.102): —*, B11†
* Solid metal, † Powder

Packaging Authorizations
a) Exceptions: 173.153*, None†
b) Non-bulk Packaging: 173.213*, .187†
c) Bulk Packaging: 173.240*, .242†

Quantity Limitations
a) Passenger Aircraft or Railcar: 100 kg*, Forbidden†
b) Cargo Aircraft Only: 200 kg*, Forbidden†

Vessel Stowage Requirements
a) Vessel Stowage: A*, D†
b) Other: –

***MSDS Collection* References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 159, 167, 169, 183, 185, 186

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** TW Thoburn, MPH, MD

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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_{Lo}: 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.

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

Material Safety Data Sheet

From Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 239

CYANOGEN

Issued: August 1988

SECTION 1. MATERIAL IDENTIFICATION 26

Material Name: CYANOGEN

Description (Origin/Uses): Usually prepared by adding an aqueous solution of sodium or potassium cyanide to an aqueous solution of copper (II) sulfate or chloride. Used in organic synthesis; as a fuel gas for welding and cutting heat-resistant metals; as a fumigant; and as a rocket propellant with ozone or fluorine.

Other Designations: Carbide Nitride; Ethanedinitrile; Nitriloacetonitrile; C_2N_2; CAS No. 0460-19-5

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

Comments: Cyanogen is a dangerous, flammable, and poison gas. Handle it with care!

4
4 2
-
NFPA

HMIS
H 4
F 4
R 2
PPG*
*See sect. 8

R 1
I 4
S 3
K 4

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Cyanogen, CAS No. 0460-19-5	Ca 100	**ACGIH TLV, 1987-88** TLV-TWA:* 10 ppm, 20 mg/m^3 **Toxicity Data**** Human, Inhalation, TC_{Lo}: 16 ppm

*Recommended by analogy with hydrogen cyanide (HCN) and to prevent irritation and systemic effects.
**See NIOSH, *RTECS* (GT1925000), for additional toxicity data with references to irritative effects.

SECTION 3. PHYSICAL DATA

Boiling Point: -6°F (-21°C)
Melting Point: -18°F (-28°C)
Vapor Density (Air = 1): 1.8

Water Solubility (%): Soluble
Molecular Weight: 52 Grams/Mole

Appearance and Odor: A colorless gas; a pungent, penetrating odor like that of almonds.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
*	*	% by Volume	6	32

Extinguishing Media: *Cyanogen is a dangerously flammable gas with a wide range of explosibility. Try to stop the flow of cyanogen gas and use a water spray to protect personnel attempting to do so.

Unusual Fire or Explosion Hazards: Cyanogen gas is denser than air and can collect in enclosed spaces. It can flow along surfaces; reach distant, low-lying sources of ignition; and flash back. It is a dangerous fire and explosion hazard; use it very carefully.

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

Cyanogen is stable if it is kept dry in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

Chemical Incompatibilities: Do not expose this material to acids or their fumes, water, fluorine, or chlorine.

Conditions to Avoid: Prevent cyanogen's exposure to all forms of water. Do not allow excessive heat and sources of ignition in areas where this gas is used.

Hazardous Products of Decomposition: Hydrogen cyanide (HCN) can be produced during cyanogen fires.

SECTION 6. HEALTH HAZARD INFORMATION

Cyanogen is not listed as a carcinogen by the NTP, IARC, or OSHA.

Summary of Risks: *This material is a highly poisonous gas.* Inhalation results in severe irritation of the respiratory system, which may develop into fatal pulmonary edema. Cyanogen reacts with the moisture of the mucous membranes lining the lungs to form hydrogen cyanide and cyanate.

Medical Conditions Aggravated by Long-Term Exposure: None reported. **Target Organs:** Skin, eyes, respiratory system. Cyanide poisoning affects each cell it comes in contact with. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** Severe irritation of the respiratory system characterized by coughing, shortness of breath, and difficulty in breathing. Rapid onset of or delayed pulmonary edema may occur. Skin and eye burns may occur. **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. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Medically trained personnel should administer oxygen for all exposures, if available. **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. NOTE TO PHYSICIAN: Treat the exposed person for pulmonary edema, which may be delayed. Hospitalization with monitoring is recommended. Specific antidote kits for cyanide exposure are available commercially and should be utilized. Specific medical protocols for cyanide poisoning are readily available.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat any cyanogen leak as an emergency.* Notify safety personnel, evacuate all nonessential personnel, and provide adequate ventilation. Cleanup personnel need protection against skin contact with and inhalation of vapor (see sect. 8). Try to shut off the flow of leaking cyanogen gas. Contact your supplier for other suggestions about dealing with accidental leaks of cyanogen gas.

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): Not Listed

EPA Designations (40 CFR 302.4)
RCRA Hazardous Waste, No. P031
CERCLA Hazardous Substance, Reportable Quantity: 100 lbs (45.4 kg), per the Clean Water Act (CWA), Section 311 (b) (4)

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:** 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. 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; and clean, impervious, body-covering clothing to prevent any possibility of skin contact. **Ventilation:** Install and operate general and local exhaust-ventilation systems powerful enough to maintain airborne levels of cyanogen gas below the exposure limit cited in section 2. Design all ventilation systems to be explosion-proof in order to minimize sources of ignition. **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. **Other:** Design all engineering systems (production, shipping, receiving, transferring, and sampling) to eliminate possible sources of ignition.

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. Do not inhale cyanogen gas.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store cyanogen gas in pressurized, secured, airtight containers (cylinders, tanks, etc.) in a cool, dry, well-ventilated area away from water, acids, acid fumes, chlorine, fluorine, heat, and sources of ignition.

Special Handling/Storage: Protect containers of cyanogen gas from heat, shock, physical damage, or exposure to direct sunlight. Store them upright and secure them tightly.

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Cyanogen Gas
DOT Hazard Class: Poison A
IMO Class: 2.3
DOT Label: Poison Gas and Flammable Gas
DOT ID No. UN1026
IMO Label: Poison Gas and Flammable Gas

References: 1, 84-94, 100, 112, 113, 114.

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

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Material Safety Data Sheet Collection

2,4-Dichlorophenol **MSDS No. 987**

Date of Preparation: 10/95

Section 1 - Chemical Product and Company Identification

Product/Chemical Name: 2,4-Dichlorophenol
Chemical Formula: $Cl_2C_6H_3OH$
CAS Number: 120-83-2
Synonyms: DCP; 2,4-DCP; phenol, 2,4-dichloro
Derivation: Produced by reacting phenol with chlorine in liquid sulfur dioxide.
General Use: As a chemical intermediate in the manufacture of herbicides, wood preservatives, antiseptics, and seed disinfectants.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

2,4-Dichlorophenol, ca 100%wt
Trace Impurities: 2,6-dichlorophenol (8%), chlorinated 2-phenoxyphenols, chlorinated diphenyl ethers, and chlorinated dibenzofurans.

OSHA PELs	ACGIH TLVs	NIOSH REL	DFG (Germany) MAK
None established	None established	None established	None established

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

2,4-Dichlorophenol exists as colorless to white crystals with a strong, medicinal odor. It is an irritant capable of causing typical phenolic burns. Central nervous system effects (tremor, headache, ringing in the ears) may also occur. It is combustible when exposed to heat or flame.

Wilson Risk Scale	
R	1
I	2
S	3
K	1
HMIS	
H	3
F	1
R	0
PPE*	
*Sec. 8	

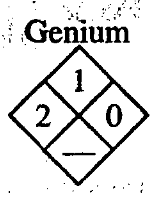
Potential Health Effects

Primary Entry Routes: Inhalation, skin and eye contact.
Target Organs: Eyes, skin, respiratory tract, central nervous system, blood, liver.
Acute Effects
Inhalation: Irritation of the respiratory tract, labored breathing, and pulmonary edema (fluid in the lungs). Symptoms similar to those via ingestion may also occur.
Eye: Severe irritation and possible corneal damage.
Skin: Contact causes a typical phenolic burn [pain, followed by quick numbness; the affected area is white with a dry eschar (scab) forming over it. It sloughs off and a brown stain remains].
Ingestion: Burning pain in the mouth and throat, white necrotic lesions in the mouth, esophagus, and stomach, abdominal pain, vomiting, bloody diarrhea, paleness, sweating, weakness, headache, dizziness, ringing in the ears, possible fleeting excitement and confusion followed by unconsciousness; scanty, dark-colored urine, kidney insufficiency, liver damage, methemoglobinemia (replacement of hemoglobin in the blood with methemoglobin, which is not capable of carrying oxygen, resulting in a lack of oxygenated blood to the tissues), hyperbilirubinemia (presence of bilirubin, a liver pigment in the urine), and hemolytic anemia (destruction of red blood cells).
Carcinogenicity: IARC, NTP, and OSHA do not list 2,4-dichlorophenol as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Chronic Effects: None reported.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.
Skin Contact: *Quickly* remove contaminated clothing. Rinse away loose material with flooding amounts of water followed quickly by a thorough soap and water wash. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *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: Treatment is symptomatic and supportive.

Section 5 - Fire-Fighting Measures



Flash Point: 237 °F (114 °C)
Flash Point Method: OC
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.
Flammability Classification: Class IIIB Combustible Liquid
Extinguishing Media: For small fires, use dry chemical, carbon dioxide, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: None reported.
Hazardous Combustion Products: Carbon oxide(s), hydrogen chloride, and chlorine gases.
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because 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.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against inhalation and skin/eye contact.
Small Spills: Carefully scoop up or vacuum (with appropriate filter) and place in suitable container. *Do not* sweep!
Large Spills
Containment: Flush with water to containment area for later disposal. *Do not* release into sewers or waterways.
Cleanup: Damp mop any residue.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use only with adequate ventilation and appropriate PPE.
Storage Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec. 10).

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all equipment used with and around 2,4-dichlorophenol. Enclose all processes where possible to prevent dust dispersion into work area.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the liver and kidneys.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for 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.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove 2,4-dichlorophenol from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using 2,4-dichlorophenol, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Colorless to white crystals.
Vapor Pressure: 0.075 mm Hg at 77 °F (25 °C)
Formula Weight: 163
Specific Gravity (H_2O=1, at 25 °C): 1.383 at 140 °F (60 °C)
Henry's Law constant: 3.57×10^{-6} atm/m^3/mole
Water Solubility: 0.45 parts/100 parts water at 68 °F (20 °C)
Other Solubilities: Soluble in alcohol, benzene, chloroform, carbon tetrachloride, and ether.
Boiling Point: 410 °F (210 °C)
Freezing/Melting Point: 113 °F (45 °C)
Octanol/Water Partition Coefficient: log Kow = 3.06

Section 10 - Stability and Reactivity

Stability: 2,4-Dichlorophenol is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Oxidizers, acids, and acid fumes.
Conditions to Avoid: Exposure to heat, ignition sources, and incompatibles.
Hazardous Decomposition Products: Thermal oxidative decomposition of 2,4-dichlorophenol can produce carbon oxide(s), hydrogen chloride, and chlorine gases.

Section 11 - Toxicological Information

Toxicity Data:*

Acute Oral Effects:
Rat, oral, LD$_{50}$: 580 mg/kg
Mouse, oral, LD$_{50}$: 1276 mg/kg
Reproductive Effects:
Rat, oral: 7500 mg/kg administered from 6 to 15 days of pregnancy produced specific developmental abnormalities of the muskuloskeletal system.
Multiple Dose Toxicity Data:
Rat, oral: 91 g/kg administered continuously for 13 weeks caused changes in bone marrow.
Tumorigenicity:
Mouse, skin: 16 g/kg applied intermittently for 39 weeks caused skin and appendage tumors.
Mutagenicity:
Hamster (ovary): 3100 µg/L caused sister chromatid exchange.

* See NIOSH, *RTECS* (SR8575000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Guppy (*Poecilia reticulata*), LC$_{50}$ = 4.2 ppm/24 hr; goldfish, LC$_{50}$ = 7.8 ppm/24 hr; fathead minnow (*Pimephales promelas*), LC$_{50}$ = 8230 µg/L/96 hr; bluegill (*Lepomis macrochirus*), LC$_{50}$ = 2020 µg/L/96 hr
Environmental Fate: If released to soil, 2,4-dichlorophenol will adsorb moderately, although leaching will occur slowly. The ionized form (alkaline soils) appears to be more susceptible to leaching than the dissociated form. In water, adsorption to sediments will occur. Photodegradation can occur in surface waters via direct photolysis (half-life = 0.7 to 3 hr) and reaction with sunlight-formed oxidants (single oxygen and peroxy radicals; half-life = 62 to 69.3 hr). Hydrolysis and volatilization will not be important removal mechanisms. Biodegradation can occur both under aerobic and anaerobic conditions. In the air, 2,4-dichlorophenol will react with photochemically-produced hydroxyl radicals (est. half-life = 5.3 days).

Section 13 - Disposal Considerations

Disposal: A good candidate for rotary kiln incineration, and removal via biological treatment, solvent extraction, and resin absorption. Waste waters can be oxidized to remove phenol by mixing 1 part 2,4-dichlorophenol with 3 parts hydrogen peroxide and 5 to 100 ppm iron; more than 95% of phenols are removed in 30 minutes from a 500 ppm phenol solution at pH 5-6 and 77 to 122 °F (25 to 50 °C). 2,4-Dichlorophenol can be burned in an incinerator equipped with an afterburner and scrubber. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Chlorophenols, solid
Shipping Symbols: –
Hazard Class: 6.1
ID No.: UN2020
Packing Group: III
Label: Keep Away From Food
Special Provisions (172.102): T7

Packaging Authorizations
a) **Exceptions:** 173.153
b) **Non-bulk Packaging:** 173.213
c) **Bulk Packaging:** 173.240

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** 100 kg
b) **Cargo Aircraft Only:** 200 kg

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** –

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): U081
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001 and CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 100 lb (45.4 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 103, 124, 136, 167, 189, 197, 190, 200, 203

Prepared By .... M Gannon, BA
Industrial Hygiene Review .... S Gilson, CIH
Medical Review .... R Teichman

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Material Safety Data Sheets Collection:

Sheet No. 470
Diesel Fuel Oil No. 2-D

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification 33

Diesel Fuel Oil No. 2-D Description: Diesel fuel is obtained from the middle distillate in petroleum separation; a distillate oil of low sulfur content. It is composed chiefly of unbranched paraffins. Diesel fuel is available in various grades, one of which is synonymous with fuel oil No. 2-D. This diesel fuel oil requires a minimum Cetane No. (efficiency rating for diesel fuel comparable to octane number ratings for gasoline) of 40 (ASTM D613). Used as a fuel for trucks, ships, and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.

Other Designations: CAS No. 68334-30-5, diesel fuel.

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

Cautions: Diesel fuel oil No. 2-D is a skin irritant and central nervous depressant with high mist concentrations. It is an environmental hazard and moderate fire risk.

R 1
I -
S 2
K 2

NFPA

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

Section 2. Ingredients and Occupational Exposure Limits

Diesel fuel oil No. 2-D*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data‡
None established	Mineral Oil Mist TWA: 5 mg/m^3† STEL: 10 mg/m^3	None established	Rat, oral, LD$_{50}$: 9 g/kg produces gastrointestinal (hypermotility, diarrhea) effects

* Diesel fuel No. 2-D tends to be low in aromatics and high in paraffinics. This fuel oil is complex mixture of: 1) >95% paraffinic, olefinic, naphthenic, and aromatic hydrocarbons, 2) sulfur (<0.5%), and 3) benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)]. Although low in the fuel itself, benzene concentrations are likely to be much higher in processing areas.

† As sampled by nonvapor-collecting method.

‡ Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 340 to 675 °F (171 to 358 °C)
Viscosity: 1.9 to 4.1 centistoke at 104 °F (40 °C)
Specific Gravity: <0.86
Water Solubility: Insoluble

Appearance and Odor: Brown, slightly viscous liquid.

Section 4. Fire and Explosion Data

Flash Point: 125 °F (52 °C) min.	**Autoignition Temperature:** >500 °F (932 °C) **LEL:** 0.6% v/v	**UEL:** 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or foam to fight fire. Use a water spray to cool fire exposed containers. Do not use a forced water spray directly on burning oil since this will scatter the fire. Use a smothering technique for extinguishing fire.

Unusual Fire or Explosion Hazards: Diesel fuel oil No. 2-D is a OSHA Class II combustible liquid. Its volatility is similar to that of gas oil. Vapors may travel to a source of ignition and flash back.

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 clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to pollution and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Diesel fuel oil No. 2-D is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: It is incompatible with strong oxidizing agents; heating greatly increases the fire hazard.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of diesel fuel oil No. 2-D can produce various hydrocarbons and hydrocarbon derivatives, and other partial oxidation products such as carbon dioxide, carbon monoxide, and sulfur dioxide.

Section 6. Health Hazard Data

Carcinogenicity: Although the IARC has not assigned an overall evaluation to diesel fuels as a group, it has evaluated occupational exposures in petroleum refining as an IARC probable human carcinogen (Group 2A). It has evaluated distillate (light) diesel oils as not classifiable as human carcinogens (Group 3).
Summary of Risks: Although diesel fuel's toxicologic effects should resemble kerosine's, they are somewhat more pronounced due to additives such as sulfurized esters. Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, vomiting, and loss of coordination, depending on concentration and exposure time. When removed from exposure area, affected persons usually recover completely. If vomiting occurs after ingestion and if oil is aspirated into the lungs, hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result. A comparative ratio of oral to aspirated lethal doses may be 1 pt vs. 5 ml. Aspiration may also result in transient CNS depression or excitement. Secondary effects may include hypoxia (insufficient oxygen in body cells), infection, pneumatocele formation, and chronic lung dysfunction. Inhalation may result in euphoria, cardiac dysrhythmias, respiratory arrest, and CNS toxicity. Prolonged or repeated skin contact may irritate hair follicles and block sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system, skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal irritation, vomiting, diarrhea, and in severe cases central nervous system depression, progressing to coma or death. Inhalation of aerosols or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish discoloration of the skin and mucous membranes caused by deficient blood oxygenation).
Chronic Effects: Repeated contact with the skin causes dermatitis.

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. If large areas of the body have been exposed or if irritation persists, get medical help immediately. 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, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately. Position to avoid aspiration.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use a noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Diesel fuel oil No. 2-D spills may be environmental hazards. Report large spills.
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 261.21): Ignitable waste
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
Air Contaminant (29 CFR 1910.1000, Subpart Z): 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).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with a mist filter and organic vapor cartridge. 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 that promote worker safety and productivity. 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: Use and storage conditions should be suitable for a OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in storage or use areas.
Engineering Controls: Avoid vapor or mist inhalation and prolonged skin contact. Wear protective rubber gloves and chemical safety glasses where contact with liquid or high mist concentration may occur. Additional suitable protective clothing may be required depending on working conditions. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. At least weekly laundering of work clothes is recommended. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Fuel oil

DOT Hazard Class: Combustible liquid

ID No.: NA1993

DOT Label: None

DOT Packaging Exceptions: 173.118a

DOT Packaging Requirements: None

MSDS Collection References: 1, 6, 7, 12, 73, 84, 101, 103, 126, 127, 132, 133, 136, 143, 146
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 809
Dinitrobenzene (All Isomers)

Issued: 3/92

Section 1. Material Identification

Dinitrobenzene ($C_6H_4N_2O_4$) Description: Derived by nitration of nitrobenzene with mixed acid under vigorous conditions. Used in organic synthesis, dyes, explosives (the *ortho* polymer is used in bursting charges and to fill artillery shells), and as a camphor substitute in cellulose nitrate. It is important to know the particular dinitrobenzene isomer you are using since physical properties and toxicities vary.
Other Designations: CAS No. 528-29-0 (*o*-dinitrobenzene), 1,2,dinitrobenzene; CAS No. 99-65-0 (*m*-dinitrobenzene), binitrobenzene, 1,3,dinitrobenzene, 2,4,dinitrobenzene, 1,3,dinitrobenzol; CAS No. 100-25-4 (*p*-dinitrobenzene), 1,4,dinitrobenzene, Dithane A-4.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.
Cautions: Dinitrobenzene is a highly shock-sensitive, explosive material. It can cause anemia (lack of red blood cells), cyanosis (bluish-purple skin discoloration due to lack of oxygenated blood), and possibly death.

R 4
I 4
S 4*
K 1
* Skin absorption

NFPA†

HMIS
H 3
F 1
R 4
PPG‡
‡ Sec. 8

† NFPA hazard rating is given for the *ortho* isomer.

Section 2. Ingredients and Occupational Exposure Limits

Dinitrobenzene (*ortho*, *meta*, and *para* isomers),* ca 98%

1990 OSHA PEL (Skin)
8-hr TWA: 1.0 mg/m³

1990 IDLH Level
200 mg/m³

1990 NIOSH REL (Skin)
TWA: 1.0 mg/m³

1991-92 ACGIH TLV (Skin)
TWA: 0.15 ppm (1.0 mg/m³)

1990 DFG (Germany) MAK
MAK Class B (suspected carcinogen)†

1985-86 Toxicity Data‡
Human, oral, TD_{Lo}: 28 mg/kg; no toxic effects noted (*meta*)
Human, skin, TD_{Lo}: 4 mg/kg applied intermittently for 2 days produced behavioral (changes in motor activity) and cyanosis (*meta*)
Rat, oral, LD_{50}: 83 mg/kg; toxic effects not yet reviewed (*meta*)
Cat, oral, LD_{Lo}: 29 mg/kg; no toxic effects noted (*para*)

* Mixed compound contains mostly the *meta* isomer.
† Danger of cutaneous absorption.
‡ See NIOSH, *RTECS* (CZ7450000, *ortho*; CZ7350000, *meta*; CZ7525000, *para*), for additional mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 606 °F (319 °C),* 572 °F (300 °C),† 570 °F (299 °C)‡
Melting Point: 245 °F (119 °C),* 192 °F (89 °C),† 343 °F (173 °C)‡
Vapor Pressure: < 1 mm Hg at 68 °F (20 °C)
Molecular Weight: 168.1
Specific Gravity: 1.565,* 1.546,† 1.63‡ at 64 °F (18 °C)
Water Solubility: 0.05%,* 0.02%,† 0.01%,‡
Other Solubilities: Soluble*† (slightly soluble‡) in alcohol, benzene, chloroform and ethyl acetate

Appearance and Odor: White crystals,* yellow crystals,† white crystals.‡

* *ortho*,† *meta*,‡ *para*

Section 4. Fire and Explosion Data

Flash Point: 302 °F (150 °C)	**Autoignition Temperature:** None reported	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray, or regular foam. For large fires, use water spray, fog, or regular foam. Apply water as fog in flooding amounts since solid streams of water may be ineffective. Use care when applying water, fog, or foam as they may cause frothing.
Unusual Fire or Explosion Hazards: Dinitrobenzene is highly friction and shock sensitive and capable of dust explosion. Closed containers may rupture when heated. Prolonged exposure to fire or heat may cause explosion due to spontaneous combustion. Combustion by-products include toxic nitrogen oxide (NO_x) fumes.
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. Structural firefighters' protective clothing is not effective for fires involving dinitrobenzene. Use chemically protective clothing specifically recommended by the manufacturer or shipper. These may not provide thermal protection unless specifically stated by the manufacturer. Fight fire from as far away as possible. Apply cooling water to sides of fire-exposed containers until long after fire is extinguished. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders. If fire becomes uncontrollable or if container is exposed to direct flame, consider evacuation of a 1/3-mile radius. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Dinitrobenzene is thermally unstable and is highly shock- and friction-sensitive. Make sure containers are kept away from areas where shock and friction are likely to occur . Hazardous polymerization cannot occur.
Chemical Incompatibilities: Dinitrobenzene is incompatible with strong oxidizers, caustics, and metals such as tin and zinc. It is explosive when mixed with nitric acid (all isomers) and tetranitromethane (*meta*). The *para* isomer becomes volatile in contact with steam.
Conditions to Avoid: Shock, friction, heating, and contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of dinitrobenzene can produce carbon dioxide (CO_2), toxic nitrogen oxides and can explode.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(142) and OSHA(164) *do not*, but the MAK Class B (suspected human carcinogen) *does* list dinitrobenzene as a carcinogen.
Summary of Risks: Dinitrobenzene is at least 5 times more toxic than its mono form and the *meta* isomer is considered the most toxicologically important, especially as a methemoglobin (pigment similar to hemoglobin in the blood but unable to combine reversibly with oxygen) former. Anoxia (oxygen deficiency in the body tissues of such severity as to cause permanent damage) and cyanosis (bluish-purple discoloration of the lips, skin, and nails from lack of oxygenated blood) due to methemoglobin formation are likely. Because the degree of exposure needed to produce symptoms is not documented, exposure limits are based on comparison to polynitroaromatic compounds.
Medical Conditions Aggravated by Long-Term Exposure: Blood and liver disorders.
Target Organs: Blood, eyes, liver, cardiovascular and central nervous systems (CNS).
Primary Entry Routes: Inhalation, skin contact and absorption, and ingestion.

Continue on next page

Section 6. Health Hazard Data, *continued*

Acute Effects: Dinitrobenzene dust inhalation can cause irritation of the respiratory tract and the formation of methemoglobin which is responsible for these symptoms: headache; nausea; vomiting; dizziness; yellowish color of the eyes, hair, and skin; difficulty breathing; general weakness, cyanosis; and possible progression to convulsions, coma, and death. When methemoglobin concentration reaches 15%, cyanosis is noticed. Up to 40% concentration, victim still feels fine, insisting nothing is wrong. At over 40% methemoglobin, weakness and dizziness occur; after 70% coma, and at concentrations of 85 to 90%, death is likely. Skin contact produces symptoms from inhalation as well as irritation, small vesicles or blisters, redness and swelling, ulceration, and necrosis (tissue destruction). Introduction into eyes can cause irritation, redness and swelling of the lids, painful sensitivity to light, and may lead to severe eye damage. Ingestion also produces symptoms like those from inhalation as well as irritation of the mouth and stomach, stomach cramps, and diarrhea. A bitter almond taste or burning sensation in the mouth, dry throat, and thirst may also occur. If treatment is not received promptly for any route of exposure, death may occur, usually by cardiovascular collapse. Alcohol consumption, exposure to sunlight, or hot baths may aggravate symptoms.

Chronic Effects: Repeated or prolonged exposure may cause anemia, paresthesia in the feet, ankles, hands and visual reduction. There are also scattered reports of liver injury.

FIRST AID *Emergency personnel should protect against contamination!*

Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* allow victim to rub or keep eyes tightly shut. Consult a physician immediately.

Skin: *Quickly* remove contaminated clothing. Be aware that dinitrobenzene vaporizes easily and poses an inhalation hazard. Carefully dispose of contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. Pay special attention to ear canals, nasal cavities and skin beneath nails. For reddened or blistered skin, consult a physician.

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

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person take 2 tablespoons Ipecac (adult dose) and drink 1 to 2 glasses of water, then induce vomiting. After patient vomits, give 2 tablespoons of activated charcoal in 8 oz. of water to drink.

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

Note to Physicians: Effects may be delayed so keep victim under observation. Determine methemoglobin concentration at regular intervals until fully reduced to hemoglobin. Methylene blue treatment for methemoglobin may be needed: 1 to 2 mg/kg per dose (adult or child), intravenously as needed every 4 hr. Be aware that doses over 15 mg/kg may cause hemolysis.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry and stay upwind. Shut off all ignition sources. Cleanup personnel should wear fully encapsulating, vapor-protective clothing. Use water spray to reduce vapors (in case of solution spills) and dike for containment since the water can become corrosive and toxic. For small dry spills, carefully scoop into clean, dry, containers and cover. Wet mopping can minimize dust creation. For small solution spills, take up with earth, sand, vermiculite or other absorbent, noncombustible material and place in containers for reclamation or disposal. For large solution spills, dike surface flow using soil, sandbags, foamed concrete, or foamed polyurethane. For water spills, if dissolved at more than 10 ppm, apply activated carbon at 10 times the spilled amount and use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates. 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 261.21): No. D001, Characteristic of Ignitability

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 100 lb (45.4 kg) [* per Clean Water Act, Sec. 311 (b)(4)]

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). Because 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 MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For 5 mg/m^3, use any dust or mist respirator except for single-use respirators. For 50 mg/m^3, use any high-efficiency particulate filter or any SCBA with a full facepiece. For 200 mg/m^3, use any supplied-air respirator with a half-mask operated in a pressure-demand or other positive-pressure mode. 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.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent any skin contact. Butyl rubber protective clothing is recommended.

Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local explosion-proof exhaust ventilation is preferred because 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: Prevent physical damage to containers. Store in cool, dry, well-ventilated area away from heat, metals, oxidizing and reducing agents, and other incompatibles (Sec. 5). *Use detached storage!*

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. To prevent static sparks, electrically ground and bond all equipment used in dinitrobenzene manufacture, use, and storage.

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers that emphasize the blood, liver, cardiovascular system and eyes. Also run liver function tests and a complete blood count. Also consider any reactions to medications or alcohol consumption.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Dinitrobenzene, solid, *or* Dinitrobenzol
DOT Hazard Class: Poison B
ID No.: UN1597
DOT Label: Poison
DOT Packaging Exceptions: 173.364, 173.345 (solution)
DOT Packaging Requirements: 173.371, 173.346 (solution)

IMO Shipping Name: Dinitrobenzenes (*o*-, *m*-, *p*-)
IMO Hazard Class: 6.1
ID No.: UN1597
IMO Label: Poison
IMDG Packaging Group: II

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 140, 148, 149, 153, 159, 162, 163, 164

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 811
2,4-Dinitrotoluene

Issued: 3/92

Section 1. Material Identification

37

2,4-Dinitrotoluene [$C_6H_3CH_3(NO_2)_2$] Description: The most important isomer of dinitrotoluene derived by nitration of toluene with nitric acid in the presence of concentrated sulfuric acid to yield about 80% 2,4- and 20% 2,6-isomers from which the 2,4-isomer is not usually separated. Used in manufacturing explosives and dyes, in inorganic synthesis, as a chemical intermediate, a plasticizer, and a modifier for smokeless powders in the munitions industry.
Other Designations: CAS No. 121-14-2, (2,4-dinitrotoluene); CAS No. 25321-14-6 (all isomers), DNT, dinitrotoluol, methyldinitrobenzene, NCI-CO1865.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

R 3
I 3
S 3*
K 2
* Skin absorption

NFPA

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

Cautions: 2,4-Dinitrotoluene is combustible and explosive. This material is highly toxic by skin absorption, inhalation, and ingestion.

Section 2. Ingredients and Occupational Exposure Limits

2,4-Dinitrotoluene, ca 80% 2,4- and 20% 2,6-, with <5% other isomers

1990 OSHA PEL (Skin)
8-hr TWA: 1.5 mg/m³

1990 IDLH Level
200 mg/m³, *all isomers. Treat as a potential human carcinogen.*

1990 NIOSH REL (Skin)
TWA: 1.5 mg/m³, *all isomers**

1991-92 ACGIH TLV (Skin)†
TWA: 1.5 mg/m³, *all isomers*

1990 DFG (Germany) MAK
Danger of cutaneous absorption
MAK-A2

1985-86 Toxicity Data‡
Rat, oral, LD_{50}: 268 mg/kg; toxic effects not yet reviewed
Rat, oral, TD_{Lo}: 2620 mg/kg administered for 78 continuous weeks caused skin and appendage tumors
Rat, oral, TD_{Lo}: 3094 mg/kg administered to a 13-week-old male produced effects on fertility (pre-implantation mortality)

* NIOSH recommends controlling potential carcinogens at the lowest possible level.
† Notice of intended change to 0.15 mg/m³
‡ See NIOSH, *RTECS* (XT1575000), for additional irritation, mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 482 °F (250 °C)
Melting Point: 158 °F (70 °C); decomposes spontaneously at 536 °F (280 °C)
Vapor Pressure: 1 mm Hg at 68 °F (20 °C)
Vapor Density (air = 1): 6.27
Refraction Index: 1.442
Molecular Weight: 182.14
Specific Gravity: 1.3 *liquid*, 1.5 *solid* at 68 °F (20 °C)
Water Solubility: Insoluble
Other Solubilities: Soluble in alcohol, acetone, benzene, carbon disulfide, ether, and pyridine

Appearance and Odor: Orange to yellow crystalline solid or liquid with a slight odor.

Section 4. Fire and Explosion Data

Flash Point: 404 °F (207 °C), CC	**Autoignition Temperature:** None reported	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray, or regular foam. For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: 2,4-Dinitrotoluene is combustible and can become highly explosive when exposed to heat, friction, or contamination. 2,4-Dinitrotoluene's explosive energy is approximately 85% of TNT (a well-known, powerful explosive). Closed containers may rupture violently when heated. DNT decomposes spontaneously at 482 °F (250 °C, anaerobic) and 536 °F (280 °C, self-sustaining) and causes an explosion if confined. Contamination of DNT with organic materials lowers the decomposition temperature and increases the risk of explosion.
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. Structural firefighters' protective clothing is *ineffective* for fires involving DNT. Use extreme caution and fight fire from as far away as possible. Apply cooling water to container sides until long after fire is extinguished. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: 2,4-Dinitrotoluene is explosive when exposed to heat, friction, or contamination. It can be detonated but only by a very strong initiator. DNT is slightly sensitive to impact shock, with the liquid form less so than the solid form.
Chemical Incompatibilities: 2,4-Dinitrotoluene is incompatible with organic materials; strong reducing agents such as sodium sulphide, zinc powder, sodium hyposulphite, and metallic hydrides; strong oxidizing agents such as bichromates, peroxides, and chlorates (especially during transit); caustics; and metals such as tin and zinc. DNT corrodes some forms of plastics, rubber, and coatings.
Conditions to Avoid: Exposure to heat, friction, and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of 2,4-dinitrotoluene can produce carbon dioxide (CO_2) and toxic nitrogen oxides (NO_x).

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, NIOSH recommends treating dinitrotoluene as a potential human carcinogen. The ACGIH and Germany (DFG) list it as Class A2 (probably carcinogenic to humans) and MAK-A2 (unmistakably carcinogenic in animals only), respectively. However, neither NIOSH, ACGIH, or MAK specify *which* or *how many* isomers are involved.
Summary of Risks: Highly toxic 2,4-dinitrotoluene is dangerous through all routes of human exposure. Skin absorption is more prevalent than inhalation (due to low vapor pressure) and ingestion. Cyanosis and anemia are the usual manifestations of exposure.
Medical Conditions Aggravated by Long-Term Exposure: Persons with blood disorders may be at increased risk.
Target Organs: Blood, liver, central nervous (CNS) and cardiovascular (CVS) systems.
Primary Entry Routes: Skin absorption, inhalation, ingestion.
Acute Effects: Skin absorption and inhalation cause many of the same effects. The major effect of exposure to DNT is cyanosis (a purplish discoloration of skin and mucous membranes due to lack of oxygenated blood) which occurs when methemoglobin (brownish blood pigment of the blood that cannot

Continue on next page

Section 6. Health Hazard Data, *continued*

combine reversibly to molecular oxygen) concentration in the blood reaches 15% or more. Other possible symptoms include headache, irritability, dizziness, weakness, nausea, vomiting, dyspnea (difficulty in breathing), drowsiness, and unconsciousness. If treatment is not prompt, death may occur usually by cardiovascular collapse. Ingestion can cause irritation of mouth and stomach, stomach cramps, and diarrhea. In addition to absorption symptoms, skin contact can cause irritation, small blisters, redness, swelling, ulceration, and necrosis (death of living tissue). Contact with eyes may produce irritation, redness and swelling of eyelids, pain on exposure to light, and severe eye damage. If molten, 2,4-dinitrotoluene can cause thermal burns. Ingestion of alcohol at time of exposure can increase an individual's susceptibility to toxicity.

Chronic Effects: Repeated or prolonged exposure to DNT may cause anemia (a deficiency in red blood cells, hemoglobin, or both). 2,4-Dinitrotoluene affects the liver's drug-metabolizing enzymes and is a liver mutagen and carcinogen in rodents.

FIRST AID *Emergency personnel should protect against contamination.*

Eyes: Gently lift 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. Rinse with flooding amounts of water for at least 15 min. Wash entire body from head to foot with soap and water. Pay special attention to the hair, scalp, finger and toenails, nostrils, and ear canals. Repeat skin cleansing if the methemoglobin concentration appears to rise after 3 to 4 hr. Carefully dispose of contaminated clothing.

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

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Consult a poison control center. Unless otherwise advised, 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: Determine the methemoglobin concentration in the blood every 3 to 6 hr. Urine excretion of dinitrotoluene in excess of 25 mg/L of urine indicates significant absorption. Consider giving intravenously 10 mL of 1% methylene blue solution at or below a 2-mL/min rate for victims with methemoglobin levels above 20%. Watch patient for 48 hr after apparent recovery to detect relapsing cyanosis and advanced anemia.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources—no flames, flares, or smoking in hazard area. Cleanup personnel should wear fully encapsulating vapor-protective clothing for spills with no fire. Use a water spray to reduce vapors. For small spills, carefully place in suitable, clean, dry containers (steel drums are preferred). Remove containers from area. For large spills, flush area with hot water to remove solid DNT and contain any liquid runoff. Cool and settle solid for disposal in steel drums. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Transport: DNT released into water absorbs slightly to sediments and suspended solids with an estimated half-life of 438 days. When released into the atmosphere, DNT has an estimated half-life of 8 hr.

Soil Absorption/Mobility: DNT is slightly mobile in soil.

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): No. U105

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 10 lb (4.54 kg) [* per RCRA, Sec. 3001, Clean Water Act, Sec. 311(b)(4), and 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 face shields (8-in. minimum), 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 MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for 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.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, cleaning, and convenient, sanitary storage areas.

Other: Wear chemically protective gloves, boots, aprons, and gauntlets (butyl rubber is the most effective material for protective clothing) to prevent all skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL (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. Separate contaminated clothing so that personnel who handle, dispose of, or clean it have no direct contact with it. 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 area away from incompatibles. DNT is normally stored as a molten liquid; be sure to keep hot water coils lower than 194 °F (90 °C).

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control the airborne contaminants and to maintain concentrations at the lowest possible level. Totally enclosed equipment systems are preferred. Be aware of mist escaping from hot charges, leaking lines, steaming operations, and hot drainage ditches because they are sources of serious skin exposure and worker environment contamination.

Administrative Controls: Suggested measures of protection include respiratory protection, job rotation, exposure time limitations, and use of protective clothing and whole body protection. Consider preplacement and periodic medical examinations of exposed workers that include blood and urine analysis, and liver function tests.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Dinitrotoluenes, solid; Dinitrotoluenes, molten
IMO Hazard Class: 6.1; 6.1
ID No.: UN1600; UN2038
IMO Label: Poison; Poison
IMDG Packaging Group: II; II

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 126, 127, 136, 139, 140, 142, 148, 149, 153, 159, 162, 163, 164

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 469
Fuel Oil No. 2

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

Fuel Oil No. 2 Description: A mixture of petroleum hydrocarbons; a distillate of low sulfur content. Fuel oil no. 2 resembles kerosine. Used as a general-purpose domestic or commercial fuel in atomizing-type burners; as a fuel for trucks, ships and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.
Other Designations: CAS No. 68476-30-2, diesel oil.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R 1
I -
S 2
K 2

NFPA

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

Cautions: Fuel oil No. 2 is a skin irritant and central nervous system depressant with high mist concentrations. It is an environmental hazard and a dangerous fire hazard when exposed to heat, flame, or oxidizers.

Section 2. Ingredients and Occupational Exposure Limits

Fuel oil No. 2*

1989 OSHA PEL	**1990-91 ACGIH TLV**	**1988 NIOSH REL**	**1985-86 Toxicity Data†**
None established	None established	None established	Rat, oral, LD$_{50}$: 9 g/kg; produces gastrointestinal effects (hypermotility, diarrhea)

* A complex mixture (<95%) of paraffinic, olefinic, naphthenic, and aromatic hydrocarbons; sulfur content (<0.5%); and benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)].
† Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 363 to 634 °F (184 to 334 °C)
Viscosity: 268 centistoke at 100 °F (37.8 °C)
Specific Gravity: 0.8654 at 59 °F (15 °C)
Appearance and Odor: Brown, slightly viscous liquid.

Water Solubility: Insoluble
Pour Point:* <21 °F (-6 °C)

*Pour point is the lowest temperature at which a liquid flows from an inverted test container.

Section 4. Fire and Explosion Data

Flash Point: 100 °F (38 °C) min.	**Autoignition Temperature:** 494 °F (257 °C) **LEL:** 0.6% v/v	**UEL:** 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, foam, water fog or spray. Do not use a forced water spray directly on burning oil since this scatters the fire. Use a smothering technique to extinguish fire.
Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. This fuel oil's volatility is similar to gasoline's.
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 pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to health and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Fuel oil no. 2 is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Incompatible with strong oxidizing agents; heating greatly increases fire hazard.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of fuel oil no. 2 yields various hydrocarbons and hydrocarbon derivatives and partial oxidation products including carbon dioxide, carbon monoxide, and sulfur dioxide.

Section 6. Health Hazard Data

Carcinogenicity: Although it has not assigned an overall evaluation to fuel oil No. 2, the IARC has evaluated distillate (light) fuel oils as not classifiable as human carcinogen (Group 3; animal evidence limited).
Summary of Risks: Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, stupor, convulsions, or unconsciousness, depending on concentration and time of exposure. Since intestinal absorption of longer chain hydrocarbons is lower than absorption from lighter fuels, a lesser degree of systemic effects and more diarrhea may result. When removed from exposed area, affected persons usually experience complete recovery. Hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result if oil is aspirated into the lungs. These results are more likely when vomiting after ingestion rather than upon ingestion, as is often the case with lower viscosity fuels. A comparative ratio of oral-to-aspirated lethal doses may be 1 pt vs. 5 ml. Prolonged or repeated skin contact may cause irritation of the hair follicles and may block the sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Central nervous system (CNS), skin, and mucous membranes.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: Systemic effects from ingestion include gastrointestinal (GI) irritation, vomiting, diarrhea, and, in severe cases, CNS depression, progressing to coma and death. Inhalation of aerosol or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish coloration of the skin and mucous membranes caused by deficient blood oxygenation).
Chronic Effects: Repeated contact with the skin causes dermatitis.

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. If large areas of the body are exposed or if irritation persists, get medical help immediately. 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, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Fuel oil no. 2 is an environmental hazard. Report large spills.
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 261.21): Ignitable waste
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

Air Contaminant (29 CFR 1910.1000, Subpart Z): 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).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with mist filter and organic vapor cartridge. 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 that promote worker safety and productivity. 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: Use and storage conditions should be suitable for an OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in areas of storage or use.
Engineering Controls: Avoid prolonged skin contact and vapor or mist inhalation. Use only in a well-ventilated area with personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Fuel oil

DOT Hazard Class: Combustible liquid

ID No.: NA1993

DOT Label: None

DOT Packaging Exceptions: 173.118a

DOT Packaging Requirements: None

MSDS Collection **References:** 1, 6, 7, 12, 73, 84, 103, 126, 127, 132, 133, 136, 143
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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Material Safety Data Sheets Collection:

Sheet No. 467
Automotive Gasoline, Lead-free

Issued: 10/81 Revision: A, 9/91

Section 1. Material Identification

Automotive Gasoline, Lead-free, Description: A mixture of volatile hydrocarbons composed mainly of branched-chain paraffins, cycloparaffins, olefins, naphthenes, and aromatics. In general, gasoline is produced from petroleum, shale oil, Athabasca tar sands, and coal. Motor gasolines are made chiefly by cracking processes, which convert heavier petroleum fractions into more volatile fractions by thermal or catalytic decomposition. Widely used as fuel in internal combustion engines of the spark-ignited, reciprocating type. Automotive gasoline has an octane number of approximately 90. A high content of aromatic hydrocarbons and a consequent high toxicity are also associated with a high octane rating. Some gasolines sold in the US contain a minor proportion of tetraethyllead, which is added in concentrations not exceeding 3 ml per gallon to prevent engine "knock." However, methyl-tert-butyl ether (MTBE) has almost completely replaced tetraethyllead.

Other Designations: CAS No. 8006-61-9, benzin, gasoline, gasolene, motor spirits, natural gasoline, petrol.

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

R 1
I 2
S 2*
K 4
* Skin absorption

NFPA
3
1 0
-

HMIS
H 2
F 3
R 1
PPG†
† Sec. 8

Cautions: Inhalation of automotive gasoline vapors can cause intense burning in throat and lungs, central nervous system (CNS) depression, and possible fatal pulmonary edema. Gasoline is a dangerous fire and explosion hazard when exposed to heat and flames.

Section 2. Ingredients and Occupational Exposure Limits

Automotive gasoline, lead-free*

1990 OSHA PELs
8-hr TWA: 300 ppm, 900 mg/m^3
15-min STEL: 500 ppm, 1500 mg/m^3

1990-91 ACGIH TLVs
TWA: 300 ppm, 890 mg/m^3
STEL: 500 ppm, 1480 mg/m^3

1990 NIOSH REL
None established

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 900 ppm/1 hr; toxic effects include sense organs and special senses (conjunctiva irritation), behavioral (hallucinations, distorted perceptions), lungs, thorax, or respiration (cough)
Human, eye: 140 ppm/8 hr; toxic effects include mild irritation
Rat, inhalation, LC_{50}: 300 g/m^3/5 min

* A typical modern gasoline composition is 80% paraffins, 14% aromatics, and 6% olefins. The mean benzene content is approximately 1%. Other additives include sulfur, phosphorus, and MTBE.
† See NIOSH, *RTECS* (LX3300000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Initially, 102 °F (39 °C); after 10% distilled, 140 °F (60 °C); after 50% distilled, 230 °F (110 °C); after 90% distilled, 338 °F (170 °C); final boiling point, 399 °F (204 °C)
Vapor Density (air = 1): 3.0 to 4.0
Density/Specific Gravity: 0.72 to 0.76 at 60 °F (15.6 °C)
Water Solubility: Insoluble

Appearance and Odor: A clear (gasoline may be colored with dye), mobile liquid with a characteristic odor recognizable at about 10 ppm in air.

Section 4. Fire and Explosion Data

Flash Point: -45 °F (-43 °C)	**Autoignition Temperature:** 536 to 853 °F (280 to 456 °C)	**LEL:** 1.3% v/v	**UEL:** 6.0% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or alcohol foam as extinguishing media. Use of water may be ineffective to extinguish fire, but use water spray to knock down vapors and to cool fire-exposed drums and tanks to prevent pressure rupture. Do not use a solid stream of water since it may spread the fuel.

Unusual Fire or Explosion Hazards: Automobile gasoline is an OSHA Class IB flammable liquid and a dangerous fire and explosion hazard when exposed to heat and flames. Vapors can flow to an ignition source and flash back. Automobile gasoline can also react violently with oxidizing agents.

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 pressure-demand or positive-pressure mode, and full protective clothing. When the fire is extinguished, use nonsparking tools for cleanup. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Automotive gasoline is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Automotive gasoline can react with oxidizing materials such as peroxides, nitric acid, and perchlorates.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of automotive gasoline can produce oxides of carbon and partially oxidized hydrocarbons.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC list gasoline as a possible human carcinogen (Group 2B). Although the IARC has assigned an overall evaluation to gasoline, it has not assigned an overall evaluation to specific substances within this group (inadequate human evidence).
Summary of Risks: Gasoline vapors are considered moderately poisonous. Vapor inhalation can cause central nervous system (CNS) depression and mucous membrane and respiratory tract irritation. Brief inhalations of high concentrations can cause a fatal pulmonary edema. Reported responses to gasoline vapor concentrations are: 160 to 270 ppm causes eye and throat irritation in several hours; 500 to 900 ppm causes eye, nose, and throat irritation, and dizziness in 1 hr; and 2000 ppm produces mild anesthesia in 30 min. Higher concentrations are intoxicating in 4 to 10 minutes. If large areas of skin are exposed to gasoline, toxic amounts may be absorbed. Repeated or prolonged skin exposure causes dermatitis. Certain individuals may develop hypersensitivity. Ingestion can cause CNS depression. Pulmonary aspiration after ingestion can cause severe pneumonitis. In adults, ingestion of 20 to 50 g gasoline may produce severe symptoms of poisoning.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eye, respiratory and central nervous systems.
Primary Entry Routes: Inhalation, ingestion, skin contact.
Acute Effects: Acute inhalation produces intense nose, throat, and lung irritation; headaches; blurred vision; conjunctivitis; flushing of the face; mental confusion; staggering gait; slurred speech; and unconsciousness, sometimes with convulsions. Ingestion causes inebriation (drunkenness), vomiting, dizziness, fever, drowsiness, confusion, and cyanosis (a blue to dark purplish coloration of skin and mucous membrane caused by lack of oxygen). Aspiration causes choking, cough, shortness of breath, increased rate of respiration, excessively rapid heartbeat, fever, bronchitis, and pneumonitis. Other symptoms following acute exposure include acute hemorrhage of the pancreas, fatty degeneration of the liver and kidneys, and passive congestion of spleen.
Chronic Effects: Chronic inhalation results in appetite loss, nausea, weight loss, insomnia, and unusual sensitivity (hyperesthesia) of the distal extremities followed by motor weakness, muscular degeneration, and diminished tendon reflexes and coordination. Repeated skin exposure can cause blistering, drying, and lesions.

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 as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Give conscious victim a mixture of 2 tablespoons of activated charcoal mixed in 8 oz of water to drink. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Use nonsparking tools. Take up small spills with sand or other noncombustible adsorbent. Dike storage areas to control leaks and spills. Follow applicable OSHA regulations (29 CFR 1910.120).
Aquatic Toxicity: Bluegill, freshwater, LC_{50}, 8 ppm/96 hr.
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 261.21): Characteristic of ignitability
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. There are no specific NIOSH recommendations. However, for vapor concentrations not immediately dangerous to life or health, use chemical cartridge respirator equipped with organic vapor cartridge(s), or a supplied-air 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 prolonged or repeated skin contact. Materials such as neoprene or polyvinyl alcohol provide excellent/good resistance for protective clothing. **Note:** Resistance of specific materials can vary from product to product.
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: 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 containers in a cool, dry, well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. Avoid direct sunlight. Storage must meet requirements of OSHA Class IB liquid. Outside or detached storage preferred.
Engineering Controls: Avoid vapor inhalation and skin or eye contact. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Indoor use of this material requires explosion-proof exhaust ventilation to remove vapors. Only use gasoline as a fuel source due to its volatility and flammable/explosive nature. Practice good personal hygiene and housekeeping procedures. Wear clean work clothing daily.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Gasoline (*including casing-head and natural*)
DOT Hazard Class: Flammable liquid
ID No.: UN1203
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Gasoline
IMO Hazard Class: 3.1
ID No.: UN1203
IMO Label: Flammable liquid
IMDG Packaging Group: II

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146, 153, 159
Prepared by: M Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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Material Safety Data Sheets Collection:

Sheet No. 30A
Hydrochloric Acid
Issued: 10/77 Revision: C, 9/92 Erratum: 5/93

Section 1. Material Identification 41

Hydrochloric Acid (HCl) Description: An aqueous solution of hydrogen chloride. Derived by dissolving hydrogen chloride gas in water at various concentrations. Hydrochloric acid is also formed as a byproduct from oxychlorination and/or oxyhydrochlorination of organic materials. Used in metal pickling and cleaning (boiler and heat exchange equipment scale removal), ore reduction, processing (corn syrup, hydrolyzing starch), dye and dye intermediate production, electroplating, leather tanning, in fertilizer, artificial silk, and paint pigment production, refining soaps and edible fats and oils, petroleum extraction, toilet bowl cleaners; as an alcohol denaturant, a chemical intermediate and solvent in organic synthesis, and in the photographic, textile, and rubber industries.
Other Designations: CAS No. 7647-01-0, Caswell No. 486, chlorohydric acid, Muriatic acid, spirits of salt.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Hydrochloric acid is highly corrosive and causes serious skin and eye burns as well as acute and chronic respiratory problems.

R 1
I 4
S 4
K 0

NFPA

HMIS
H 2*
F 0
R 0
PPE†
* Chronic effects
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Hydrochloric acid; ~38% (commercial), 20% ("azeotrope"). Trace impurities include ammonia, arsenic, iron, sulfate, free Cl-, and heavy metals.

1991 OSHA PEL
Ceiling: 5 ppm (7 mg/m^3)

1990 IDLH Level
100 ppm

1990 NIOSH REL
Ceiling: 5 ppm (7 mg/m^3)

1992-93 ACGIH TLV
Ceiling: 5 ppm (7.5 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 5 ppm (7 mg/m^3)
Category 1: local irritants
Peak Exposure Limit: 10 ppm, 5 min momentary value/8 per shift

1985-86 Toxicity Data*
Human, inhalation, LC_{Lo}: 1300 ppm/30 min; toxic effects not yet reviewed
Rabbit, oral, LD_{50}: 900 mg/kg; toxic effects not yet reviewed
Rat, inhalation, TC_{Lo}: 450 mg/m^3/1 hr (1 day prior to pregnancy) produced fetotoxicity (except death) & specific developmental abnormalities (homeostasis).
Rabbit, eye: 100 mg rinse caused mild irritation.

*See NIOSH, *RTECS* (MW4025000), for additional irritation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: -120.64 °F (-84.8 °C)*
Vapor Pressure: 4 atm at 64 °F (17.8 °C)
Vapor Density (Air = 1): 1.257
Surface Tension: 23 at 244.68 (118.16 °C)
Molecular Weight: 36.46
Odor Threshold: 0.1 to 5 ppm
Ionization Potential: 12.74 eV

Freezing Point: 1.1 °F (-17.14 °C) for 10.81%, -51.16 °F (-46.2 °C) for 31.24%
Density: 1.194 at -14.8 °F (-26 °C)
Water Solubility: Soluble, 823 g/L at 32 °F (0 °C); 561 g/L at 140 °F (60 °C).
Other Solubilities: Soluble in alcohol, benzene, and ether; insoluble in hydrocarbons.
pH: 1N (0.1), 0.1N (1.1), 0.01N (2.02), 0.001N (3.02), 0.0001N (4.01)
Refraction Index (1N solution): 1.34168 at 64.4 °F (18 °C/D)

Appearance and Odor: Colorless liquid that fumes in air and has a strong pungent odor. Can be slightly yellow from traces of iron, chlorine, or organic matter. Forms a constant boiling azeotrope at 20 % HCl, 108.58 °C and 760 mm Hg.

* Decomposes at 3239.6 °F (1782 °C).

Section 4. Fire and Explosion Data

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

Extinguishing Media: Use extinguishing agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: *Extreme heat or contact with many metals liberates hydrogen gas which has explosion limits of 4 to 75%.
Special Fire-fighting Procedures: Because 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. Structural firefighter's protective clothing is *ineffective* for fires involving hydrochloric acid. Stay away from ends of tanks. Cool tanks with water spray until well after fire is out. *Do not* release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Hydrochloric acid has high thermal stability (decomposes at 3239.6 °F/1782 °C). Hazardous polymerization does not occur unless exposed to aldehydes or epoxides.
Chemical Incompatibilities: Polymerizes on contact with aldehydes or epoxides; attacks most metals (except mercury, silver, gold, platinum, tantalum, and some alloys), some plastics, rubber, and coatings; reacts explosively with alcohols + hydrogen cyanide, potassium permanganate, tetraselenium tetranitride; ignites on contact with fluorine, hexalithium disilicide, metal acetylides or carbides (cesium acetylide, rubidium acetylide); and is incompatible with acetic anhydride, 2-amino ethanol, ammonium hydroxide, calcium phosphide, chlorosulfonic acid, 1,1-difluoroethylene, ethylene diamine, ethylene imine, oleum, perchloric acid, ß-propiolacetone, propylene oxide, sodium hydroxide, silver perchlorate + carbon tetrachloride, sulfuric acid, uranium phosphide, acetate, calcium carbide, magnesium bromide, mercuric sulfate, and chlorine + dinitroaniline.
Conditions to Avoid: Avoid contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of HCl produces toxic chloride fumes and explosive hydrogen gas.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list HCl as a carcinogen.
Summary of Risks: HCl is a highly corrosive liquid and depending on concentration and duration of exposure, symptoms range from irritation to ulcerations and permanent injury. **Target Organs:** Eyes, skin, respiratory tract, and liver (in animals). **Primary Entry Routes:** Inhalation, skin and eye contact. **Medical Conditions Aggravated by Long-Term Exposure:** Respiratory disorders.

Continue on next page

Section 6. Health Hazard Data, *continued*

Acute Effects: Inhalation of vapors or mists is corrosive to the respiratory tract and can cause tracheal and bronchial epithelium necrosis (tissue death), cough, choking, ulceration. Liquid aspiration can cause pulmonary edema, lung collapse, emphysema and damage to the pulmonary blood vessels. Skin contact with HCl solutions causes burns and ulcerations. Permanent eye damage may result from splashes. Ingestion is unlikely but if it occurs, symptoms include gray tongue color, corrosion of mucous membranes, esophagus, and stomach, nausea, vomiting, intense thirst, diarrhea, difficulty swallowing, circulatory collapse and possible death. **Chronic Effects:** Repeated or prolonged exposure can cause dermatitis, conjunctivitis, gastritis, photosensitization, tooth erosion, and repeated exposure to mists from heated-metal pickling solutions can cause nose and gum bleeds, ulceration of oral or nasal mucosa, and "renders facial skin so tender that shaving is painful."(133)

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift 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. Treat skin with a 5% triethanolamine solution. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting!

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

Note to Physicians: Consider a chest x-ray in acute overexposure.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Neutralize spills with crushed limestone, soda ash, lime, or sodium bicarbonate. After neutralizing, take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for disposal; flush large spills to containment area and reclaim (if possible) or await disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** In soil, HCl will infiltrate moving faster in the presence of moisture. It may dissolve some soil matter, particularly those of a carbonate base will be neutralized to some degree and will be transported to groundwater. **Ecotoxicity Values:** Chronic plant toxicity = 100 ppm; injurious to irrigatable crops at 350 mg/L; trout, LC_{100}, 10 mg/L/24 hr shrimp, LC_{50}, 100 to 330 ppm/starfish, LC_{50}, 100 to 330 mg/L/48 hr; shore crab, LC_{50}, 240 mg/L/48 hr. **Disposal:** Neutralize to between 5.5 & 8.5 before 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 261.23, *0.01N solution or higher*): No. D002, Characteristic of corrosivity
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 5000 lb (2270 kg) [* per CWA, Sec. 311 (b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 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 chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because 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 MSHA/NIOSH-approved respirator. For < 50 ppm, use a cartridge respirator with acid gas cartridges, or any supplied-air respirator (SAR) or SCBA. For < 100 ppm, use any chemical cartridge respirator with a full facepiece and cartridge that protects against HCl inhalation, or any SAR or SCBA with a full facepiece. 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.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polycarbonate, butyl rubber, polyvinyl chloride, and chlorinated polyethylene are recommended materials for PPE. Polyvinyl alcohol is not recommended. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because 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: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area on a cement floor away from direct sunlight and heat sources. Use decanting pumps or pouring frames to minimize spillage during loading and unloading operations.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. HCl should be manufactured in closed systems. Pay close attention to leak detection. Aqueous scrubbers are used to control hydrogen chloride emissions from vent stacks and other sources. Workers shouldn't enter tanks previously containing HCl until they have been cleaned.

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the eyes, skin, and respiratory tract. Pulmonary function tests (FEV, FVC) are useful in determining lung disorders. Conduct difficult operations in fume hoods.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Hydrochloric acid, solution
DOT Hazard Class: 8
ID No.: UN1789
DOT Label: Corrosive
DOT Packing Group: II
Special provisions (172.102): A3, A6, B2, B15, N41, T9, T27

Packaging Authorizations
a) **Exceptions:** 173.154
b) **Non-bulk Packaging:** 173.202
c) **Bulk Packaging:** 173.242

Quantity limitations
a) **Passenger, Aircraft, or Railcar:** 1 L
b) **Cargo Aircraft Only:** 30 L

Vessel Stowage Requirements
a) **Vessel Stowage:** C
b) **Other:** 8

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 180

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD

Material Safety Data Sheet
from Genium's Reference Collection

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GENIUM PUBLISHING CORP.

No. 674

ISOBUTYLENE

Issued: November 1988

SECTION 1. MATERIAL IDENTIFICATION 27

Material Name: ISOBUTYLENE

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NFPA

Description (Origin/Uses): Obtained from refinery steams by absorption on 65% sulfuric acid (H_2SO_4) at 59°F (15°C). Used primarily to produce diisobutylene, trimers, butyl rubber, and other polymers; also used to produce antioxidants for foods, plastics, and packaging food supplements.

Other Designations: Isobutene; 2-Methylpropene; *gamma*-Butylene; $CH_2{=}C(CH_3)_2$; CAS No. 0115-11-7

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

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F 4
R 0
PPG*
*See sect. 8

R 1
I 1
S 1
K 4

SECTION 2. INGREDIENTS AND HAZARDS	%	EXPOSURE LIMITS
Isobutylene, CAS No. 0115-11-57 *Monitor NIOSH, *RTECS* (UD0890000), for additional data.	Ca 100	**OSHA PEL** None Established **ACGIH TLV, 1988-89** None Established **NIOSH REL** None Established **Toxicity Data*** Rat, Inhalation, LC_{50}: 620 g/m^3 (4 Hrs) Mouse, Inhalation, LC_{50}: 415 g/m^3 (2 Hrs)

SECTION 3. PHYSICAL DATA

Boiling Point: -19.6°F (-6.9°C)
Melting Point: -220°F (-140°C)
Vapor Density (Air = 1): 1.9
Specific Gravity (H_2O = 1): Ca 0.6

Molecular Weight: 56 Grams/Mole
Solubility in Water (%): Insoluble*
% Volatile by Volume: 100

Appearance and Odor: A colorless, extremely flammable gas; odor not listed.

*Isobutylene is very soluble in alcohol, ether, and sulfuric acid.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point*	Autoignition Temperature: 869°F (465°C)	LEL: 1.8% v/v	UEL: 9.6% v/v

Extinguishing Media: Isobutylene gas is an extremely flammable gas that has a substantial explosive air-gas range. For isobutylene fires, the recommended fire-fighting technique is to stop the flow of gas instead of extinguishing the fire. If the flames are extinguished and the isobutylene gas continues to escape or leak, an explosive air-gas mixture can form quickly and ignite without warning. A resulting explosion could cause greater damage than that which would be caused by allowing the fire to burn itself out. If the fire must be extinguished to allow safe access to shutoff valves, recommended extinguishing agents include CO_2 and dry chemical. **Unusual Fire or Explosion Hazards:** In many cases, the preferred strategy is to allow the flames to continue to burn and to cool the surroundings with water spray to prevent ignition of nearby combustibles. Isobutylene gas is heavier than air and can collect in low-lying, confined spaces. Potentially explosive air-gas mixtures are especially likely to build up in such an area, so enter it with extreme caution whether or not it is presently involved in a fire. Possible sources of ignition must not be brought into any area suspected of containing substantial concentrations of isobutylene 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.

* Sax (Genium ref. 6) reports a flash point of -105°F (-76°C) for isobutylene.

SECTION 5. REACTIVITY DATA

Stability/Polymerization: Isobutylene is stable in closed, pressurized containers during routine operations at room temperature. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Isobutylene can react dangerously with strong oxidizing materials. **Conditions to Avoid:** Prevent exposing isobutylene to any source of ignition such as an open flame, sparks, lighted tobacco products, or steam lines. **Hazardous Products of Decomposition:** Isobutylene fires can produce toxic gases such as carbon monoxide (CO) or lower-molecular-weight hydrocarbons. **Comments:** The extreme flammability of isobutylene means that any reactions involving this material, including nonhazardous ones, must be performed carefully in order to prevent fires and/or explosions.

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Isobutylene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Isobutylene is a simple asphyxiant. As such it will not cause significant physiological responses, but it can displace the minimum required atmospheric oxygen level. Significant displacement by isobutylene results in an oxygen-deficient atmosphere with no adequate warning properties. Asphyxiation fatalities can occur especially in confined, low-lying, poorly ventilated spaces because isobuty-

SECTION 6. HEALTH HAZARD INFORMATION, cont.

lene gas is almost twice as dense as air itself (see sect. 3). **Medical Conditions Aggravated by Long-Term Exposure**: None reported. **Target Organs:** None reported. **Primary Entry:** Inhalation. **Acute Effects:** Initial symptoms of the effects of simple asphyxiant gases are rapid respiration and air hunger, diminished mental alertness, and impaired muscular coordination. Continuing lack of oxygen causes faulty judgment, depression of all sensations, rapid fatigue, and emotional instability. As the asphyxia continues, nausea; vomiting; prostration; loss of consciousness; and, finally, convulsions; deep coma; and death can occur. **Chronic Effects:** None reported. **FIRST AID: Inhalation.** Would-be rescuers need to be concerned about their own safety when entering confined, poorly ventilated, oxygen-deficient areas. Self-contained breathing equipment must be readily available for rescuers. Station standby workers outside the immediate area so that they can summon additional help if it is needed. 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. **Comments:** The extreme flammability of isobutylene gas warrants special attention even during rescue operations. Rescue personnel must not smoke. All emergency lamps and floodlights that must be lowered into enclosed areas for rescue operations must be explosion proof. Obtain this equipment before any emergency occurs and make it accessible to emergency-response personnel. **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 isobutylene gas leak as an emergency.* If the leaking gas has not yet ignited, use water spray to direct flammable gas-air mixtures away from sources of ignition. Extinguish all sources of ignition as quickly as possible; however, if the leaking gas is burning, do not attempt to extinguish the flames until the source of the isobutylene gas is located and sealed. Otherwise, flammable isobutylene gas-air mixtures can explode without warning and cause widespread damage that might not have occurred if the original fire had been allowed to burn itself out. If it is necessary to extinguish isobutylene flames in order to gain access to a shutoff valve, use dry chemical or carbon dioxide as extinguishing agents. **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): Not Listed

EPA Designations (40 CFR 302.4): Not Listed

SECTION 8. SPECIAL PROTECTION INFORMATION

Respirator: 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, which lack warning properties; to work in them safely requires that an SCBA be worn. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the lower explosive limit cited in section 4. 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. **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 isobutylene vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store isobutylene in closed, pressurized containers in a cool, dry, well-ventilated area away from sources of ignition, combustible materials, 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, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent static sparks. **Comments:** Isobutylene is an extremely explosive and flammable gas. It must not be exposed to any possible source of ignition in work or storage areas.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Liquefied Petroleum Gas
DOT Hazard Class: Flammable Gas
ID No. UN1055
DOT Label: Flammable Gas
DOT Packaging Requirements: 49 CFR 173.304, .314, .315
DOT Packaging Exceptions: 49 CFR 173.306

IMO Shipping Name: Isobutylene
IMO Hazard Class: 2.1
IMO Label: Flammable Gas

References: 1, 6, 84-94, 116, 117, 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 Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

32

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.

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* 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

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.(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 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 Collection

Malathion **MSDS No. 177**

Date of Preparation: 6/94

Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Malathion
Chemical Formula: $(CH_3O)_2P(S)SCH(COOC_2H_5)CH_2COOC_2H_5$
CAS No.: 121-75-5
Synonyms: carbophos; Cythion; O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate; O,O-dimethyl-S-(1,2-dicarbethoxyethyl) phosphorodithioate; Maldison; mercaptothion
Derivation: Obtained from diethyl maleate and dimethyldithiophosphoric acid. **General Use:** As an insecticide for the control of mosquitoes, flies, spiders, animal ectoparasites, and human head and body lice. **Vendors:** Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Malathion, 99.6 % vol: technical grade; 25% and 50%: wettable powders
Trace Impurities: phosphorothioate and phosphorodithioate; malaoxon (crude grade impurity)

OSHA PELs, *Skin*
8-hr TWA :15 mg/m^3, total dust

Vacated 1989 Final Rule Limit:
8-hr TWA: 10 mg/m^3, total dust
5 mg/m^3, respirable fraction

NIOSH REL, *Skin*
10-hr TWA: 10 mg/m^3

IDLH Level
5000 mg/m^3

DFG (Germany) MAK
Ceiling: 15 mg/m^3, total dust

ACGIH TLVs, *Skin*
TWA: 10 mg/m^3*

* Biological Exposure Index for organophosphorus cholinesterase inhibitors: 70% of individual's baseline.

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Malathion is a colorless (when pure) to light-amber liquid with a skunk-like or garlic odor. It is an anticholinesterase agent and severe intoxication causes profound pulmonary secretions and respiratory distress. Take the necessary precautions to prevent any exposure to malathion. It is absorbed through the skin and may produce systemic effects.

Wilson Risk Scale	
R	1
I	2
S	1*
K	1

* Skin absorption

HMIS	
H	2
F	1
R	1

PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin absorption.
Target Organs: Respiratory system, liver, blood cholinesterase, gastrointestinal tract, and central nervous and cardiovascular systems.
Acute Effects
Severe Intoxication by all Routes: Weakness, general twitching and paralysis, dizziness, confusion, staggering, slurred speech, sweating, irregular or slow heartbeat, convulsions, breathing may stop, and coma. **Inhalation:** Tightness of the chest, wheezing, increased pulmonary secretions, bluish discoloration of skin, small pupils, aching in and behind eyes, blurred vision, tearing, runny nose, headache, and watering of the mouth. **Eye:** Irritation.
Skin: Skin absorption causes sweating and twitching in area of absorption usually within 15 min to 4 hr. Weak skin sensitization and dermatitis may occur at high exposures.
Ingestion: Loss of appetite, nausea, vomiting, abdominal cramps, diarrhea within 2 hr.
Carcinogenicity: IARC, NTP, and OSHA do not list malathion as a carcinogen. IARC designates malathion as Group 3 (not classifiable as to carcinogenicity to humans).
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.
Chronic Effects: Repeated exposure to malathion may make a person more susceptible to the effects of organophosphates.
Comments: Malathion is an anticholinesterase agent which causes the inactivation of the enzyme cholinesterase resulting in the accumulation of acetylcholine at synapses in the neuromuscular system and secretory glands. It is less toxic to humans than most anticholinesterase agents because malathion and its metabolite, malaoxon, are metabolized in the liver to an inactive form. The acute lethal dose is estimated to be somewhat below 1.0 g/kg.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Thoroughly wash exposed area with soap and water. Do repeat soap washings. For reddened or blistered skin, consult a physician.

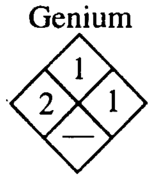
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, *do not* induce vomiting because of possible early onset of respiratory depression and seizures. Consider gastric lavage after control of any seizures.

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

Note to Physicians: Give 5 mg of atropine intravenously. Atropine may induce ventricular fibrillation in the presence of cyanosis. Repeat the dose of atropine at 5- to 10-minute intervals until signs of atropinization appear (dry, flushed skin, tachycardia as high as 140 beats/min, and pupillary dilatation). Repeat the dose of atropine if muscarinic symptoms appear. Maintain a mild degree of atropinization for at least 48 hr. Pralidoxime (2-PAM, Protopam) chloride is a cholinesterase reactivator that complements the action of atropine. For moderate-to-severe cases, give adults 1 to 2 g intravenously at a rate not in excess of 500 mg/min. A second dose of 1 g is indicated if muscle weakness has not been relieved, or if it recurs within 20 min. Pralidoxime chloride is ineffective after aging has occurred. Morphine, aminophyline, and phenothiazines are contraindicated. Depression in red blood cell cholinesterase in excess of 50% activity is generally associated with severe symptoms. Correlation between cholinesterase levels and clinical effects in milder poisonings may be poor. Individuals homozygous for the CHE gene display a defective serum butyrylcholinesterase and are particularly vulnerable to poisoning by organophosphorus insecticides.

Special Precautions/Procedures: Emergency personnel should protect against exposure when rescuing victims.

Section 5 - Fire-Fighting Measures



Flash Point: >325 °F (>163 °C)

Flash Point Method: OC

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Flammability Classification: Class IIIB Combustible Liquid, but may be difficult to ignite.

Extinguishing Media: Small fires: use dry chemical or carbon dioxide. Large fires: use water spray or foam.

Unusual Fire or Explosion Hazards: Containers may explode in the heat of fire.

Hazardous Combustion Products: Sulfur dioxide, phosphoric acid, phosphorus oxides, and carbon monoxide.

Fire-Fighting Instructions: If feasible and without undue risk, move containers from fire hazard area. Otherwise, cool fire-exposed containers with water spray until well after fire is extinguished. Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because 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. Structural firefighters' protective clothing is *not* effective. Wear chemically protective clothing specifically recommended by the manufacturer. Decontaminate equipment and clothing with a chlorine bleach solution.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel of large spills, evacuate all unnecessary personnel, provide adequate ventilation, and remove all heat and ignition sources. Cleanup personnel should protect against exposure. Fully-encapsulating, vapor-protective clothing (polycarbonate, butyl rubber, PVC, nitrile, Neoprene) is recommended.

Small Spills: Take up with sand or noncombustible absorbent material and place into containers for later disposal. For dry spills, scoop up with a clean shovel and place into a clean, dry container for disposal.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Decontaminate equipment and surfaces with an alkaline solution (5% sodium hydroxide).

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid any contact with skin or vapor inhalation. Use only with adequate personal protective equipment and proper ventilation.

Storage Requirements: Store in tightly closed and properly labeled containers in a cool, well-ventilated area. Outdoor or detached storage is preferred. *Do not* store in iron, steel, tin plate, lead, or copper containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)

Administrative Controls: Provide preplacement and periodic medical exam with emphasis on the respiratory system, liver, and blood cholinesterase levels. Biological Exposure Index (BEI): cholinesterase activity in red blood cells (timing is discretionary) is 70% of individual's baseline. Background levels are included in the BEI value. Consider precluding from exposure those

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Material Safety Data Sheets Collection:

Sheet No. 440
Methane

Issued: 7/80 Revision: A, 8/89

Section 1. Material Identification

29

Methane Description: Widely distributed in nature, methane comprises 0.00022% by volume of the earth's atmosphere. American natural gas is mostly methane (85%). At temperatures greater than 2012 °F (1100 °C), pure carbon combines with pure hydrogen to form methane. Above 2732 °F (1500 °C), the amount of methane produced increases with temperature. Obtained from sodium acetate and sodium hydroxide or from aluminum carbide and water. Commercially prepared from natural gas or by fermentation of cellulose and sewage sludge. Constituent of illuminating and cooking gas. Used in the manufacture of hydrogen, hydrogen cyanide, ammonia, acetylene, formaldehyde, and many other organics.
Other Designations: Fire damp; marsh gas; methyl hydride; CH_4; CAS No. 0074-82-8.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R	1
I	-
S	-
K	4

NFPA

HMIS
H 1
F 4
R 0
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Methane, ca 100%*

OSHA PEL	ACGIH TLV, 1988-89	NIOSH REL	Toxicity Data†
None established	None established	None established	Not listed

* Check with your supplier to determine the exact composition of the purchased methane. Possible contaminants are ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}), higher molecular weight alkanes, carbon dioxide (CO_2), nitrogen (N_2), and oxygen(O_2).
† Monitor NIOSH, *RTECS* (PA1490000), for future toxicity data.

Section 3. Physical Data

Boiling Point: -259 °F (161.6 °C)
Vapor Density (Air = 1): 0.544 at 32 °F (0 °C)
Molecular Weight: 16 g/mol
Water Solubility: Slight*
Melting Point: -296.5 °F (-182.5 °C)

Appearance and Odor: A colorless, odorless, tasteless, extremely flammable gas. Commercial methane's trace amounts of a suitable mercaptan compound give it natural gas's familiar rotten egg smell.

*Soluble in alcohol and ether.

Section 4. Fire and Explosion Data

Flash Point: -213 °F (-136.11 °C) | **Autoignition Temperature:** 999 °F (537 °C) **LEL:** 5% v/v* | **UEL:** 15% v/v*

Extinguishing Media: Methane's extreme flammability, extensive explosibility range, and very low flash point represent dangerous fire and explosion risks. *Treat any fire situation involving rapidly escaping and burning methane gas as an emergency.* Extinguish methane fires by shutting off the source of the gas. Use water sprays to cool fire-exposed containers and to protect the personnel attempting to seal the source of the escaping gas.
Unusual Fire or Explosion Hazards: Methane gas is very flammable with an extensive explosibility range. The best fire-fighting technique may be simply to let the burning gas escape from the pressurized cylinder, tank car, or pipelines. Never extinguish the burning gas without first locating and sealing its source. Otherwise, the still leaking gas could explosively re-ignite without warning and cause more damage than if it burned itself out.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

* The loudest methane-air explosions occur when 1 volume of methane is mixed with 10 volumes of air (or 2 volumes of oxygen). **Warning:** Air with more than 14% by volume methane burns *noiselessly*. Methane burns with a pale, faintly luminous, not always easily detected flame.

Section 5. Reactivity Data

Stability/Polymerization: Methane is stable at room temperature in closed, pressurized containers during routine operations. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Genium reference 84 reports that methane can react violently with bromine pentafluoride, chlorine, chlorine dioxide, nitrogen trifluoride, liquid oxygen, and oxygen difluoride.
Conditions to Avoid: Never expose methane to ignition sources such as open flame, lighted cigarettes or pipes, uninsulated heating elements, or electrical or mechanical sparks. Prevent any accidental or uncontrollably rapid release of methane gas from high-pressure cylinders, tank cars, or pipelines.
Hazardous Products of Decomposition: Thermal oxidative degradation of methane can produce carbon dioxide and toxic carbon monoxide (CO).

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists methane as a carcinogen. **Summary of Risks:** As a simple asphyxiant, methane does not cause significant physiological responses, but it can displace the minimum required atmospheric oxygen level. Significant displacement results in an oxygen-deficient atmosphere with no adequate warning properties. Asphyxiation can occur especially in confined, poorly ventilated, undisturbed spaces infrequently entered by workers. Frostbite (cryogenic damage) can result from contact with liquid methane's extremely low temperature. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** None reported. **Primary Entry:** Inhalation. **Acute Effects:** The initial symptoms of simple asphyxiant gases's effects are rapid respiration and air hunger, diminished mental alertness, and impaired muscular coordination. Continuing lack of oxygen causes faulty judgement, depression of all sensations, rapid fatique, emotional instability, nausea, vomiting, prostration, unconsciousness, and finally, convulsions, coma, and death. **Chronic Effects:** None reported.

FIRST AID

Skin: (Liquid methane): Promptly flush the affected area with lots of tepid/lukewarm water to reduce freezing of tissues. Never apply direct heat to frostbitten areas. Loosely apply dry, bulky dressings to protect the area from further injury. Get treatment from qualified medical personnel.

Inhalation: Rescuers must consider their own safety when entering confined, poorly ventilated, oxygen-deficient areas. Self-contained breathing equipment must be readily available. Rescuers must use nonsparking tools and equipment; e.g., floodlights lowered into any incident area must be electrically grounded and bonded, shatter-resistant, and sparkproof. **After first aid, get appropriate in-plant, paramedic, or community medical attention and support for inhalation exposures in oxygen-deficient atmospheres.** Seek prompt medical assistance for further observation and treatment.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a methane spill control and countermeasure plan (SCCP).* When a leak occurs, notify safety personnel, eliminate heat and ignition sources, evacuate unnecessary personnel, provide maximum explosion-proof ventilation, and implement the SCCP. Use only nonsparking tools and equipment. Locate and seal the source of the leaking gas. Use water sprays to protect the personnel attempting this shutoff. Large methane releases can result in spectacular explosions. If attempts to shut off the leaking gas are unsuccessful, evacuate the likely explosion area. **Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations. Remove leaking or defective cylinders to a safe, outside, posted, discharge location. Let the methane gas discharge at a moderate rate. When it is empty, return the cylinder to the supplier after it is properly tagged, labelled, or stenciled MT (empty) or defective.

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

EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Gloves:** To prevent skin contact, workers handling liquid methane should wear appropriate insulating gloves, safety glasses, and splash aprons, as required by the particular work conditions. **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; use self-contained breathing equipment there. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the 5% v/v LEL (Sec. 4). Local exhaust ventilation is preferred since it prevents methane dispersion into the work area by eliminating it at its source (Genium ref. 103). Give special attention to proper ventilation of enclosed areas. **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, washing facilities, fire extinguishers, and oxygen bottles for emergency first-aid. **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:** If appropriate, consider installing automatic sensing equipment that warns workers of oxygen-deficient atmospheres or of potentially explosive air-gas mixtures. All engineering systems in any methane gas storage, handling, or processing area must be explosion-proof so they have no spark potential or hot spots. Pressurized systems must use only approved valves, manifolds, flanges, and flame arrestors. **Comments:** Methane gas presents dangerous fire, explosion, and reactivity risks. Regularly inspect and service all the piping systems which transport methane gas in production and storage areas. Before use, thoroughly test methane lines with nitrogen gas for leaking, especially in enclosed areas.

Section 9. Special Precautions and Comments

Storage Requirements: Store methane in closed, pressurized cylinders, tank cars, pipelines, or other containers in a cool, dry, well-ventilated, fireproof area away from heat and ignition sources and incompatible chemicals (Sec. 5). Protect these containers from physical damage and heat. Shield them from direct sunlight. **Special Handling/Storage:** Electrically ground and bond all containers, tanks, cylinders, tank cars and pipelines used in methane shipping, receiving, or transferring operations. Never smoke in any work area where the possibility of exposure to methane gas (fire hazard) exits. Recommended storage containers include steel.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Methane
DOT Hazard Class: Flammable gas
DOT ID No.: UN1971
DOT Label: Flammable gas
DOT Packaging Requirements: 49 CFR 173.302
DOT Packaging Exceptions: 49 CFR 173.306

IMO Shipping Name: Methane, compressed
IMO Hazard Class: 2.1
IMO Label: Flammable gas

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:** MJ Hardies, MD

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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.

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.

R 1
I 2
S 1*
K 4
* Skin absorption

NFPA
3
1 0
-

HMIS
H 2
F 3
R 0
PPG†
† Sec. 8

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.

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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Material Safety Data Sheets Collection:

Sheet No. 7
Nitric Acid

Issued: 10/88 Revision: D, 9/92

Section 1. Material Identification

Nitric Acid (HNO_3) Description: A solution of nitrogen dioxide in water commercially available in many concentrations. Derived by oxidation of ammonia by catalytic process (heated platinum catalyst); or by direct synthesis, combining atmospheric nitrogen and oxygen in an electric arc (an expensive process, thus largely abandoned). HNO_3 is usually found in conjunction with nitrogen dioxide, which is considered more hazardous. Used in fertilizer production (ammonium nitrate), in photoengraving, steel etching, explosives (TNT, nitroglycerin, trinitrophenol); manufacture of metallic nitrates, sulfuric acid, aqua regia and oxalic acid, jewelry, various dyes and dyestuffs, pharmaceuticals; as a laboratory reagant, in metallurgy (*mainly* as a pickling agent) and the printing industy.
Other Designations: CAS No. 7697-37-2, aqua fortis, aqua regia, azotic acid, engravers nitrate, hydrogen nitrate, red fuming nitric acid (RFNA), white fuming nitric acid (WFNA).
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for suppliers list.

Cautions: Nitric acid is a corrosive, strong oxidizer that causes irritation or severe burns to the skin, eyes, and respiratory tract. Exposures to high levels of the concentrated acid can be fatal. Increases the flammability of combustibles. Use extreme caution when handling HNO_3.

R	2	HMIS			**NFPA**
I	4	H	3*	*Fuming*	0
S	4	F	0	nitric acid	3 1
K	0	R	1		ox
		PPE**			
R	2	HMIS			
I	4	H	3*	*> 40%*	0
S	4	F	0	nitric acid	3 0
K	0	R	1		ox
		PPE**			
R	2	HMIS			
I	3	H	3*	*≤ 40%*	0
S	3	F	0	nitric acid	3 0
K	0	R	0		–
		PPE**			

* Chronic effects ** See Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Nitric acid, various %. Commercially available in nearly all concentrations; most common are 56 and 68%. RFNA (85%), WFNA (97.5%).

1991 OSHA PELs
8-hr TWA: 2 ppm (5 mg/m^3)
15-min STEL: 4 ppm (10 mg/m^3)

1990 IDLH Level
100 ppm

1990 NIOSH REL
8-hr TWA: 2 ppm (5 mg/m^3)
15-min STEL: 4 ppm (10 mg/m^3)

1992-93 ACGIH TLVs
TWA: 2 ppm (5.2 mg/m^3)
STEL: 4 ppm (10 mg/m^3)

1990 DFG (Germany) MAK
2 ppm (5 mg/m^3)
Category I: local irritants
Peak Exposure Limit: 2 ppm
5 min momentary value, 8 per shift

1985-86 Toxicity Data*
Man, unreported route, LD_{Lo}: 110 mg/kg; toxic effects not yet reviewed
Rat, oral, TD_{Lo}: 5275 g/kg administered from 1 to 21 days of pregnancy caused post-implantation mortality and specific developmental abnormalities of the musculoskeletal system.
Rat, inhalation, LC_{50}: 67 ppm (NO_2)/4 hr; toxic effects not yet reviewed

* See NIOSH, *RTECS* [QU5775000 (nitric acid), QU5900000 (RFNA), QU6000000 (WFNA)], for additional reproductive and toxicity data.

Section 3. Physical Data

Boiling Point: 186.8 °F (86 °C)
Melting Point: -43.6 °F (-42 °C)
Vapor Pressure: 67% HNO_3 = 6.8 mm Hg at 68 °F (20 °C); 95 to 98% = 113 at 100.4 °F (38 °C)
Saturated Vapor Density (Air = 1.2 kg/m^3): 1.212 kg/m^3 or 0.0757 lb/ft^3 (67 % HNO_3)
pH: 1

Molecular Weight: 63.02
Density: 1.50269 at 77/39.2 °F (25/4 °C)
Water Solubility: Soluble (releases heat)
Ionization Potential: 11.95 eV

Appearance and Odor: Transparent, clear to yellow, fuming liquid with an acrid, suffocating odor which darkens to a brownish color on aging and exposure to light. "Fuming" nitric acid is red-brown in color.

Section 4. Fire and Explosion Data

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

Extinguishing Media: For small fires (< 40% HNO_3), use dry chemical, carbon dioxide (CO_2), water spray, or regular foam. For large fires, use water spray, fog, or regular foam. For small fires (> 40% HNO_3), use water spray, dry chemical, or soda ash. For large fires, flood area with water (*do not* get inside HNO_3 containers). Apply water from as far a distance as possible.
Unusual Fire or Explosion Hazards: HNO_3 is noncombustible but is an oxidizer which increases fire involving combustibles and can initiate an explosion. It releases flammable hydrogen gas in contact with many metals.
Special Fire-fighting Procedures: Because 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. Structural firefighters' protective clothing is not effective for fires involving nitric acid. Acid-resistant clothing is needed. Apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. *Do not* release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Nitric acid decomposes in air and in contact with light and organic matter. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Nitric acid reacts explosively with combustibles, organics or readily oxidizable materials such as wood, turpentine, metal powder and hydrogen sulfide, carbides, cyanides, and alkalies; causes spattering with strong bases; is corrosive to paper, cloth and most metals (except aluminum, gold, platinum, thorium, and tantalum. Will also attack some forms of plastics, rubber, and coatings. There are at least 150 chemicals and chemical combinations which are incompatible with nitric acid. HNO_3 reacts with water to produce heat and toxic corrosive fumes. Refer to *Genium* references 126 and 159 for further detail. **Conditions to Avoid:** Avoid exposure to moisture, heat, and incompatibles.
Hazardous Decomposition Products: Thermal oxidative decomposition of HNO_3 produces nitrogen peroxide and toxic, irritating nitrogen oxides.

Section 6. Health Hazards Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list nitric acid as a carcinogen.
Summary of Risks: Nitric acid is very corrosive to the skin, eyes, digestive and respiratory tract or any tissue it comes in contact with. 58 to 68% (nitric acid) vapors are moderately irritating and can't be tolerated at high concentrations. 95% (nitric acid) vapors cause severe irritation at very low levels and the liquid causes 2nd and 3rd degree burns on short contact with skin or eyes. Vapor inhalation may cause pulmonary edema (fluid in lungs) leading to death. HNO_3 vapor or mist can slowly corrode teeth when chronically exposed. **Medical Conditions Aggravated by Long-Term Exposure:** Chronic respiratory diseases. **Target Organs:** Eyes, skin, respiratory tract, teeth.

Continue on next page

Section 6. Health Hazard Data, continued

Primary Entry Routes: Inhalation, ingestion, skin and eye contact. **Acute Effects:** Inhalation symptoms may take several hours and include throat and nose irritation, cough, chest pain, difficulty breathing, salivation, giddiness, nausea, muscular weakness, ulceration of nasal mucous membranes, pulmonary edema, and chemical pneumonia. Skin contact is moderately irritating to severely corrosive depending on % of nitric acid. Burns may penetrate deeply causing ulcers. Skin may be stained yellowish brown. Dilute solutions cause irritation and tend to harden the epithelium (outer skin layer) without destroying it. HNO_3 liquid causes yellow discoloration of the eyes and severe burns which may result in permanent damage, i.e., sight loss. Ingestion produces immediate pain and digestive tract burns followed by throat swelling, convulsions, risk of stomach perforation (causing a rigid abdomen) and possible coma. **Chronic Effects:** Repeated inhalation of low concentrations may cause chronic bronchitis, tooth erosion, and/or appetite loss. Repeated exposure to $NO_{(x)}$ such as produced by thermal decomposition of HNO_3 is implicated in chronic lung diseases.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift 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 (*do not force removal if stuck to skin*). Rinse with flooding amounts of water for at least 15 min. Apply a 5% triethanolamine solution to affected area. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute followed by lime milk or milk of magnesia. Do not induce vomiting. *Do not* give sodium bicarbonate or attempt to neutralize the acid.

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

Note to Physicians: Observe for several hours since symptoms such as pulmonary edema may be delayed.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should wear fully-encapsulating vapor-protective clothing. Use water spray to cool and disperse vapor. Keep combustibles away from spilled material. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in dry containers for disposal. For large spill, flush with water to containment area and neutralize with agricultural (slaked) lime, sodium bicarbonate, crushed limestone, soda ash, or lime. Report any release in excess of 1000 lb. Control runoff and dike 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

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 1000 lb

Listed as a RCRA Hazardous Waste (40 CFR 261.22): No. D001, Characteristic of corrosivity

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311(b)(4)]

OSHA Designations

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

Listed as a Process Safety Hazardous Chemical (29 CFR 1910.119), TQ: 500 lb

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because 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 MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For < 50 ppm, use any supplied-air respirator operated in a continuous-flow mode. For < 100 ppm, use any supplied-air respirator or SCBA with a full facepiece. 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.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear acid-proof gloves, boots, aprons, and gauntlets to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because 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: Prevent physical damage to containers. Store in aluminum, stainless steel, or glass containers on a cement floor in a cool, dry, well-ventilated area away from incompatibles (Sec. 5). Dike around storage tanks with large kirbs or stills to retain the acid in event of leakage. Keep neutralization agents on hand and install a fire hydrant in storage area. (See NFPA Code 43A). **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the eyes, skin, respiratory tract and teeth. Pulmonary function tests (FEV< FVC) are helpful. Educate workers about the hazardous properties of nitric acid.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: *, †, ‡, §, ¥, ψ, φ
DOT Hazard Class: 8

ID No.: UN1826 (*†), UN1796 (‡§), UN2031 (¥ψ), UN2032 (φ)
DOT Packing Group: I (†§¥φ), II (*‡ψ)

DOT Packaging Label: Corrosive (*‡¥ψ), Corrosive, Oxidizer (†§), Corrosive, Oxidizer, Poison (φ)
Special Provisions (172.102): B2, T12, T27 (*); T12, T27 (†); B2, T12, T27 (‡); T12, T27 (§); B12, B53, T9, T27 (¥); B2, B12, B53, T9, T27(ψ); 2, B9, B32, B74, T38, T43, T45(φ)

* Nitrating acid mixtures spent, < 50% HNO_3
† Nitrating acid mixtures spent, > 50% HNO_3
‡ Nitrating acid mixtures, < 50% HNO_3
§ Nitrating acid mixtures, > 50% HNO_3
¥ Nitric acid other than red fuming, > 70% HNO_3
ψ Nitric acid other than red fuming, < 70% HNO_3
φ Nitric acid, red fuming.

Packaging Authorizations
a) Exceptions: None
b) Non-bulk Packaging: 173.158 (*†‡§¥ψ), 173.227 (φ)
c) Bulk Packaging: 173.242 (*‡ψ), 173.243 (†§¥), 173.244(φ)

Quantity limitations
a) Passenger Aircraft or Railcar: Forbidden
b) Cargo Aircraft Only: 30L (*‡ψ), 2.5L (†§¥), Forbidden (φ)

Vessel Stowage Requirements
a) Vessel stowage: D
b) Other: 40(*); 40, 66, 89 (†); 40 (‡); 40, 66, 89 (§); 110, 111 (¥); 110, 111 (ψ); 40, 66, 74, 89, 90, 95 (φ)

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 136, 139, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 175
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD

Material Safety Data Sheet

from Genium's Reference Collection

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GENIUM PUBLISHING CORP.

No. 439

NITROBENZENE
(Revision A)
Issued: July 1980
Revised: April 1989

SECTION 1. MATERIAL IDENTIFICATION ¥28

Material: NITROBENZENE

Description (Origin/Uses): Prepared by treating benzene with a mixture of nitric acid (HNO_3) and sulfuric acid (H_2SO_4). Used as an intermediate in the manufacture of aniline and benzidine; also used in some shoe and metal polishes.

Other Designations: Nitrobenzol; Essence of Mirbane; Oil of Mirbane; $C_6H_5NO_2$; CAS No. 0098-95-3

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

Comments: Simultaneous exposure to ethanol aggravates the poisonous effects of exposure to nitrobenzene. Workers must not drink alcoholic beverages before or after their shifts.

2
3 0
-
NFPA

HMIS			
H	3	I	4
F	2	S	2†
R	0	K	2
PPG*		†Absorption risk is high	

Top right of second pair: R 1

*See sect. 8

SECTION 2. INGREDIENTS AND OCCUPATIONAL EXPOSURE LIMITS

Nitrobenzene, ca 100%

OSHA PEL (Skin*)	**ACGIH TLV (Skin*), 1988-89**	**Toxicity Data†**
8-hr TWA: 1 ppm, 5 mg/m^3	TLV-TWA: 1 ppm, 5 mg/m^3	Woman, Oral, TD_{Lo}: 200 mg/kg Rat, Oral, LD_{50}: 640 mg/kg

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

†See NIOSH, *RTECS* (DA6475000), for additional data with references to irritative, reproductive, and mutagenic effects.

SECTION 3. PHYSICAL DATA

Boiling Point: 410 °F (210 °C)
Melting Point: 42.8 °F (6 °C)
Vapor Density (Air = 1): 4.25
Vapor Pressure: <1 Torr
Molecular Weight: 123 g/mol
Solubility in Water (%): Slight
Specific Gravity (H_2O = 1): 1.205 at 59 °F (15 °C)

Appearance and Odor: A colorless to pale yellow oily liquid or bright yellow solid crystals; a distinctive odor of volatile almond oil. Its identification threshold is 4.7 parts per billion (ppb).

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point: 190 °F (88 °C) CC	**Autoignition Temperature:** 900 °F (482 °C)	**LEL:** 1.8% v/v	**UEL:** Not Found

Extinguishing Media: Use dry chemical, "alcohol" foam, carbon dioxide (CO_2), or a water spray to put out fires involving nitrobenzene. Water spray can be used to disperse vapor, to cool fire-exposed containers, and to flush nonignited spills or vapor away from sensitive exposures such as incompatible chemicals or sources of ignition. **Unusual Fire or Explosion Hazards:** Nitrobenzene vapor is more than 4 times heavier than air (see sect. 3); it can flow along surfaces, collect in low-lying, confined areas, reach a distant source of ignition, and flash back to its source. This vapor can easily form an explosive mixture with air, especially if the nitrobenzene is heated (heating will cause more nitrobenzene vapor to be given off). **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: Nitrobenzene is stable in closed containers during routine operations at room temperature. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Nitrobenzene is an oxidizing agent that can react dangerously with reducing agents such as nitric acid (HNO_3); phenol (C_6H_5OH) and aluminum chloride ($AlCl_3$); aniline and glycerine; silver perchlorate ($AgClO_4$); dinitrogen tetroxide (N_2O_4); caustics; and reactive metals such as tin or zinc. **Conditions to Avoid:** Prevent exposure to sources of heat and ignition or to incompatible chemicals. **Hazardous Products of Decomposition:** Thermal oxidative degradation of nitrobenzene can produce toxic gases such as carbon monoxide (CO) and oxides of nitrogen (NO_x).

SECTION 6. HEALTH HAZARD INFORMATION

Carcinogenicity: Nitrobenzene is not listed as a carcinogen by the NTP, IARC, or OSHA.
Summary of Risks: Nitrobenzene is a deadly poison that can be rapidly absorbed through intact skin. It reacts with hemoglobin in the blood to form methemoglobin, which seriously depletes the blood's oxygen-carrying capacity. The onset of even potentially fatal methemoglobinemia is insidious; severe symptoms can be delayed for up to 4 hours. The exposed person may feel well and have no complaints; he or she may exhibit signs of cyanosis such as blue lips, nose, and ears, which are noticeable but not uncomfortable; headache is commonly the first symptom of intoxication and may become more intense as the condition progresses. Workers can be exposed to dangerous levels of this poison without immediately discernible health effects. Cyanosis, anemia, and deleterious effects on the central nervous system (CNS) and the cardiovascular system (CVS) can develop following significant occupational exposure to nitrobenzene. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the heart, liver, and blood. **Target Organs:** Skin, eyes, blood, liver, kidneys, testicles, and CVS. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Symptoms of occupational exposure to nitrobenzene include headache, vertigo, vomiting, nausea, dizziness, anemia, atoxia, shortness of breath, rapid pulse, and irritation of the skin and eyes. Coma and death may ensue. **Chronic Effects:** Chronic exposure produces a reversible anemia. *(cont'd.)*

SECTION 6. HEALTH HAZARD INFORMATION, continued

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.** Completely remove nitrobenzene from the exposed person's body. Immediately remove all clothing and wash the entire body from head to foot with soap and water. Pay special attention to the ear canals, fingernails, toenails, hair, and scalp because they are sources of continuing absorption of this poison. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen to alleviate the headache and general sense of weakness that characterize nitrobenzene intoxication. Keep exposed person warm and at rest until medical help is available. **Ingestion.** Unlikely. If accidental ingestion should occur, have the exposed person drink 1 to 2 glasses of water, then induce vomiting. **Comments:** Do not expose workers with existing heart, liver, or blood disorders to nitrobenzene. Screen prospective employees by testing them for hypersensitivity to hemolytic chemicals such as nitrobenzene. Alcohol ingestion and a heated environment may increase susceptibility. Instruct employees on methemoglobinemia signs and symptoms. **Get in-plant, paramedic, or community medical help for all exposures.** Seek prompt medical assistance for further treatment and support after first aid. **Physician's Note:** Determine the methemoglobin concentration in the blood; repeat this test hourly for at least 24 hr until a definite decline is noted. Repeat thorough skin cleaning if the methemoglobin level rises after 3 or 4 hr. Patients usually return to normal within 24 to 48 hr if all absorption sources are eliminated. Administer oxygen, using intermittent positive-pressure breathing (IPPB) if its available.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Spill/Leak: *Treat accidental bulk releases of nitrobenzene as emergencies.* Prior planning and designing of emergency response routines are necessary. Notify safety personnel, evacuate nonessential personnel, eliminate sources of heat and ignition, and provide adequate explosion-proof ventilation, particularly at floor level (see sect. 4). Cleanup personnel must wear a complete set of personal protective equipment (see sect. 8) to protect the skin and eyes against any contact with this liquid poison or inhalation of its vapor. Shovel, scoop, or vacuum the released nitrobenzene and place it into appropriate containers for disposal. **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

Listed as RCRA Hazardous Waste No. U169 (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [*per CWA, §311(b)(4) and 307(a); and RCRA, §3001]

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), Threshold Planning Quantity (TPQ): 10000 lb

Listed as a SARA Toxic Chemical* (40 CFR 372.65) [*EPA Form R may apply to your facility; see 40 CFR 372.85 for instructions]

SECTION 8. SPECIAL PROTECTION INFORMATION

Goggles: Always wear protective eyeglasses or chemical safety goggles. Where splashing of nitrobenzene 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 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 to prevent any contact of nitrobenzene with your skin. **Ventilation:** Install and operate general and local maximum-explosion-proof ventilation systems powerful enough to maintain airborne concentrations 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 your shoes and equipment. **Comments:** The health effects of nitrobenzene are so dangerous that persons exposed to it should be periodically instructed in safe-handling procedures and in recognizing the symptoms of developing cyanosis (see sect. 6). 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. Avoid all skin contact with this liquid and inhalation of its vapor.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Storage/Segregation: Store nitrobenzene in closed containers in a cool, dry, well-ventilated, low fire-risk area away from incompatible chemicals (see sect. 5) and sources of heat or ignition. Protect these containers from physical damage; shield them from direct sunlight. **Engineering Controls:** Electrically ground and bond all containers and equipment used in shipping, receiving, or sampling operations in production or storage areas to prevent static sparks.

Transportation Data (49 CFR 172.101-2)

DOT Shipping Name: Nitrobenzene, Liquid
DOT Hazard Class: Poison B
DOT ID No.: UN1662
DOT Label: Poison
DOT Packaging Requirements: 49 CFR 173.346
DOT Packaging Exceptions: 49 CFR 173.345

IMO Shipping Name: Nitrobenzene
IMO Hazard Class: 6.1
IMO Label: Poison
IMDG Packaging Group: II

References: 1, 6, 26, 38, 84-94, 100, 116, 118, 119, 122

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. 683
Polychlorinated Biphenyls (PCBs)

Issued: 11/88 Revision: A, 9/92

Section 1. Material Identification

Polychlorinated Biphenyls [$C_{12}H_{10-n}Cl_n$ (n=3, 4, 5)] Description: A class of nonpolar chlorinated hydrocarbons with a biphenyl nucleus (two benzene nuclei connected by a single C-C bond) in which any or all of the hydrogen atoms have been replaced by chlorine. Commercial PCBs are mixtures of chlorinated biphenyl isomers with varying degrees of chlorination. Prepared industrially by the chlorination of biphenyl with anhydrous chlorine in the presence of a catalyst such as ferric chloride or iron filings. Except for limited research and development applications, PCBs have not been produced in the US since 1977. When large quantities of PCBs were manufactured in the US, they were marketed under the tradename Aroclor (Monsanto) and were characterized by four digit numbers. The first two digits indicating biphenyls (12), triphenyls (54), or both (25, 44); the last two digits indicating the weight percent of chlorine. PCBs' thermal stability, nonflammability, and high dielectric capability made them very useful in electrical equipment. Formerly used as additives in hydraulic fluids, heat transfer systems, lubricants, cutting oils, printer's ink, fire retardants, asphalt, brake linings, automobile body sealants, plasticizers, adhesives, synthetic rubber, floor tile, wax extenders, dedusting agents, pesticide extenders, and carbonless reproducing paper. PCBs are still used in certain existing electrical capacitors and transformers that require enhanced electrical protection to avoid heating from sustained electric faults.

R 1
I 4
S 3*
K 1
* Skin absorption

NFPA

HMIS
H 2‡
F 1
R 0
PPE†
† Sec. 8
‡ Chronic Effects

Other Designations: CAS No. 1336-36-3, Aroclor, Clophen, Chlorextol, chlorinated biphenyls, chlorinated diphenyl, chlorinated diphenylene, chloro biphenyl, chloro-1,1-biphenyl, Dykanol, Fenclor, Inerteen, Kaneclor, Montar, Noflamol, Phenoclor, Pyralene, Pyranol, Santotherm, Sovol, Therminol FR-1

Cautions: PCBs are potent liver toxins that may be absorbed through skin. Potentially, chronic or delayed toxicity is significant because PCBs accumulate in fatty tissue and may reasonably be anticipated to be carcinogens. PCBs are a bioaccumulative environmental hazard. When burned, decomposition products may be more hazardous than the PCBs.

Section 2. Ingredients and Occupational Exposure Limits

PCBs, contain various levels of polychlorinated dibenzofurans and chlorinated naphthalenes as contaminants

1991 OSHA PELs, Skin
8-hr TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
8-hr TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

1990 DFG (Germany) MAK, Danger of Cutaneous Absorption
TWA (Chlorodiphenyl, 42% chlorine): 0.1 ppm (1 mg/m^3)
Category III: Substances with systemic effects, onset of effect > 2 hr., half-life > shift length (strongly cumulative)
Short-term Level: 1 ppm, 30 min., average value, 1 per shift

TWA (Chlorodiphenyl, 54% chlorine): 0.05 ppm (0.5 mg/m^3)
Category III: (see above)
Short-term Level: 0.5 ppm, 30 min., average value, 1 per shift

1985-86 Toxicity Data*
Rat, oral, TD: 1250 mg/kg administered intermittently for 25 weeks produced liver tumors.
Mammal, oral, TD_{Lo}: 325 mg/kg administered to female for 30 days prior to mating and from the 1st to the 36th day of gestation produced effects on newborn (stillbirth; live birth index; viability index).

1990 NIOSH REL
TWA (Chlorodiphenyl, 42% chlorine): 0.001 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.001 mg/m^3

1992-93 ACGIH TLVs, Skin *
TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m^3
TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m^3

* These guidelines offer reasonably good protection against systemic intoxication, but may not guarantee that chloroacne won't occur.
† See NIOSH, *RTECS* (TQ1350000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: 644-707 °F (340-375 °C)
Melting Point: 42%: -2.2 °F (-19°C); 54%: 14 °F (-10 °C)
Vapor Pressure: 1 mm Hg at 100 °F (38 °C); 10^{-6} to 10^{-3} mm at 20 °C
Molecular Weight: 188.7 to 398.5
Specific Gravity: 1.3 to 1.8 at 20 °C
Water Solubility: Low solubility (0.007 to 5.9 mg/L)
Other Solubilities: Most common organic solvents, oils, and fats; slightly soluble in glycerol and glycols.

Appearance and Odor: PCBs vary from mobile oily liquids to white crystalline solids and hard non-crystalline resins, depending upon chlorine content.

* Physical and chemical properties vary widely according to degree and to the position of chlorination.

Section 4. Fire and Explosion Data

Flash Point: 286-385 °F (141-196 °C) OC*	**Autoignition Temperature:** 464 °F (240 °C)	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: Use extinguishing media suitable to the surrounding fire. Use dry chemical, foam, carbon dioxide (CO_2), or water spray. Water spray may be ineffective. Use water spray to cool fire-exposed containers or transformers. Do not scatter PCBs with high-pressure water streams. **Unusual Fire or Explosion Hazards:** Combustion products (hydrogen chloride, phosgene, polychlorinated dibenzofurans, and furans) are more hazardous than the PCBs themselves. **Special Fire-fighting Procedures:** Because 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. Approach fire from upwind to avoid highly toxic decomposition products. Structural firefighter's protective clothing will provide *limited* protection. Do not release runoff from fire control methods to sewers or waterways. Dike for later disposal.

* Flash points shown are a range for various PCBs. Some forms do not have flash points.

Section 5. Reactivity Data

Stability/Polymerization: PCBs are very stable materials but are subject to photodechlorination when exposed to sunlight or UV (spectral region above 290 nanometers). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** PCBs are chemically inert and resistant to oxidation, acids, and bases. **Conditions to Avoid:** Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition [1112-1202 °F (600-650 °C)] of PCBs can produce highly toxic derivatives, including polychlorinated dibenzo-para-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), hydrogen chloride, phosgene and other irritants.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) and NTP(169) list PCBs as an IARC probable carcinogen (overall evaluation is 2A; limited human data; sufficient animal data) and NTP anticipated carcinogen, respectively. **Summary of Risks:** PCBs are potent liver toxins that can be absorbed through unbroken skin in toxic amounts without immediate pain or irritation. PCBs have low acute toxicity, but can accumulate in fatty tissue and severe health effects may develop later. Generally, toxicity increases with a higher chlorine content; PCB-oxides are more toxic. The toxic action on the liver also increases with simultaneous exposure to other liver toxins, e.g. chlorinated solvents, alcohol, and certain drugs. Pathological pregnancies (abnormal pigmentations, abortions, stillbirths, and underweight births) have been associated with increased PCB serum levels in mothers; PCBs can be passed in breast milk. PCBs can affect the reproductive system of adults. **Medical Conditions Aggravated by Long-Term Exposure:** Skin, liver, and respiratory disease. **Target Organs:** Skin, liver, eyes, mucous membranes, and respiratory tract. **Primary Entry Routes:** Inhalation, dermal contact, ingestion. **Acute Effects:** Exposure to PCB vapor or mist is severely irritating to the skin, eyes, nose, throat, and upper respiratory tract. Intense acute exposure to high concentrations may result in eye, lung, and liver injury. Systemic effects include nausea, vomiting, increased blood pressure, fatigue, weight loss, jaundice, edema and abdominal pain. Cognitive, neurobehavior and psychomotor impairment and memory loss have also been seen after acute exposure. **Chronic Effects:** Repeated exposure to PCBs can cause chloroacne; redness, swelling, dryness, thickening and darkening of the skin and nails; swelling and burning of the eyes, and excessive eye discharge; distinctive hair follicles; gastrointestinal disturbances; neurological symptoms including headache, dizziness, depression, nervousness, numbness of the extremities, and joint and muscle pain; liver enlargement; menstrual changes in women; and chronic bronchitis. Cancer, primarily liver, is also a possible result of exposure, but data is inconclusive.

FIRST AID **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Rinsing eyes with medical oil (olive, mineral) initially may remove PCB and halt irritation better than water rinsing alone. Gently lift 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. Wash exposed area with soap and water. *Multiple soap and water washings are necessary.* Avoid the use of organic solvents to clean the skin. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** In most cases, accidental PCB ingestion will not be recognized until long after vomiting would be of any value. Never give anything by mouth to an unconscious or convulsing person. Vomiting of the pure substance may cause aspiration. Consult a physician.

Note to Physicians: Monitor patients for increased hepatic enzymes, chloroacne, and eye, gastrointestinal, and neurologic symptoms listed above. Diagnostic tests include blood levels of PCBs and altered liver enzymes.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, provide adequate ventilation, and isolate hazard area. Cleanup personnel should protect against vapor inhalation and skin or eye contact. For small spills, take up with sand or other noncombustible material and place into containers for later disposal. For larger spills, dike far ahead of spill to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** PCBs have been shown to bio-concentrate significantly in aquatic organisms. **Ecotoxicity:** Bluegill, TLm: 0.278 ppm/96 hr. Mallard Duck, LD_{50}: 2000 ppm. **Environmental Degradation:** In general, the persistence of PCBs increases with an increase degree of chlorination. **Soil Absorption/Mobility:** PCBs are tightly absorbed in soil and generally do not leach significantly in most aqueous soil systems. However, in the presence of organic solvents, PCBs may leach rapidly through the soil. Volatilization of PCBs from soil may be slow, but over time may be significant. **Disposal:** Approved PCB disposal methods include: incineration with scrubbing, high-efficiency boilers, landfills, and EPA-approved alternative disposal methods. Each disposal method has various criteria. 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
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 311(b)(4) and 307(a)]

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). Because 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 MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. Minimum respiratory protection should include a combination dust-fume-mist and organic vapor cartridge or canister or air-supplied, depending upon the situation. 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.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. Butyl rubber, neoprene, Teflon, and fluorocarbon rubber have break through times greater than 8 hrs. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because 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 and launder before reuse. Segregate contaminated clothing in such a manner so that there is no direct contact by laundry personnel. Implement quality assurance to ascertain the completeness of the cleaning procedures. Remove this material from your shoes and clean PPE. **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 closed, labelled, container in a ventilated area with appropriate air pollution control equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Inform employees of the adverse health effects associated with PCBs. Limit access to PCB work areas to authorized personnel. Consider preplacement and periodic medical examinations with emphasis on the skin, liver, lung, and reproductive system. Monitor PCB blood levels. Consider possible effects on the fetus. Keep medical records for the entire length of employment and for the following 30 yrs.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Polychlorinated biphenyls
DOT Hazard Class: 9
ID No.: UN2315
DOT Packing Group: II
DOT Label: CLASS 9
Special Provisions (172.102): 9, N81

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 100 L
b) Cargo Aircraft Only: 220 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 34

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 163, 164, 168, 169, 174, 175, 180

Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy MPH, CIH; **Medical Review:** AC Darlington, MD

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Material Safety Data Sheet Collection

Silver **MSDS No. 181**

Date of Preparation: 4/86 Revision: A, 6/94

Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Silver
Chemical Formula: Ag
CAS No.: 7440-22-4
Synonyms: argentum

Derivation: Occurs naturally in sea water (0.01 ppm) and the earth's crust (0.1 ppm). Silver containing ores include argentite, stephanite, polybasite, proustite, pyrargyrite, and cerargyrite. Extraction of silver is essentially as a by-product of copper, lead, or zinc extraction and this accounts for 3/4 of its production. The two main production methods are *slime melting* from electrolytic refining of copper and the *Parkes process* from lead and zinc ores.

General Use: Used in the manufacture of jewelry, tableware, ornaments, mirrors, electrical contacts, batteries, solder; in photography, dental amalgams; as a sterilant, for water purification, and as a coating for the inside of light bulbs (sandwiched between two layers of titanium oxide).

Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Silver, ca 100 % wt. 97.5 % silver + 2.5 % copper = *sterling* silver.

OSHA PEL
8-hr TWA: 0.01 mg/m^3

ACGIH TLV
TWA: 0.1 mg/m^3

NIOSH REL
10-hr TWA: 0.01 mg/m^3

DFG (Germany) MAK
TWA: 0.01 mg/m^3 (total dust)
Category III: Substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:
0.1 mg/m^3, 30 min. average value, 1/shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Silver exists as a hard, brilliant white, malleable metal. It is noncombustible as a solid, but the finely divided powder is flammable. Silver has no known function in man and appears to have low toxicity other than a localized or general bluish-gray pigmentation of the mucous membranes, eyes, and skin due to deposition of silver particles over a period of time. The condition called *argyria* appears to be more of a cosmetic problem than a toxicological concern.

Wilson Risk Scale

R	1
I	4
S	1
K	0

HMIS

H	1*
F	0
R	0

*Chronic effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin and eye contact.

Target Organs: Skin, eyes (especially the conjunctiva), and mucous membranes.

Acute Effects

Inhalation: Heavy exposure of a worker to heated metallic silver vapor for 4 hr caused lung damage and pulmonary edema (fluid in lungs). Diffuse pulmonary fibrosis is also possible.

Eye and Skin: Effects are generally chronic.

Carcinogenicity: IARC, NTP, and OSHA do not list silver as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: The main effect associated with exposure to silver is argyria, a bluish-gray pigmentation of the eyes, skin, and mucous membranes caused by deposition of silver particles. This effect can be either local or generalized. It appears that localized deposition occurs by penetration of fine, metallic particles and that generalized argyria occurs from inhalation or ingestion of silver salts. It is estimated that a gradual intake of 1 to 5g silver will lead to generalized argyria. Generalized argyria appears to be darker in areas exposed to the light. Silver deposition in the respiratory tract may result in a mild chronic bronchitis. Silver polishers exposed for long periods to silver and polishing dusts have developed increased lung densities (shown by x-ray). Argyria of the eyes is not accompanied by vision loss although there may be some difficulty adapting to the dark. There is some evidence for skin absorption; amalgam tattoos (accidental implantation of dental amalgams) caused fatigue, headache, sinusitis, and weight loss. Repeated skin contact may cause allergic contact dermatitis in some individuals.

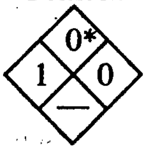
Other: The reason that silver toxicity rarely occurs beyond argyria is due to rapid binding to various proteins and precipitation of silver chloride. Tissue damage only occurs when this binding ability is altered by a heavy dose. Kidney, liver, and neurologic damage has been associated with silver, but these cases are not well documented.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin Contact: *Quickly* remove contaminated clothing. Rinse away loose material and move quickly to a soap and water wash.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *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: Silver deposited in tissues is relatively inert and does not respond well to chelation therapy. There is no known treatment for argyria. Background serum levels of silver vary widely: 0.004 mcg/g to 0.03 mcg/g of blood. Discoloration of Descemet's membrane is the most sensitive indicator of chronic exposure to silver. Background excretion is 8 to 28 nmol/L. In one study, the urinary enzyme, N-acetyl-β-D glucosaminidase was significantly elevated and correlated with blood silver concentrations and age. It may be an indicator of exposure.

Section 5 - Fire-Fighting Measures

Genium



Flash Point: Noncombustible as the solid.
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: None reported.
Hazardous Combustion Products: Silver fumes.
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because 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.
* Flammable when in highly divided powder form.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area. Cleanup personnel should protect against inhalation and skin/eye contact with dusts.
Spills: Carefully scoop up spill and place in sealed containers for reclamation.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Wear appropriate PPE to avoid inhalation or skin/eye contact with silver dusts.
Storage Requirements: Store in a cool, dry, well-ventilated area away from incompatibles (Sec. 10).

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: No special controls needed.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin, eyes, and mucous membranes (for presence of argyria).
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For ≤ 0.25 mg/m^3, use any supplied-air respirator (SAR) operated in continuous-flow mode or any powered, air-purifying respirator with a high-efficiency particulate filter. Use eye protection when necessary. For ≤ 0.5 mg/m^3, use any high-efficiency particulate filter respirator with a full facepiece, any SCBA with a full facepiece, or any SAR with a full facepiece. For ≤ 20 mg/m^3, use any SCBA or SAR (with auxiliary SCBA) with a full facepiece and operated in pressure demand or other positive pressure mode. 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.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Protective Clothing/Equipment: Wear protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.
Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove silver from your shoes and clean personal protective equipment. *Do not* shake dust off contaminated clothing; vacuum with a HEPA filter.

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

Section 9 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Hard, brilliant white, lustrous, ductile, malleable metal; odorless.
Vapor Pressure: 0 mm Hg at 77 °F (25 °C), 100 mm Hg at 3389 °F (1865 °C)
Atomic Weight: 107.868
Density: 10.5 g/mL
Thermal Conductivity: 101 cal/cm/sec/ °C
Water Solubility: Insoluble
Other Solubilities: Insoluble in most cold acids except dilute nitric acid. Reacts with hot, concentrated sulfuric acid. Soluble in fused alkali hydroxides in the presence of air, fused alkali peroxides, and in alkali cyanides in presence of air or oxygen.
Boiling Point: 4013 °F (2212 °C)
Melting Point: 1763 °F (961 °C)

Section 10 - Stability and Reactivity

Stability: Silver is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization does not occur.
Chemical Incompatibilities: Include acetylene and acetylenic compounds (forms explosive silver acetylides), aziridine, bromine azide, 3-bromopropyne, carboxylic acids, copper + ethylene glycol, electrolytes + zinc, ethanol + nitric acid, ethylene oxide, ethyl hydroperoxide, iodoform, ethyleneimine, peroxomonosulfuric acid, and peroxyformic acid. Silver is flammable by chemical reaction with ammonia, chlorine trifluoride, ethylene imine, hydrogen peroxide, oxalic acid, and tartaric acid. It turns black (tarnishes) on contact with ozone, sulfur, or hydrogen sulfide.
Conditions to Avoid: Contact with incompatibles.
Hazardous Decomposition Products: Silver fumes will be given off when heated.

Section 11- Toxicological Information

Toxicity Data:*

Carcinogenicity: Rat, multiple routes: 330 mg/kg/43 weeks (intermittently) caused tumors at site of application.

* See NIOSH, *RTECS* (VW3500000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Sticklebacks, LD_{50} = 0.004 mg/L/168 hr; sticklebacks, LD_{50} = 0.1 mg/L/24 hr. Although silver accumulates in body tissue it does not appear to bioaccumulate through the food chain (no magnification at higher trophic levels).
Environmental Degradation: In water, silver will undergo absorption by manganese dioxide and precipitation with halides.

Section 13 - Disposal Considerations

Disposal: Return silver and silver-containing solutions from photography and x-rays to supplier for reclamation. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101): Not listed

Shipping Name: Environmentally hazardous substances, solid, n.o.s.*
Shipping Symbols: —
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: Class 9
Special Provisions (172.102): 8, B54, N50

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: None
b) Cargo Aircraft Only: None

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: —

* Classified as a hazardous substance when silver is in a quantity, in one package, which equals or exceeds the RQ of 1000 lb (454 kg)

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste Classification (40 CFR 261.24): D011, Characteristic of Toxicity (regulatory level = 5 mg/L)
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ), 1000 lb (454 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 103, 124, 132, 136, 148, 149, 167, 176, 187, 189
Prepared By .... M Gannon, BA
Industrial Hygiene Review .... RE Langford, PhD, CIH
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Material Safety Data Sheets Collection:

Sheet No. 9
Sulfuric Acid, Concentrated

Issued: 10/77 Revision: D, 9/92

Section 1. Material Identification

Sulfuric Acid Concentrated (H_2SO_4) Description: Prepared by the "Cat-Ox" process; by the contact process (vanadium pentoxide catalyst) with sulfur, pyrite (FeS_2), hydrogen sulfide, or sulfur-containing smelter gases; and from gypsum (calcium sulfate). Sulfuric acid is by far the most widely used industrial chemical. Its uses include: in the manufacture of fertilizers, chemicals, nitrate explosives, parchment paper, glue, dyes and pigments; as an etchant, a lab reagent, an electrolyte in lead/acid batteries, a dehydrating agent in the manufacture of ethers and esters, and an alkylation catalyst; in the purification of petroleum, the refining of mineral and vegetable oils, the leather industry, the carbonization of wool fabrics, the recuperation of fatty acids from soapworks waste water, the production of rayon and film, the extraction of uranium from pitchblende, and pickling of metal; in electroplating baths, gas drying and nonferrous metallurgy; and to obtain glucose by the hydrolysis of cellulose.

Other Designations: CAS No. 7664-93-9, battery acid, BOV, Caswell No 815, dipping acid, electrolyte acid, hydrogen sulfate, matting acid, oil of vitriol, sulphuric acid, vitriol brown oil.

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

Cautions: Handle concentrated sulfuric acid with extreme caution because it is corrosive to all body tissues. Vapor inhalation can cause severe lung damage. Skin or eye contact can produce severe burns; blindness may result.

R	1
I	3
S	4
K	0

NFPA

HMIS

H	3*
F	0
R	2
PPE†	

* Chronic effects
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Sulfuric acid concentrated, 93-98% sulfuric acid; remainder is water. Impurities include nonvolatiles, 0.02-0.03 ppm; SO_2, 40-80 ppm; iron, 50-100 ppm; nitrate, 5-20 ppm.

1991 OSHA PEL
8-hr TWA: 1 mg/m^3

1990 IDLH Level
80 mg/m^3

1990 NIOSH REL
TWA: 1 mg/m^3

1992-93 ACGIH TLVs
TWA: 1 mg/m^3
STEL: 3 mg/m^3

1990 DFG (Germany) MAK
TWA: 1 mg/m^3
Category: Local irritants
Peak: 2 mg/m^3, 5 min, momentary value †, 8 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC$_{Lo}$: 3 mg/m^3 for 24 weeks; toxic effects not yet reviewed.
Man, unreported route, LD$_{Lo}$: 135 mg/kg; toxic effects not yet reviewed.
Rat, oral, LD$_{50}$: 2140 mg/kg; toxic effects not yet reviewed.
Rabbit, eye: 100 mg rinse produced severe irritation.

* See NIOSH, *RTECS* (WS5600000), for additional toxicity data.
† The momentary value is a level which the concentration should never exceed.

Section 3. Physical Data

Boiling Point: 554 °F (290 °C); decomposes at 644 °F (340 °C) into sulfur trioxide and water.
Melting Point (100%): 50.65 °F (10.36 °C)
Vapor Pressure: <0.001 mm Hg at 20 °C
Saturated Vapor Density (air = 1.2 kg/m^3): 1.2 kg/m^3, 0.075 lbs/ft^3
pH: 1 N sol = 0.3, 0.1 N sol = 1.2, 0.01 N sol = 2.1
Molecular Weight: 98.08
Density/Specific Gravity (96-98%): 1.841
Water Solubility: Soluble; reacts!*
Other Solubilities: Ethyl alcohol
Odor Threshold: 0.150 ppm
Appearance and Odor: Colorless (pure) to dark brown (impure), odorless, dense, oily liquid. Pure compound is a solid below 51 °F (11 °C).

* Sulfuric acid reacts violently with water with the evolution of heat. *Always add the acid to water or other diluent, not the water to acid!*

Section 4. Fire and Explosion Data

Flash Point: Not combustible	**Autoignition Temperature:** None reported	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: Use extinguishing media appropriate to surrounding fire. Only use water if absolutely necessary and use with great caution. Water applied directly to sulfuric acid results in violent heat liberation and splattering of the material. Use water spray only to keep fire-exposed containers cool. **Unusual Fire or Explosion Hazards:** Sulfuric acid, a strong dehydrating agent, reacts with organic materials and produces enough heat ignition, chars wood, and may cause ignition of finely divided materials on contact. Reaction with metals may produce highly flammable, hydrogen gas. **Special Fire-fighting Procedures:** Because 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. Structural firefighter's protective clothing is *not* effective. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Sulfuric acid is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include acetic acid; acetone cyanohydrin; (acetone + nitric acid); (acetone + potassium dichromate); acetonitrile; acrolein; acrylonitrile; acrylonitrile + water; (alcohol + hydrogen peroxide); allyl alcohol; allyl chloride; ammonium hydroxide; 2-amino ethanol; ammonium; triperchromate; aniline; (bromates + metals); bromine pentafluoride; *n*-butyraldehyde; carbides; cesium acetylene carbide; chlorates; (chlorates + metals); chlorine trifluoride; chlorosulfonic acid; cuprous nitride; diisobutylene; (dimethylbenzylcarbinol + hydrogen peroxide); epichlorohydrin; ethylene cyanohydrin; ethylene diamine; ethylene glycol; ethylene imine; fulminates; hydrochloric acid; hydrogen; iodine heptafluoride; (indene + nitric acid); iron; isoprene; lithium silicide; mercuric nitride; mesityl oxide; powdered metals; (nitric acid + glycerides); *p*-nitrotoluene; pentasilver trihydroxydiaminophosphate; perchlorates; perchloric acid; (permanganates + benzene); (1-phenyl-2-methylpropryl alcohol + hydrogen peroxide); phosphorus; phosphorus isocyanate; picrates; potassium *tert*-butoxide; potassium chlorate; (potassium permanganate + potassium chloride); (potassium permanganate + water); beta-propiolactone; propylene oxide; pyridine; rubidium acetylene carbide; silver permanganate; sodium; sodium carbonate; sodium chlorate; sodium hydroxide; steel; styrene monomer; (toluene + nitric acid); vinyl acetate; and water. **Conditions to Avoid:** Water, combustibles, heat, ignition sources, and other incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of sulfuric acid can produce sulfur oxides.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list sulfuric acid as a carcinogen. However, a number of studies have associated exposures to sulfuric acid or to acid mists in general with laryngeal cancer. In 50 confirmed cases there was an approximately four-fold increased risk among highly exposed individuals relative to matched controls. It is not known if sulfuric acid can act as a direct carcinogen, as a promoter, or in combination with other substances. (167) **Summary of Risks:** Concentrated sulfuric acid is a severe respiratory tract, skin, and eye irritant.

Continue on next page

Section 6. Health Hazard Data, *continued*

Exposure can result in severe burns, tissue damage, scarring, functional inhibition, and blindness if splashed in the eye. Although ingestion is unlikely, it may cause severe injury and death. **Medical Conditions Aggravated by Long-Term Exposure:** Chronic respiratory, gastrointestinal, nervous, skin or eye diseases. **Target Organs:** Respiratory system, eyes, skin, and teeth. **Primary Entry Routes:** Inhalation, skin and eye contact. **Acute Effects:** Vapor or mist inhalation causes coughing, sneezing, nose irritation and nose bleeds, reflex bronchospasm, shortness of breath, pulmonary edema (fluid in lungs), emphysema, and permanent changes in pulmonary function. Ingestion causes corrosion of the mucous membranes of mouth, throat, and esophagus; and epigastric pain with nausea and vomiting of mucoid and "coffee ground" material. Skin contact produces severe burns; initially the zone of contact is bleached and turns brown prior to the formation of a clearly defined ulcer. These wounds are slow in healing and may cause extensive scarring that results in functional inhibition. If burns are extensive, the outcome may prove fatal. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow ingestion or skin contact. Circulatory shock is often the immediate cause of death. Eye contact produces deep corneal ulceration, kerato-conjunctivitis, palpebral lesions, and possible blindness. **Chronic Effects:** Chronic effects may include dental erosion, conjunctivitis, tracheobronchitis, emphysema, stomatitis (inflammation of the mouth mucous membranes), gastritis (inflammation of stomach mucous membranes), and dermatitis. **FIRST AID Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Use a 2% sodium bicarbonate solution to further neutralize any H_2SO_4 on the skin. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water or milk to dilute. *Do not* induce vomiting! Do not attempt to neutralize the acid with sodium bicarbonate. **Note to Physicians:** Monitor arterial blood gases, chest x-ray, and pulmonary function tests if respiratory tract irritation or respiratory depression is evident. Treat dermal irritation or burns with standard topical therapy.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all ignition sources, and provide adequate ventilation. Cleanup personnel should wear fully-encapsulating, vapor-protective clothing to protect against inhalation and skin or eye contact. Keep water and combustibles away from release. Stop or control leak if this can be done without undue risk. Neutralize small spills with sodium bicarbonate or a mixture of soda ash/slaked lime (50/50) and place into sealed containers for disposal. If a neutralizing agent is not available, absorb spilled sulfuric acid with vermiculite, dry sand, or earth. *Never* use organic material (e.g., sawdust) to absorb spill. For large spills, dike far ahead to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). Report any release in excess of 1000 lbs. **Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Neutralize waste water pH between 5.5 and 8.5. Follow applicable Federal, state, and local regulations.

Aquatic Toxicity: LC_{50} (saltwater, prawns): 42.5 ppm for 48 hrs; lethal (freshwater, bluegill): 24.5 ppm/24 hr.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): Characteristic of corrosivity

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311(b)(4)]

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 1000 lbs.

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). Because 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 MSHA/NIOSH-approved respirator. For concentrations < 25 mg/m^3 use any powered, air-purifying respirator with acid gas cartridge(s) in combination with a high-efficiency particulate filter. For concentrations < 50 mg/m^3, use any chemical cartridge respirator with a full facepiece and acid gas cartridge(s) in combination with a high-efficiency particulate filter. For concentrations < 80 mg/m^3, use any supplied air-respirator with a full facepiece and operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. H_2SO_4 has a minor to moderate effect on neoprene or rubber.(131) **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because 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 and launder before reuse. 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: Store in clearly labelled, steel containers in a cool [below 50 °F (10 °C)], dry, well-ventilated location on an acid-resistant cement floor and away from direct sunlight, combustibles, and other reactive materials. Separate from carbides, chlorates, fulminates, nitrates, picrates, and powdered metals. Protect storage containers against damage and water. Use non-sparking tools near sulfuric acid carboys, drums, tank cars, or metal storage tanks because of the possible production of hydrogen during storage. Use hand pumps for the decanting and emptying of carboys. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Total enclosures of processes and the mechanization of handling procedures are the most effective measures to prevent contact with sulfuric acid. Protect electrical installations against the corrosive action of acid vapors. **Administrative Controls:** Consider preplacement and periodic physical examinations with emphasis on the respiratory tract (including pulmonary function tests), skin, eyes, and teeth.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Sulfuric acid
DOT Hazard Class: 8
ID No.: UN1830
DOT Packaging Group: II
DOT Label: Corrosive
Special Provisions (172.102): A3, A7, B2, B83, B84, N34, T9, T27

Packaging Authorizations
a) Exceptions: 173.154
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 1L
b) Cargo Aircraft Only: 30L

Vessel Stowage Requirements
a) Vessel Stowage: C
b) Other: 14

***MSDS Collection* References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 131, 132, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 180

Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH

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Material Safety Data Sheet Collection

2,4,5-Trichlorophenoxyacetic Acid

MSDS No. 942

Date of Preparation: 4/95

Section 1 - Chemical Product and Company Identification

46

Product/Chemical Name: 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)
Chemical Formula: $C_6H_2Cl_3OCH_2CO_2H$
CAS Number: 93-76-5
Synonyms: acetic acid, (2,4,5-trichlorophenoxy); Brush Rhap; Dacamine; Dinoxol; Esteron 245; Forron; Fortex; Inverton 245; Phortox; Reddon, Reddox; Spontox; Super D Weedone; 2,4,5-T; Transamine: Tributon; Trinoxol; Trioxone; Veon; Weedar
Derivation: Produced by reacting 2,4,5-Trichlorophenol with monochloroacetic acid.
General Use: Formerly used as a plant hormone, herbicide, and defoliant. The EPA has gradually canceled the registration of products containing 2,4,5-T since 1970 with final cancellation in 1985.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

2,4,5-Trichlorophenoxyacetic acid, ca >95 %wt
Trace Impurities: 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) is found in concentrations from < 0.05 to 0.5 mg/kg. A typical batch of 2,4,5-T from one producer contained > 95% 2,4,5-T; 2 - 9% dichloromethoxyphenoxyacetic acids; 0.6% related trichlorophenoxyacetic acids; 0.5% dichlorophenoxyacetic acids; 0.4% bis 2,4,5-T; and < 0.5 mg/kg TCDD.

OSHA PEL
8-hr TWA: 10 mg/m^3

ACGIH TLV
TWA: 10 mg/m^3

NIOSH REL
10-hr TWA: 10 mg/m^3

IDLH Level
250 mg/m^3

DFG (Germany) MAK
TWA: 10 mg/m^3
Category II: Substances with systemic effects
Onset of Effect: ≤ 2 hr
Half-life: 2 hr to shift length

Peak Exposure Limit:
50 mg/m^3, 30 min. average value, 2/shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

2,4,5-Trichlorophenoxyacetic acid exists as white to light tan, odorless crystals. The pure compound is not considered highly toxic, but the commercial product is because it contains a small percentage of the impurity, 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD) which is a highly toxic chemical. In general, the toxic effects experienced from exposure to 2,4,5-T may be to a large extent due to TCDD contamination.

Wilson Risk Scale

R	1
I	2
S	1
K	1

HMIS

H	2*
F	0
R	0

* Chronic Effects
PPE†
†Sec. 8

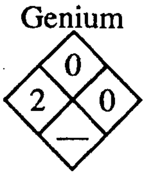
Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin and eye contact.
Target Organs: Eyes, skin, gastrointestinal tract, respiratory system, cardiovascular system. The liver and central and peripheral nervous systems may be affected by exposure to TCDD which is a contaminant of 2,4,5-T.
Acute Effects
Inhalation: Irritation of the eyes and respiratory tract.
Eye: Irritation can occur.
Skin: Irritation can occur. Chloracne may develop as a result of contamination by TCDD. 2,4,5-T is slowly absorbed by the skin and may result is systemic effects (see ingestion).
Ingestion: Ingestion of chlorophenoxy compounds in general may cause mouth, throat, and gastrointestinal irritation, chest pain (fromesophagitis), abdominal pain, diarrhea, fibrillary muscle and skeletal muscle twitching, and myotonia (muscle spasms involving prolonged contraction); metabolic acidosis, fever, tachycardia, hyperventilation, vasodilation, and sweating. Contamination with TCDD can cause other effects such as liver function impairment, peripheral neuropathy, and personality changes. The approximate lethal human dose is 4 teaspoonfuls. An acceptable daily intake is 0.03 mg/kg.
Carcinogenicity: IARC classifies 2,4,5-T as Group 2B (possible human carcinogen with limited human evidence and insufficient animal evidence). The NTP and OSHA do not list 2,4,5-T as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Chronic Effects: Chronic effects may occur from exposure to the contaminant TCDD (see *Genium* MSDS No. 906).
Other: Volunteers given 100 to 150 mg 2,4,5-T orally, excreted 80% in urine within 72 hr. Experimental reproductive and mutagenic effects have been reported (Sec. 11).

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.
Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water. Consult a physician or ophthalmologist if pain or irritation persist.
Skin Contact: *Quickly* remove contaminated clothing. Rinse away loose material with flooding amounts of water followed quickly by several soap and water washes. Wash exposed hair and nails. For reddened or blistered skin, consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. This is most effective if performed within 30 minutes of ingestion.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Monitor respiratory status, electrolytes, renal and liver function, CBC, and cardiac status. Follow LDH, SGOT, and alkaline phosphatase to detect liver injury, and CPK to detect muscle damage. Blood plasma and urine measurements may be useful in determining exposure.

Section 5 - Fire-Fighting Measures



Flash Point: Noncombustible
Autoignition Temperature: Noncombustible
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: Container may explode in heat of fire (316.4 °F/158 °C). 2,4,5-T may be transported in molten form.
Hazardous Combustion Products: Carbon monoxide, hydrogen chloride, chlorine, and phosgene gas.
Fire-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: Because 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. Structural firefighters' protective clothing *does not* protect against 2,4,5-T or its contaminant, TCDD.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should protect against inhalation and skin/eye contact.
Small Spills: Carefully scoop up spills or vacuum (use appropriate filter). To avoid dust generation, *do not* sweep! If 2,4,5-T is in solution with oil or diesel fuel, take up with absorbent, noncombustible material and place in suitable container for later disposal.
Large Spills
Containment: Flush with water to containment area for later disposal. Do not release into sewers or waterways.
Cleanup: Thoroughly wash spill area with detergent to remove any residue.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use appropriate PPE when handling 2,4,5-T.
Storage Requirements: Because the use of 2,4,5-T is no longer allowed, storage of this material should only be for purposes of awaiting disposal. Store in a cool, dry, well-ventilated area away from other agrochemicals or seeds. 2,4,5-T has a minimum shelf-life of 2 years.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all processes where possible to prevent dispersion of 2,4,5-T dusts into work area.
Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin and liver. Routine measurements of blood plasma and urine may be helpful.
Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For ≤ 50 mg/m^3, use any dust and mist respirator. For ≤ 100 mg/m^3, use any dust and mist respirator except single-use and quarter-mask respirators. For ≤ 250 mg/m^3, use any supplied-air respirator operated in a continuous-flow mode; any air-purifying, full facepiece respirator with a high-efficiency particulate filter; any powered, air-purifying respirator with a dust and mist filter; or any SCBA with a full facepiece. Select respirator based on its suitability to provide adequate worker protection for 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.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. *Do not* wear leather clothing. If leather does become contaminated, dispose of rather than clean. Decontamination is highly ineffective for leather items because it concentrates 2,4,5-T. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

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

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove 2,4,5-T from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using 2,4,5-T, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: White to light tan, odorless crystals with a metallic taste.

Vapor Pressure: 0 mm Hg at 68 °F (20 °C)

Formula Weight: 255.49

Specific Gravity (H_2O=1, at 4 °C): 1.803 at 68 °F (20 °C)

Water Solubility: 0.028% at 77 °F (25 °C)

Henry's Law Constant: 3.44×10^{-8} atm m^3/mole

Other Solubilities: % 2,4,5-T as follows: 95% ethanol (54.8%), *n*-heptane (0.039 %), ethyl ether (23.4 %), methanol (49.6 %), toluene (0.73 %), xylene (0.61 %). Slightly soluble in petroleum ether.

Boiling Point: Decomposes

Melting Point: 303.8 to 307.8 °F (151 to 153 °C)

Octanol/Water Partition Coefficient: log Kow = 4

Section 10 - Stability and Reactivity

Stability: 2,4,5-Trichlorophenoxyacetic acid is stable at room temperature in closed containers under normal storage and handling conditions. Temperatures above 316 °F (158 °C) lead to instability (melting point).

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Although *pure* 2,4,5-T is noncorrosive itself, some oil-based mixtures may affect painted surfaces.

Conditions to Avoid: Exposure to excessive heat and generation of 2,4,5-T dusts.

Hazardous Decomposition Products: Thermal oxidative decomposition of 2,4,5-trichlorophenoxyacetic acid can produce carbon monoxide, chlorine, hydrogen chloride, and phosgene gas.

Section 11 - Toxicological Information

Toxicity Data:*

Acute Dermal Effects: Rat, skin, LD_{50}: 1535 mg/kg

Reproductive Effects:

Rat, oral: 6 mg/kg administered on the 8th day of pregnancy caused behavioral effects.

Rat, oral: 27600 µg/kg administered from the 10th to 15th day of pregnancy caused specific developmental abnormalities of the urogenital system and other developmental abnormalities.

Mutagenicity:

Salmon, sperm cell: 100 µmol/L caused mutation.

Acute Oral Effects:

Rat, oral, LD_{50}: 300 mg/kg

Mouse, oral, LD_{50}: 242 mg/kg

Dog, oral, LD_{50}: 100 mg/kg

Multiple Dose Toxicity Data:

Rat, oral: 196 mg/kg administered intermittently for 28 weeks caused fatty liver degeneration.

Tumorigenicity:

Mouse, oral: 3379 mg/kg administered continuously for 33 weeks produced kidney, ureter, bladder, and skin tumors.

* See NIOSH, *RTECS* (AJ8400000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Rainbow trout (*Salmo gairdneri*), LC_{50} = 0.98 mg/L/96 hr; bluegill (*Lepomis machrochirus*), LC_{50} = 0.5 mg/L/48 hr.

Environmental Transport: 2,4,5-T can be carried to the atmosphere during wind erosion of treated soils.

Environmental Degradation: In soil, 2,4,5-T is expected to biodegrade rapidly to form 2,4,5-trichlorophenol and 2,4,5-trichloroanisole. 2,4,5-T can persist in soil anywhere from 14 to 300 days depending on climate conditions and concentration of microorganisms in soil, but is not expected to exceed one year. However, the TCDD contained as a contaminant within 2,4,5-T may persist for longer periods (see *Genium* MSDS No. 906). In water, 2,4,5-T will be found in the dissociated form due to a pKa of 2.88. It is then subject to photochemical decomposition and biodegradation. The estimated half-life in surface water is 15 days during summer at 40° latitude. If humic substances are present at levels > 15 mg of organic carbon/L, humic-induced photoreactions may dominate the photodegradation process. 2,4,5-T can also be degraded by photocatalytic processes involving iron species and peroxides. The primary products of aquatic decomposition are 2,4,5-trichlorophenol and 2-hydroxy-4,5-dichlorophenoxyacetic acid. Oxidation, chemical hydrolysis, volatilization, and bioaccumulation are not expected to occur. The bioconcentration factor in static ecosystems is 23 to 25 in fish. In the air, 2,4,5-T can exist in vapor form as fine droplets or adsorbed to particulates. It can undergo direct photolysis due to ultraviolet absorption at > 290 nm or react with photochemically-produced hydroxyl radicals (est. vapor half-life = 1.12 days). Removal from air may also occur via washout due to precipitation.

Soil Absorption/Mobility: Mobility varies depending on soil type. It is expected to be highly mobile in sandy soil, moderately mobile in clay and silt loams, and slightly mobile in muck due to adsorption to humic material.

Section 13 - Disposal Considerations

Disposal: 2,4,5-Tetrachlorophenoxyacetic acid is a good candidate for liquid injection, rotary kiln, and fluidized bed incineration. Sanitary landfill is not a recommended means of disposal because TCDD, the contaminant in 2,4,5-T is very persistent in soils. Although it is possible to degrade 2,4,5-T by acidification and chlorination, the end products are not clearly identified. As a result, no practical detoxification methods are currently available. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Triple rinse containers. Dispose of rinse water as above. If reuse is permitted by regulations, return to supplier. If reuse is not permitted, puncture container and ship to scrap metal facility.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Phenoxy pesticides, solid, toxic
Shipping Symbols: –
Hazard Class: 6.1
ID No.: UN2765
Packing Group: III
Label: Keep Away From Food
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 100 kg
b) Cargo Aircraft Only: 200 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): U232 & F027
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001 & CWA, Sec. 311 (b)(4)
CERCLA Reportable Quantity (RQ), 1000 lb (454 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 136, 189, 197, 201, 203

Prepared By .... M Gannon, BA
Industrial Hygiene Review .... S Gilson, CIH
Medical Review .... W Boucher, MD

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Material Safety Data Sheet Collection

Trichlorotrifluoroethane **MSDS No. 314**
Date of Preparation: 2/86 Revision: A, 6/94
Errata Date: 4/96

Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Trichlorotrifluoroethane
Chemical Formula: CCl_2FCClF_2
CAS No.: 76-13-1
Synonyms: Arcton 63; Arklone P; CFC-113; Daiflon S 3; F 113; FC 113; Flugene 113; Fluorocarbon 113; Forane 113; Freon 113 TR-T; Freon TF; Frigen 113; Frigen 113A; Frigen 113TR; Frigen 113TR-N; Frigen 113TR-T; Genetron 113; Kaltron 113MDR; R 113; TCTFE; 1,2,2-Trichlorotrifluoroethane; TTE; Ucon 113
Derivation: From perchloroethylene and hydrofluoric acid; by the reaction of perchloroethylene with a mixture of hydrogen fluoride and chlorine in the presence of a zirconium fluoride catalyst; or by catalytic fluorination of perhalo-olefins or alkanes with hydrogen fluoride.
General Use: Used as a dry-cleaning solvent and a solvent for cleaning electronic equipment and degreasing of machinery, a refrigerant, in fire extinguishers, to make chlorotrifluoroethylene, as a blowing agent and polymer intermediate, in solvent drying and drying electronic parts and precision equipment.
Note: Trichlorotrifluoroethane is a Class 1 Ozone Depleting Substance and its production and use is being phased out in accordance with The Montreal Protocol on Substances that Deplete the Ozone Layer.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Trichlorotrifluoroethane, ca 100% vol
Impurities: 0.0005% water

OSHA PELs*
8-hr TWA: 1000 ppm (7600 mg/m^3)
Vacated 1989 Final Rule Limit:
STEL: 1250 ppm (9500 mg/m^3)

ACGIH TLVs*
TWA: 1000 ppm (7670 mg/m^3)
STEL: 1250 ppm (9590 mg/m^3)

NIOSH REL
10-hr TWA: 1000 ppm (7600 mg/m^3)
STEL: 1250 ppm (9500 mg/m^3)

IDLH Level
4500 ppm

DFG (Germany) MAK
TWA: 500 ppm (3800 mg/m^3)
Category IV: Substances eliciting very weak effects MAK > 500 mL/m^3
Peak Exposure Limit:
1000 ppm (7900 mg/m^3), 60 min, momentary value, 3 per shift

* Note! Many workers may find the PEL and TLV concentrations are sufficient to cause central nervous system effects and irritation. Keep exposures to all volatile organic compounds as low as possible.

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Trichlorotrifluoroethane is a colorless liquid and gas above 117.9 °F (47.7 °C). It has an ether-like odor similar to carbon tetrachloride at high concentrations. Trichlorotrifluoroethane is a central nervous system depressant and cardiac (heart) sensitizer. It is irritating to the mucous membranes and defatting to skin. High concentrations can cause asphyxiation. It burns with difficulty, but emits highly toxic decomposition products.

Wilson Risk Scale
R 1
I 2
S 2
K 1

HMIS
H 1*
F 1
R 0

* Chronic Effects
PPE †
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin or eye contact, and ingestion.
Target Organs: Skin, central nervous and cardiovascular (heart) systems.
Acute Effects
Inhalation: Eye, nose, and throat irritation, headache, dizziness, drowsiness, and inability to concentrate. The threshold concentration for impairment of psychomotor (performance is about 2500 ppm as determined by the exposure of human volunteers. High concentrations can cause shortness of breath, bronchial constriction, lung irritation, pulmonary edema (fluid in lungs), irregular heart beat, unconsciousness, and death. High concentrations can cause asphyxiation due to dilution of available oxygen in air below levels necessary to sustain life.
Eye: Irritation.
Skin: Prolonged or repeated skin contact can cause defatting, drying, irritation, and redness.
Ingestion: Transient cyanosis (dark blue or purplish coloration of the skin and mucous membrane caused by lack of oxygen in the blood), rectal irritation, and diarrhea.
Carcinogenicity: IARC, NTP, and OSHA do not list trichlorotrifluoroethane as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Skin, respiratory (bronchopulmonary), or cardiovascular disease.

Chronic Effects: Palpitations (abnormally rapid heart beat), light headedness, defatting of the skin and dermatitis. One case of sensorimotor neuropathy (an abnormal and usually degenerative state of the nervous system involving sensory and motor skills) was reported in a laundress who worked with trichlorotrifluoroethane for several years. Weakness, pain, and paresthesias ("pins and needles" sensation) were most severe distally in the legs.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air, monitor for respiratory distress, and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of tepid water for at least 15 min. Consult an ophthalmologist immediately if pain or irritation persist.

Skin Contact: *Quickly* remove contaminated clothing. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Because trichlorotrifluoroethane has a low potential for oral toxicity, inducing vomiting is recommended only in cases of large oral ingestion.

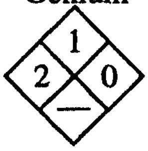
After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Dilantin improves atrio-ventricular conduction and may be useful in management of ventricular arrhythmias. Beta-blocking agents may also be useful.

Special Precautions/Procedures: *Do not* administer epinephrine or other sympathomimetic amines and adrenergic activators because they will further sensitize the heart to development of arrhythmias. Cardiopulmonary resuscitation may be necessary. Carefully monitor EKG, vital signs, and arterial blood gases. Minimize physical exertion and provide a quiet, calm atmosphere.

Section 5 - Fire-Fighting Measures

Genium



Flash Point: None reported.

Ignition Temperature: 572 °F (300 °C): decomposition temperature

LEL: None reported.

UEL: None reported.

Extinguishing Media: Use agents suitable for type of surrounding fire since trichlorotrifluoroethane burns with difficulty.

Unusual Fire or Explosion Hazards: High concentrations may tend to accumulate in low-lying areas. Very high concentrations can dilute available oxygen in the air below levels necessary to sustain life.

Hazardous Combustion Products: Hydrogen fluoride, hydrogen chloride, phosgene, carbonyl fluoride, and chloride and fluoride gases.

Fire-Fighting Instructions: Use water spray to cool fire-exposed containers. Apply water from as far a distance as possible. Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because 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.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate area. Cleanup personnel should protect against vapor inhalation and skin or eye contact.

Small Spills: Collect for reclamation or absorb in vermiculite, dry sand, earth, or similar noncombustible absorbent material.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor inhalation. Products of thermal decomposition can form halogen acids that have very sharp, irritating effects and can be detected by odor. Such odor is a hazard warning; when detected, immediately evacuate and ventilate area.

Storage Requirements: Store in a cool, well-ventilated area away from heat and ignition sources and incompatibles (Sec. 10). Protect containers against physical damage.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose all processes to keep airborne concentrations at a minimum. Isolate reaction vessels and properly design and operate filling heads for packaging and shipping.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as practically achievable (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)

Administrative Controls: Consider preplacement and periodic medical examinations with emphasis on the skin and cardiovascular system. Monitor work areas for oxygen levels and halocarbons.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For concentrations ≤ 2000 ppm, use a supplied-air respirator or a SCBA. For emergency or planned entry into unknown concentrations or IDLH conditions, wear any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode; or any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive-pressure mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

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

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove trichlorotrifluoroethane from your shoes and clean personal protective equipment.

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

Section 9 - Physical and Chemical Properties

Physical State: Liquid; a gas above 117.9 °F (47.7 °C)

Appearance and Odor: Colorless; little odor in low concentrations; at high concentrations, the odor is ether-like and similar to carbon tetrachloride.

Odor Threshold: Detection: 45 ppm; recognition: 68 ppm

Vapor Pressure: 284 mm Hg at 68 °F (20 °C); 363.6 mm Hg at 77 °F (25 °C)

Saturated Vapor Density (Air = 1.2 kg/m^3, 0.075 lb/ft^3): 3.65 kg/m^3, 0.228 lb/ft^3

Formula Weight: 187.38

Specific Gravity (H_2O=1, at 4 °C): 1.5635 at 77 °F (25 °C)

Water Solubility: 0.017 g/100 g water at 68 °F (20 °C)

Other Solubilities: Alcohol, ether, benzene

Boiling Point: 117.9 °F (47.7 °C) at 760 mm Hg

Freezing Point: -33.5 °F (-36.4 °C)

Viscosity: 0.68 cP at 77 °F (25 °C) (liquid); 0.010 cP at 10 kPa (vapor)

Refractive Index: 1.3557 at 25 °C/D

Surface Tension: 17.3 dyne/cm

Relative Evaporation Rate: (Ether =1); 1.3

Critical Temperature: 417.4 °F (214.1 °C)

Critical Pressure: 33.7 atm

Henry's Law Constant: 0.53 atm-cu m/mole

Ionization Potential: 11.99 eV

Octanol/Water Partition Coefficient: log Kow = 1.66

Section 10 - Stability and Reactivity

Stability: Trichlorotrifluoroethane is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Calcium, powdered aluminum, zinc, magnesium, beryllium, magnesium alloys >2% of magnesium, granular barium, lithium shavings, powdered titanium, samarium, sodium-potassium alloy, and acids (evolve highly toxic chloride fumes). Trichlorotrifluoroethane also attacks some forms of plastics, rubber, and coatings.

Conditions to Avoid: Avoid incompatibles and heat and ignition sources.

Hazardous Decomposition Products: Thermal oxidative decomposition of trichlorotrifluoroethane can produce hydrogen fluoride, hydrogen chloride, phosgene, carbonyl fluoride, and chloride and fluoride gases.

Section 11- Toxicological Information

Toxicity Data:*

Skin Effects:
Rabbit: 500 mg/24 hr caused mild irritation.

Acute Inhalation Effects:
Rat, inhalation, LC_{Lo}: 87000 ppm/6 hr caused general depressed activity, convulsions or effect on seizure threshold, and acute pulmonary edema.

Acute Oral Effects:
Rat, oral, LD_{50}: 43 g/kg caused general depressed activity, gastrointestinal changes, and changes involving skin and appendages-hair.

Multiple Dose Toxicity:
Rat, inhalation: 20 pph/6 hr/2 yr (intermittent) caused kidney, ureter, and bladder changes (changes in urine composition) and decreased weight gain.

* See NIOSH, *RTECS* (KJ4000000), for additional toxicity data.

Section 12 - Ecological Information

Aquatic Toxicity: Flat head minnow, LC_{50}: 1250 ppm/96 hr. Trichlorotrifluoroethane will not bioaccumulate significantly in aquatic organisms.

Environmental Fate: If released on soil, trichlorotrifluoroethane rapidly volatilizes from soil surfaces or leaches through soil, possibly into groundwater. If released in water, essentially all of trichlorotrifluoroethane is expected to be lost by volatilization (half-life 4 hr from a model river). Chemical hydrolysis and bioaccumulation are not expected to be significant fate processes in water. If released to the atmosphere, it will not degrade in the troposphere and diffuses to the stratosphere (lifetime ranges between 63 and 122 yr). In the stratosphere, trichlorotrifluoroethane slowly photolyzes to release chlorine atoms which in turn participates in the catalytic removal of stratospheric ozone.

Soil Absorption/Mobility: Koc values of 191 and 259 (estimated) suggest moderate mobility in soil and moderate adsorption to suspended solids and sediment in water.

Section 13 - Disposal Considerations

Disposal: Trichlorotrifluoroethane is a potential candidate for liquid injection, rotary kiln, or fluidized bed incineration. Exercise care to assure complete combustion to prevent the formation of phosgene. An acid scrubber is necessary to remove the haloacids produced. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Environmentally hazardous substances, liquid, n.o.s.*
Shipping Symbols: —
Hazard Class: 9
ID No.: UN3082
Packing Group: III
Label: Class 9
Special Provisions (172.102): 8, N50, T1

Packaging Authorizations
a) Exceptions: 173.155
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger, Aircraft, or Railcar: None
b) Cargo Aircraft Only: None

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: —

* Classified as a hazardous substance when trichlorotrifluoroethane is in a quantity, in one package, which equals or exceeds the RQ of 5000 lb (2270 kg)

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste Number (40 CFR 261.31): F002; a hazardous waste from nonspecific sources when a spent solvent.
Listed as a CERCLA Hazardous Substance (40 CFR 302.4), F002, spent halogenated solvent.
CERCLA Reportable Quantity (RQ): 5000 lb (2270 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 101, 103, 132, 139, 140, 148, 149, 167, 176, 186, 187, 189, 190

Prepared By .... MJ Wurth, BS
Industrial Hygiene Review .... PA Roy, MPH, CIH
Medical Review .... J Brent, MD, PhD

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Material Safety Data Sheet Collection

2,4,6-Trinitrotoluene **MSDS No. 979**

Date of Preparation: 10/95

Section 1 - Chemical Product and Company Identification 47

Product/Chemical Name: 2,4,6-Trinitrotoluene
Chemical Formula: $CH_3C_6H_2(NO_2)_3$; $C_7H_5N_3O_6$
CAS Number: 118-96-7
Synonyms: benzene, 2-methyl-1,3,5-trinitro; 1-methyl-2,4,6-trinitrobenzene; Entsufon; TNT; Tolite; sym-trinitrotoluene; Tritol; Triton; Trotyl oil
Derivation: Nitration of toluene with mixed acid; small amounts of the 2,3,4- and 2,4,5-isomers are produced which are removed by washing with an aqueous sodium sulfite solution.
General Use: Used as an explosive and as an intermediate in dyestuffs and photographic chemicals. Not produced commercially in the US, except in military arsenals.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

2,4,6-Trinitrotoluene
Trace Impurities: Tetranitromethane

OSHA PEL
8-hr TWA: 1.5 mg/m^3 (*skin*)
Vacated 1989 Final Rule Limit
8-hr TWA: 0.5 mg/m^3 (*skin*)

ACGIH TLV
TWA: 0.5 mg/m^3 (*skin*)

NIOSH REL
10-hr TWA: 0.5 mg/m^3 (*skin*)

IDLH Level
500 mg/m^3

DFG (Germany) MAK
TWA: 0.01 ppm (0.1 mg/m^3), skin
Category II: Substances with systemic effects
Onset of Effect: ≤ 2 hr
Half-life: < 2 hr

Peak Exposure Limit:
0.02 ppm (0.2 mg/m^3), 30 min average value, 4/shift

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

2,4,6-Trinitrotoluene exists as a colorless to pale yellow, odorless solid. It is irritating to the eyes, skin, and respiratory tract. Skin sensitization may occur in some individuals. Anemia and liver damage are likely with exposures exceeding 1 mg/m^3, especially in individuals with a glucose-6-phosphate dehydrogenase deficiency. This material is an explosive subject to detonation by exposure to shock or temperatures exceeding its boiling point 464 °F (240 °C).

Wilson Risk Scale	
R	3
I	3
S	2*
K	1

*Skin absorption

HMIS	
H	2
F	4
R	4

*Chronic Effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, eye and skin contact/absorption.
Target Organs: Eyes, skin, blood, liver, respiratory tract, central nervous system, cardiovascular system.
Acute Effects
Inhalation: Symptoms include gastritis, acute yellow atrophy of the liver, aplastic anemia, varying degrees of central nervous system depression, peripheral neuritis, muscular pains, cardiac, muscular and menstrual irregularities, leukocytosis or leukopenia (abnormally high or low number of circulating leukocytes, respectively), urinary and kidney irritation. Persons with a deficiency in glucose-6-phospahte dehydrogenase are at an increased risk of acute hemolytic (red blood cell destruction) disease characterized by weakness, dizziness, headache, nausea, paleness, enlarged liver and spleen, dark urine, decreased hemoglobin levels, and reticulocytosis. Cyanosis (pale, bluish color of lips, skin, and fingernails due to a lack of oxygenated blood in the tissues) does occur, but TNT is not viewed as a strong producer of methemoglobin.
Eye: Irritation many occur.
Skin: Irritation may occur. Sensitization occurs in some individuals exhibited by a red, itchy, papular eczema. Dermatitis generally affects the hands, wrist, forearms and friction points such as the collar line, belt line, and ankles.
Ingestion: Gastrointestinal tract irritation may occur.
Carcinogenicity: DFG (MAK-B, justifiably suspected as having carcinohenic potential), EPA (group C, possible human carcinogen with limited animal evidence in the absence of human data). IARC, NTP, and OSHA *do not* list 2,4,6-trinitrotoluene as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Blood, liver, or skin disorders.
Chronic Effects: Exposure to > 1 mg/m^3 for more than 5 years can result in bilateral peripheral cataracts although they do not appear to interfere with visual acuity or visual fields. These cataracts *do not* disappear after exposure stops.

Section 4 - First Aid Measures

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

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain or irritation persist.

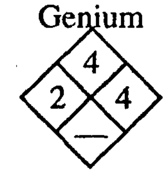
Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water followed quickly by a thorough soap and water wash. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *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: Treatment is symptomatic and supportive.

Section 5 - Fire-Fighting Measures



Flash Point: 450 °F (232 °C)

Flash Point Method: CC

Autoignition Temperature: None reported.

LEL: None reported.

UEL: None reported.

Flammability Classification: Explosive

Extinguishing Media: Use flooding quantities of water. If water is unavailable, use dry chemical or dirt.

Unusual Fire or Explosion Hazards: 2,4,6-Trinitrotoluene is an explosive which can explode or detonate when heated (especially if rapidly heated) or exposed to friction/shock.

Hazardous Combustion Products: Carbon oxide(s) and nitrogen oxide(s).

Fire-Fighting Instructions: For massive fire in cargo area, use unmanned hose holders or monitor nozzles, if this is impossible, evacuate area and let fire burn. *Do not* release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because 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.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off all ignition sources. Clear area, especially of materials which are oxygen-rich. Shut off all machinery to prevent TNT ignition via shock or friction. Cleanup personnel should prevent against inhalation and skin/eye contact and should be specifically trained to take care of an explosives spill.

Small Spills: With non-sparking tools, carefully scoop up and place in suitable container for immediate removal from spill area. *Do not* sweep, vacuum, or otherwise create shock or friction. 2,4,6-trinitrotoluene is an explosive and should only be handled by specifically trained personnel.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.

Cleanup: Damp mop any residue and dispose of as per Sec. 13.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Only those personnel specifically trained to deal with explosives should handle 2,4,6-trinitrotoluene.

Storage Requirements: Store only in a permanent magazine designed specifically for explosives. Prevent from any physical damage, shock, friction, or exposure to heat, ignition sources, or incompatibles (especially oxygen-rich materials).

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all equipment used with and around 2,4,6-trinitrotoluene.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin,eyes, liver, and blood.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for 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.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

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

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Laundry personel should be aware of the dangers associated with 2,4,6-trinitrotoluene. Remove any residue from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using 2,4,6-trinitrotoluene, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Solid

Appearance and Odor: Colorless to pale-yellow; odorless.

Vapor Pressure: 0.046 mm Hg at 179.6 °F (82 °C)

Formula Weight: 227.13

Specific Gravity (H_2O=1, at 4 °C): 1.654 at 68 °F (20 °C)

Water Solubility: 0.01% at 77 °F (25 °C); 1g/700 mL at 212 °F (100 °C)

Ionization Potential: 10.59 eV

Other Solubilities: 0.1 g/0.4 cc chloroform; 0.1 g/4 cc ether; 0.1 g/7 cc carbon tetrachloride; 55 g/100 g toluene; 67 g/100 g benzene; 72.1 g/100 g methyl acetate; 109 g/100 g acetone; 33.9 g/100 g chlorobenzene; 18.7 g/100 g 1,2-dichloroethane; 137 g/100 g pyridine.

Boiling Point: 464 °F (240 °C); explodes!

Melting Point: 176.18 °F (80.1 °C)

Octanol/Water Partition Coefficient: log Kow = 1.60

Section 10 - Stability and Reactivity

Stability: 2,4,6-trinitrotoluene is considered one of the most stable explosives because it does require an initiating source (rapid heating, slow heating to at least 240 °C, or friction/shock), however, it *is* an explosive and should be treated as such.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Bases, nitric acid, lead, iron (increase shock sensitiveness); addition of fresh red lead, sodium carbonate, and potassium hydroxide reduce explosion temperatures to 192 °C, 218 °C, and 192 °C, respectively; mixture with potassium hydroxide + methanol will interact even at -65 °C to give explosive aci-nitro salts; addition of oxygen-rich materials increase explosive power.

Conditions to Avoid: Exposure to heat, ignition sources, shock, friction and incompatibles, especially oxygen-rich materials.

Hazardous Decomposition Products: Thermal oxidative decomposition of 2,4,6-trinitrotoluene can produce carbon oxide(s) and nitrogen oxide(s).

Section 11 - Toxicological Information

Toxicity Data:*

Skin Effects:
Rabbit, skin: 500 mg/24 hr caused mild irritation.

Mutagenicity:
S. typhimurium: 10 µg/plate (+/- S9)

Reproductive Effects:
Rat, oral: 5376 mg/kg (male-28 days prior to mating) had an effect on the testes, epididymis, and the spleen duct.

Acute Oral Effects:
Rat, oral, LD_{50}: 795 mg/kg resulted in somnolence, tremor, and convulsions or effect on seizure threshold.
Human, oral, LD_{Lo}: 28 g/kg caused hallucinations, distorted perceptions, cyanosis, and gastrointestinal changes.
Rat, oral, TDLo: 3 g/kg administered intermittently for 30 days caused biochemical (monoamine oxidase, lipids including transport) and liver changes

Multiple Dose Toxicity Data:
Rat, oral: 7200 mg/kg administered intermittently for 6 weeks resulted in blood and liver changes.

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* See NIOSH, *RTECS* (XU0175000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: *Lepomis macrochirus* (bluegill sunfish), LC_{50} = 2.7 mg/L/96 hr; *Pimephales promelas* (fathead minnow), LC_{50} = 0.46 mg/L/96 hr

Environmental Fate: In soil, 2,4,6-trinitrotoluene not be highly mobile. Some may photolyze to trinitrobenzene and trinitrobenzaldehyde. In water, it is expected to photolyze with increasing rapidity in waters with a high pH and high organic matter content. Volatilization occurs slowly with an estimated half-life from a model river 1 m deep, flowing 1 m/sec, with a wind speed of 3 m/sec. of 119 days. In air, it will exist almost entirely in the vapor-phase and undergoe reaction with photochemically-produced hydroxyl radicals with a half-life of 110 days.

Section 13 - Disposal Considerations

Disposal: Wastewater can be treated using amines or via electrochemical oxidation. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Trinitrotoluene, *dry or wetted with less than 30% water, by mass**; trintitrotoluene, *wetted with not less than 30% water. by mass*†
Shipping Symbols: –
Hazard Class: 1.1D*, 4.1†
ID No.: UN0209*, UN1356†
Packing Group: II*, I†
Label: Explosive 1.1D*, Flammable Solid†
Special Provisions (172.102): –*; A2, A8, A19, N41†

Packaging Authorizations
a) **Exceptions:** None
b) **Non-bulk Packaging:** 173.62*, 173.211†
c) **Bulk Packaging:** None

Quantity Limitations
a) **Passenger, Aircraft or Railcar:** Forbidden*, 0.5 kg†
b) **Cargo Aircraft Only:** Forbidden*, 0.5 kg

Vessel Stowage Requirements
a) **Vessel Stowage:** B*, E†
b) **Other:** 1E, 5E*; 28, 36†

Section 15 - Regulatory Information

EPA Regulations:
Classified as a RCRA Hazardous Waste (40 CFR 261.21, .23): D001, D003; Characteristic of Ignitability & Reactivity
Listed "Unlisted Hazardous Waste, Characteristic of Ignitability & Reactivity" as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001
CERCLA Reportable Quantity (RQ), 100 lb (45.4 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 103, 124, 136, 149, 167, 176, 189, 197, 201, 203

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Medical Review ....T Thoburn, MD, MPH

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ATTACHMENT B

Woodward-Clyde Safety Procedures

OPERATING PROCEDURE NO. HS-102

102.0 INCIDENT REPORTS

102.1 PURPOSE

All health and safety incidents shall be reported to Woodward-Clyde (W-C) management and health and safety staff. The prompt investigation and reporting of incidents will reduce the risk of future incidents, better protect W-C employees, and reduce W-C liability.

102.2 DEFINITIONS

A health and safety incident is any event listed below:

- Illness resulting from chemical exposure or suspected chemical exposure.
- Physical injury, including both those that do and do not require medical attention to W-C employees or W-C subcontractors.
- Fire, explosions, and flashes resulting from activities performed by W-C and its subcontractors.
- Property damage resulting from activities performed by W-C and its subcontractors.
- Vehicular accidents occurring on-site, while travelling to and from client locations, or with any company-owned vehicle.
- Infractions of safety rules and requirements.
- Unexpected chemical exposures.
- Complaints from the public regarding W-C field operations.

102.3 REPORTING PROCEDURES

102.3.1 Reporting Format

Incident reports shall be prepared by completing Form HS-102. This form may be obtained from any W-C Health and Safety Officer (HSO) and is attached to this operating procedure.

102.3.2 Responsible Party

Reports of incidents occurring in the field shall be prepared by the Site Safety Officer or, in the absence of the site safety officer, the supervising field engineer, witness, or injured/exposed individual.

102.3.3 Filing

A report must be submitted to the Health and Safety Officer of the Operating Unit to which the Project Manager belongs within 24 hours of each incident involving medical treatment. In turn, the Health and Safety Officer must distribute copies of the report to the Corporate Health and Safety Manager and the Corporate Health and Safety Officer. When an injury or illness is reported, the Health and Safety Officer must deliver a copy of the report to the individual in charge of Human Resources so that a Worker's Compensation Insurance Report can be filed if necessary. Reports must be received by Human Resources within 48 hours of each qualifying incident.

102.3.4 Major Incidents

Incidents that include fatalities, hospitalization of employees or subcontractors, or involve injury/illness of the public shall be reported to the HSO and Project Manager as soon as possible. Any contact with the media should be referred to the Project Manager and Operating Unit Manager.

FORM HS-102

W-C HEALTH AND SAFETY INCIDENT REPORT

Project Name: ____________________

Project Number: ____________________

Date of Incident: ____________________

Time of Incident: ____________________

Location: ____________________

____

TYPE OF INCIDENT (Check all applicable items)

☐ Illness ☐ Fire, explosion, flash

☐ Injury ☐ Unexpected exposure

☐ Property Damage ☐ Vehicular Accident

☐ Health & Safety Infraction

☐ Other (describe) ____________________

DESCRIPTION OF INCIDENT (Describe what happened and possible cause. Identify individual involved, witnesses, and their affiliations; and describe emergency or corrective action taken. Attach additional sheets, drawings, or photographs as needed.)

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____

Reporter: ____________________
Print Name

____________________ Signature ____________________ Date

Reporter must deliver this report to the Operating Unit Health & Safety Officer within 24 hours of the reported incident for medical treatment cases and within five days for other incidents.

Reviewed by: ____________________ ____________________
Operating Unit Health & Safety Officer Date

Distribution by HSO:
- WCGI Corporate Health and Safety Manager
- Corporate Health and Safety Officer
- Project Manager
- Personnel Office (medical treatment cases only)

OPERATING PROCEDURES NO. HS-201

201.0 HEAT STRESS

201.1 PURPOSE

The purpose of this Operating Procedure is to provide general information on heat stress and the methods that can be utilized to prevent or minimize the occurrence of heat stress.

Adverse climatic conditions are important considerations in planning and conducting site operations. Ambient temperature effects can include physical discomfort, reduced efficiency, personal injury, and increased accident probability. Heat stress is of particular concern while wearing impermeable protective garments, since these garments inhibit evaporative body cooling.

201.2 TYPES OF HEAT STRESS

Heat stress is the combination of environmental and physical work factors that constitute the total heat load imposed on the body. The environmental factors of heat stress are the air temperature, radiant heat exchange, air movement, and water vapor pressure. Physical work contributes to the total heat stress of the job by producing metabolic heat in the body in proportion to the intensity of the work. The amount and type of clothing also affects heat stress.

Heat strain is the series of physiological responses to heat stress. When the strain is excessive for the exposed individual, a feeling of discomfort or distress may result, and, finally, a heat disorder may ensue. The severity of strain will depend not only on the magnitude of the prevailing stress, but also on the age, physical fitness, degree of acclimatization, and dehydration of the worker.

Heat disorder is a general term used to describe one or more of the heat-related disabilities or illnesses shown in Table 201-1.

201.3 METHODS OF CONTROLLING HEAT STRESS

As many of the following control measures, as appropriate, should be utilized to aid in controlling heat stress:

- Provide for adequate liquids to replace lost body fluids. Encourage personnel to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.
- Replace body fluids primarily with water, with commercial mixes such as Gatorade or Quick Kick used only as a portion of the replacement fluids. Avoid excessive use of caffeine drinks such as coffee, colas or tea.
- Establish a work regimen that will provide adequate rest periods for cooling down. The heat exposure Threshold Limit Values (TLV) may be used for guidelines.
- Provide shaded work areas, if possible.
- Wear cooling devices such as vortex tubes or cooling vests.
- Consider adjusting work hours to avoid the worst heat of the day.
- Take breaks in a cool rest area.
- Remove any impermeable protective garments during rest periods.
- Do not assign other tasks to personnel during rest periods.
- Inform personnel of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress.

201.6 MONITORING

201.6.1 Temperature

The environmental heat stress of an area can be monitored by the Wet Bulb Globe Temperature Index (WBGT) technique. When heat stress is a possibility, a heat stress monitoring device, such as the Wibget Heat Stress Monitor (Reuter Stokes) can be utilized.

The WBGT shall be compared to the TLV outlined by the American Conference of Governmental Industrial Hygienists (ACGIH) TLV guides, and a work-rest regiment can be established in accordance with the WBGT. Note that approximately 5°C must be subtracted from the TLVs listed for heat stress to compensate for the wearing of impermeable protective clothing.

201.6.2 Medical

In addition to the provisions of the Woodward-Clyde (W-C) medical surveillance program, on-site medical monitoring of personnel should be performed for projects where heat stress is a significant concern. Blood pressure, pulse, body temperature (oral), and body weight loss may be utilized.

Heart Rate: Count the radial pulse during 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. If the heart rate still exceeds 110 beats per minute at the next rest cycle, shorten the following work cycle by one-third.

Oral Temperature: Use a clinical thermometer or similar device to measure the oral temperature at the end of the work period (before drinking liquids). If the oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period. If the oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.

Do not permit a worker to wear a semipermeable or impermeable garment if his/her oral temperature exceeds 100.6°F (38.1°C).

Body Water Loss: Measure body weight on a scale accurate to ±0.25 pounds at the beginning and end of each work day (also at lunch break, if possible) to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, nude. The body water loss should not exceed 1.5 percent total body weight loss in a work day.

Physiological Monitoring: Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work. The length of the work cycle will be governed by the frequency of the required physiological monitoring.

201.7 REFERENCES

American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents, 1992-1993.

EPA, Standard Operating Safety Guides, 1992, Pages 91-93.

National Institute for occupational Safety and Health, Criteria for a Recommended Standard: Occupational Exposure to Hot Environments, 1986.

TABLE 201-1
Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbances	Treatment	Prevention
Temperature Regulation Heatstroke **Heatstroke:** (1) Hot, dry skin; usually red, mottled, or cyanotic; (2) rectal temperature 40.5°C (104°F) and over; (3) confusion, loss of consciousness, convulsions, rectal temperature continues to rise; fatal if treatment is delayed	(1) Sustained exertion in heat by unacclimatized workers; (2) lack of physical fitness and obesity; (3) recent alcohol intake; (4) dehydration; (5) individual susceptibility; and (6) chronic cardiovascular disease	Failure of the central drive for sweating (cause unknown) leading to loss of evaporative cooling and an uncontrolled accelerating rise in t_{re}; there may be partial rather then complete failure of sweating	Immediate and rapid cooling by immersion in chilled water with massage or by wrapping in wet sheet with vigorous fanning with cool dry air; avoid overcooling; treat shock if present	Medical screening of workers, selection based on health and physical fitness; acclimatization for 5-7 days by graded work and heat exposure; monitoring workers during sustained work in severe heat
Circulatory Hypostasis Heat Syncope Fainting while standing erect and immobile in heat	Lack of acclimatization	Pooling of blood in dilated vessels of skin and lower parts of body	Remove to cooler area; rest in recumbent position; recovery prompt and complete	Acclimatization; intermittent activity to assist venous return to heat
Water and or Salt Depletion (a) Heat Exhaustion (1) Fatigue, nausea, headache, giddiness; (2) skin clammy and moist; complexion pale, muddy, or hectic flush; (3) may faint on standing with rapid thready pulse and low blood pressure; (4) oral temperature *normal or low*, but rectal temperature usually elevated (37.5-38.5°C or 99.5-101.3°F); water restriction type: urine volume small, highly concentrated; salt restriction type; urine less concentrated chlorides less than 3 g/L	(1) *Sustained exertion in* heat; (2) lack of acclimatization; and (3) failure to replace water lost in sweat	(1) *Dehydration from* deficiency of water; (2) depletion of circulating blood volume; (3) circulatory strain from competing demands for blood flow to skin and to active muscles	Remove *to cooler* environment; rest in recumbent position; administer fluids by mouth; keep at rest until urine volume indicates that water balances have been restored	*Acclimatize workers using* a breaking-in schedule for 5-7 days; supplement dietary salt only during acclimatization; ample drinking water to be available at all times and to be taken frequently during work day
(b) Heat Cramps Painful spasms of muscles used during work (arms, legs, or abdominal); onset during or after work hours	(1) Heavy sweating during hot work; (2) drinking large volumes of water without replacing salt loss	Loss of body salt in sweat, water intake dilutes electrolytes; water enters muscles, causing spasm	Salted liquids by mouth or more prompt relief by IV infusion	Adequate salt intake with meals; for unacclimatized workers, supplement salt intake at meals.

TABLE 201-1 (continued)
Classification, Medical Aspects, and Prevention of Heat Illness

Category and Clinical Features	Predisposing Factors	Underlying Physiological Disturbances	Treatment	Prevention
Skin Eruptions				
(a) Heat Rash (miliaria rubra, or "prickly heat") Profuse tiny raised red vesicles (blisterlike) on affected areas; prickling sensations during heat exposure	Unrelieved exposure to humid heat with skin continuously wet from unevaporated sweat	Plugging of sweat gland ducts with sweat retention and inflammatory reaction	Mild drying lotions; skin cleanliness to prevent infection	Cool sleeping quarters to allow skin to dry between heat exposures
(b) Anhidrotic Heat Exhaustion (miliaria profunda) Extensive areas of skin which do not sweat on heat exposure, but present gooseflesh appearance, which subsides with cool environments; associated with incapacitation in heat	Weeks or months of constant exposure to climatic heat with previous history of extensive heat rash and sunburn	Skin trauma (heat rash; sunburn) causes sweat retention deep in skin; reduced evaporative cooling causes heat intolerance	No effective treatment available for anhidrotic areas of skin; recovery of sweating occurs gradually on return to cooler climate	Treat heat rash and avoid further skin trauma by sunburn; provide periodic relief from sustained heat
Behavioral Disorders				
(a) Heat Fatigue - Transient Impaired performance of skilled sensorimotor, mental, or vigilance tasks, in heat	Performance decrement greater in unacclimatized and unskilled worker	Discomfort and physiologic strain	Not indicated unless accompanied by other heat illness	Acclimatization and training for work in the heat
(b) Heat Fatigue - Chronic Reduced performance capacity; lowering of self-imposed standards of social behavior (e.g., alcoholic over-indulgence); Inability to concentrate, etc.	Workers at risk come from temperature climates for long residence in tropical latitudes	Psychosocial stresses probably as important as heat stress; may involve hormonal imbalance but no positive evidence	Medical treatment for serious causes; speedy relief of symptoms on returning home	Orientation on life in hot regions (customs, climate, living conditions, etc.)

OPERATING PROCEDURE NO. HS-202

202.0 COLD STRESS

202.1 PURPOSE

The purpose of this Operating Procedure is to provide information on cold stress and the procedures for preventing and dealing with cold stress. Adverse climatic conditions are important considerations in planning and conducting site operations. Ambient temperature effects can include physical discomfort, reduced efficiency, personal injury, and increased accident probability.

202.2 TYPES OF COLD STRESS EFFECTS

202.2.1 Frostbite

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

- **Frost Nip or Initial Frostbite:** (1st degree frostbite) Characterized by blanching or whitening of skin.
- **Superficial Frostbite:** (2nd degree frostbite) Skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient. Blistering and peeling of the frozen skin will follow exposure.
- **Deep Frostbite:** (3rd degree frostbite) Tissues are cold, pale, and solid; extremely serious injury with possible amputation of affected area.

Frostbite can occur without hypothermia when the extremities do not receive sufficient heat. The toes, fingers, cheeks, and ears are the most commonly affected. Frostbite occurs when there is freezing of the fluids around the cells of the affected tissues. The first symptom of frostbite is an uncomfortable sensation of coldness, followed by numbness. There may be tingling, stinging, or cramping. Contact by the skin with tools or other metal objects below 20°F (-7°C) may result in contact frostbite.

The prevention of frostbite includes early recognition of problems, adequate protective clothing, recognizing the combination of wind and low temperature (see Table 202-1 Windchill Index), adequate fluids, work-rest regimens with heated rest areas, and use of controls such as wind-breaks and heaters.

The initial treatment for frostbite includes bringing the individual to a warm location, removal of clothing in the affected area, and placing the affected parts in warm (100-105°F) water. Do not massage or rub the frostbite area. After the initial treatment, wrap the affected area loosely in sterile gauze and seek medical attention.

202.2.2 Hypothermia

Hypothermia results when the body loses heat faster than it can be produced. When this situation first occurs, blood vessels in the skin constrict in an attempt to conserve vital internal heat. Hands and feet are first affected. If the body continues to lose heat, involuntary shivers begin. This is the body's way of attempting to produce more heat, and it is usually the first real warning sign of hypothermia. Further heat loss produces speech difficulty, confusion, loss of manual dexterity, collapse, and finally death. Wet clothes or immersion in cold water greatly increases the hypothermia risk. The progressive clinical presentation of hypothermia may be seen in Table 202-2.

Prevention of hypothermia includes planning for outside work in winter conditions, particularly work over water. Planning will include adequate layers of clothing, training employees in recognizing hypothermia in themselves and others, recognition of the combination of wind and temperature (see Windchill Index in Table 202-1), use of controls such as wind-breaks and heaters, a work-rest schedule, and adequate fluid intake.

Fatal exposure to cold among workers has usually resulted from immersion in low temperature water. Water transmits body heat over 200 times faster than air. Wetsuits or drysuits are recommended for work over water with water temperatures below 45°F. Individuals who fall into cold water without wetsuits or drysuits may not be able to swim due to the rapid onset of hypothermia.

Prompt treatment of hypothermia is essential. Once the body temperature drops below 95°F, the loss of temperature control occurs, and the body can no longer rewarm itself. Initial treatment includes reducing heat loss by moving the individual out of the wind and cold, removal of wet clothing, applying external heat (such as a pre-warmed sleeping bag, electric blanket, or body-heat from other workers) and follow-up medical attention.

202.4 EXPOSURE LIMITS

The American Conference of Governmental Industrial Hygienists (ACGIH) has adopted Threshold Limit Values (TLVs) for cold stress. These limits set maximum work periods based on a combination of wind and temperature.

202.5 REFERENCES

American Conference of Governmental Industrial Hygienists, Documentation of Threshold Limit Values, 1984

EPA, Standard Operating Safety Guides, 1992, pages 95-100.

TABLE 202-1

Windchill Index[1]

	ACTUAL THERMOMETER READING (°F)									
	50	40	30	20	10	0	-10	-20	-30	-40
Wind speed in mph	EQUIVALENT TEMPERATURE (F)									
calm	50	40	30	20	10	0	-10	-20	-30	-40
5	48	37	27	16	6	-5	-15	-26	-36	-47
10	40	28	16	4	-9	-21	-33	-46	-58	-70
15	36	22	9	-5	-18	-36	-45	-58	-72	-85
20	32	18	4	-10	-25	-39	-53	-67	-82	-96
25	30	16	0	-15	-29	-44	-59	-74	-88	-104
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116
Over 40 mph	Little Danger				Increasing Danger			Great Danger		
(little added effect)	(for properly clothed person)				(Danger from freezing of exposed flesh)					

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[1] Source: Fundamentals of Industrial Hygiene, Third Edition. Plog, B.A., Benjamin, G.S., Kerwin, M.A., National Safety Council, 1988.

TABLE 202-2

Progressive Clinical Presentations of Hypothermia*

Core Temperature °C	 °F	 Clinical Signs
37.6	99.6	"Normal" rectal temperature
37	98.6	"Normal" oral temperature
36	96.8	Metabolic rate increases in an attempt to compensate for heat loss
35	95.0	Maximum shivering
34	93.2	Victim conscious and responsive, with normal blood pressure
33	91.4	Severe hypothermia below this temperature
32	89.6	Consciousness clouded; blood pressure becomes difficult to obtain; pupils dilated but react to light; shivering ceases
31	87.8 _	
30	86.0	Progressive loss of consciousness; muscular rigidity increases; pulse and blood pressure difficult to obtain; respiratory rate decreases
29	84.2 _	
27	82.4	Ventricular fibrillation possible with myocardial irritability
27	80.6	Voluntary motion ceases; pupils nonreactive to light; deep tendon and superficial reflexes absent
26	78.8	Ventricular fibrillation may occur spontaneously
25	77.0	
24	75.2	Pulmonary edema
22	71.6	Maximum risk of ventricular fibrillation
21	69.8 _	
20	68.0	Cardiac standstill
18	64.4	Lowest accidental hypothermia victim to recover
17	62.6	Isolectric electroencephalogram
9	48.2	Lowest artificially cooled hypothermia patient to recover

* Presentations approximately related to core temperature. Reprinted from the January 1982 issue of American Family Physician, published by the American Academy of Family Physicians.

OPERATING PROCEDURE NO. HS-203

203.0 SAFETY GUIDELINES FOR DRILLING INTO SOIL AND ROCKS

203.1 PURPOSE

The purpose of this Operating Procedure (OP) is to provide an overview for working safely around drilling operations with truck-mounted and other engine-powered drill rigs. The procedure addresses off-road movement of drill rigs, overhead and buried utilities, use of augers, rotary and core drilling, and other drilling operations and activities.

203.2 APPLICATION

The guidelines shall be applied to Woodward-Clyde (W-C) projects in which truck-mounted, or other engine-powered, drill rigs are used. The guidelines are applicable to W-C employees and W-C owned rigs. For drill rigs operated by contractors, the primary responsibility for drilling safety is with the drilling contractor.

203.3 RESPONSIBILITY AND AUTHORITY

Drill rig safety and maintenance is the responsibility of the drill rig operator. W-C employees are responsible for their own safety including recognizing and avoiding drill rig hazards. W-C employees that observe a drill rig condition believed to be unsafe, shall advise the drill rig operator of the unsafe condition.

203.4 SAFETY GUIDELINES

203.4.1 Movement of Drill Rigs

Before moving a rig, the operator must do the following:

1. To the extent practical, walk the planned route of travel and inspect it for depressions, gullies, ruts, and other obstacles.

2. Check the brakes of the truck/carrier, especially if the terrain along the route of travel is rough or sloped.

3. Discharge all passengers before moving on rough or steep terrain.

4. Engage the front axle (on 4x4, 6x6, etc. vehicles) before traversing rough or steep terrain.

Driving drill rigs along the sides of hills or embankments should be avoided; however, if side-hill travel becomes necessary, the operator must conservatively evaluate the ability of the rig to remain upright while on the hill or embankment. The possibility must be considered that the presence of drilling tools on the rig may reduce the ability of the rig to remain upright (raises the center of mass of the rig).

Logs, ditches, road curbs, and other long and horizontal obstacles should be normally approached and driven over squarely, not at an angle.

When close lateral or overhead clearance is encountered, the driver of the rig should be guided by another person on the ground.

Loads on the drill rig and truck must be properly stored while the truck is moving, and the mast must be in the fully lowered position.

After the rig has been positioned to begin drilling, all brakes and/or locks must be set before drilling begins. If the rig is positioned on a steep grade and leveling of the ground is impossible or impractical, the wheel of the transport vehicle should be blocked and other means of preventing the rig from moving or topping over employed.

203.5 BURIED AND OVERHEAD UTILITIES

The location of overhead and buried utility lines must be determined before drilling begins, and the locations should be noted on boring plans and/or assignment sheets. Further information on electrical safety may be seen in HS-206.

When overhead power lines are close by, the drill rig mast should not be raised unless the distance between the rig and the nearest power line is at least 20 feet or other distance as required by local ordinances, whichever is greater. The drill rig operator or assistant should walk completely around the rig to make sure that proper distance exists.

When the drill rig is positioned near an overhead line, the rig operator should be aware that hoist lines and power lines can be moved towards each other by wind. When necessary and approved by the Project Manager (PM), the utility and/or powerlines may be shielded, shut down, or moved by the appropriate personnel.

203.6 CLEARING THE WORK AREA

Before a drill rig is positioned to drill, the area on which the rig is to be positioned should be cleared of removable obstacles and the rig should be leveled if sloped. The cleared/leveled area should be large enough to accommodate the rig and supplies.

203.7 SAFE USE OF AUGERS

Never place hands or fingers under the bottom of an auger flight or drill rods when hoisting the augers or rods over the top of another auger or rod in the ground or other hard surfaces, such as the drill rig platform.

Never allow feet to get under the auger or drill rod while they are being hoisted.

When the drill is rotating, stay clear of the drill string and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason.

Move auger cuttings away from the auger with a long-handled shovel or spade; never use hands or feet.

Never clean an auger attached to the drill rig unless the transmission is in neutral or the engine is off, and the auger has stopped rotating.

203.8 SAFE USE OF HAND TOOLS

OSHA regulations regarding hand tools should be observed in addition to the guidelines provided below:

- Each tool should be used only to perform tasks for which it was originally designed.
- Damaged tools should be repaired before use or discarded.
- Safety goggles or glasses should be worn when using a hammer or chisel. Nearby co-workers and by-standers should be required to wear safety goggles or glasses also, or move away.
- Tools should be kept cleaned and stored in an orderly manner when not in use.

203.9 SAFE USE OF WIRE LINE HOISTS, WIRE ROPE, AND HOISTING HARDWARE

Safety rules described in Title 29 Code of Federal Regulations (CFR) 1926.552 and guidelines contained in the Wire Rope User's Manual published by the American Iron and Steel Institute shall be used whenever wire line hoists, wire rope, or hoisting hardware are used.

203.10 PROTECTIVE GEAR

203.10.1 Minimum Protective Gear

Items listed below should be worn by all members of the drilling team while engaged in drilling activities.

- Hard Hat;
- Safety Shoes (shoes or boots with steel toes and shanks); and
- Gloves.

203.10.2 Other Gear

Items listed below should be worn when conditions warrant their use. Some of the conditions are listed after each item.

1. **Safety Goggles or Glasses:** Use when working within 25 feet of a drill rig or when using hand tools or chemicals that may create eye hazards.

2. **Safety Harnesses and Lifelines:** Safety harnesses and lifelines shall be worn by all persons working on top of an elevated derrick beam or mast. The lifeline should be secured at a position that will allow a person to fall no more than six feet. OSHA Full Protection (1926 Subpart m) requirements apply.

3. **Life Vests:** Use for work over water.

203.11 TRAFFIC SAFETY

Drilling in streets, parking lots or other areas of vehicular traffic requires definition of the work zones with cones, warning tape, etc. and compliance with local police requirements.

203.12 FIRE SAFETY

- Fire extinguishers shall be kept on or near drill rigs for fighting small fires.

- If methane is suspected in the area, a combustible gas instrument (CGI) shall be used to monitor the air near the borehole with all work to stop at 20 percent of the Lower Explosive Limit (LEL).

- Work shall stop during lightning storms.

OPERATING PROCEDURE NO. HS-211

211.0 BLOODBORNE PATHOGENS

211.1 BLOODBORNE PATHOGENS EXPOSURE CONTROL PLAN

The following Exposure Control Plan has been developed in accordance with the Occupational Safety and Health Administration (OSHA) Bloodborne Pathogens Standard, Title 29 Code of Federal Regulations (CFR) 1910.1030. The goal is to reduce the risk of disease in employees potentially exposed to bloodborne pathogens.

211.2 EXPOSURE ROUTES

The transmission of infectious agents such as bacteria and virus's may occur through direct contact, airborne, and vector routes of exposure. Direct contact is an important route of exposure for bloodborne pathogens due to needlestick injuries, puncture injuries, contact with abraded skin, or contact with areas such as the eyes, without skin protection. While very few organisms can enter the body through normal intact skin, direct contact with blood is to be avoided.

The airborne route of exposure is significant for common viral diseases including colds, flu, mumps, and chicken pox, but is not typically an exposure route for pathogens such as Human Immodeficiency Virus (HIV) or Hepatitis B Virus (HBV) infections.

Vector borne diseases are those transferred to humans by insects or animals and include lyme disease, malaria, plague, and rabies. (Further information on tick-borne diseases may be seen in HS-213.) Vectors are not considered a significant route of exposure for HIV or HBV.

Woodward-Clyde (W-C) employees that may have potential exposure to blood or to biohazard waste include Site Safety Officers (SSO) during first aid procedures and field staff on projects involving medical or other infectious waste. The W-C job classification and associated tasks for these categories are as follows:

Job Classification	Task Procedures/Description
Site Health and Safety Officer (SSO)	Enforcement of the Site Health and Safety Plan during field activities and First Aid
Field Staff	Field projects involving potential exposure to medical or other infectious waste as defined by the Site Health and Safety Plan

211.3 IMPLEMENTATION SCHEDULE AND METHODOLOGY

W-C will incorporate this Operating Procedure when first-aid capability is provided by W-C or when field work involves medical or infectious waste. More detailed procedures, if needed, will be incorporated into a site specific safety and health plan.

211.4 COMPLIANCE METHODS

Universal precautions will be observed at all work site locations in order to prevent contact with blood or other potentially infectious materials. All blood or other potentially infectious material will be considered infectious regardless of the perceived status of the source individual.

Engineering and work practice controls will be utilized to eliminate or minimize exposure to employees at all work site locations. Where occupational exposure remains after institution of these controls, personal protective equipment shall also be utilized. At all work site locations the following procedures will be utilized:

- Separate containers for used first aid equipment

- Flush skin areas where cuts or abrasions have occurred before adding band aids or clean wrappings

- Gloves to be worn by those administering first aid
- Handwashing after administering first aid
- Removal of blood contaminated clothing
- Clean-up of blood on tools or equipment

The controls will be checked and maintained on a regular schedule. The schedule for reviewing the effectiveness of the controls is as follows:

- Controls and procedures will be checked daily before start of any field activities.
- Maintaining and enforcing these controls will be the responsibility of the Site Health and Safety Officer.

Handwashing facilities must be readily accessible after incurring exposure. If handwashing facilities are not feasible, the SSO is required to provide either an antiseptic cleanser in conjunction with a clean cloth/paper towels or antiseptic towelettes. If these alternatives are used, then the hands are to be washed with soap and running water as soon as feasible.

If employees incur exposure to their skin or mucous membranes then those areas shall be washed or flushed with water, as appropriate, as soon as feasible following contact.

211.5 CONTAINERS

Contaminated cutting materials, (i.e., knife, scissors) that are re-usable are to be placed immediately, or as soon as possible after use, into a separate container. These containers must be puncture resistant, labeled with a biohazard label, and be leakproof.

Containers for biohazard waste (used bandages, used gloves, etc.) will be located in the same area as the first aid equipment, and will be the responsibility of the SSO for proper disposal. Disposal will be arranged as soon as possible after use. These containers must be labeled with a biohazard label, and be leakproof

211.6 WORK AREA RESTRICTIONS

Workers are not to eat, drink, or smoke in areas with potential exposure to infectious materials.

All procedures will be conducted in a manner which will minimize splashing, spraying, splattering, and generation of droplets of blood or other potentially infectious materials. To help accomplish this, first aid personnel will not apply their unprotected hands to any patient body areas where blood is present.

211.7 SPECIMENS

Certain W-C worksites require the collection of blood or urine specimens for worker monitoring. Specimens will be placed in a container which prevents leakage during the collection, handling, processing, storage, and transport of the specimens. The container used for this purpose will be labeled or color coded with correct information.

If outside contamination of the primary container occurs, the primary container shall be placed within a secondary container which prevents leakage during the handling, processing, storage, transport, or shipping.

211.8 CONTAMINATED EQUIPMENT

Equipment which has become contaminated with blood or other potentially infectious materials shall be decontaminated as necessary unless the decontamination of the equipment is not feasible. This decontamination will be kept separate from any other on-site decontamination. Items contaminated with blood and also possible chemical contamination shall be placed in a container and labeled with its suspected contaminants, including the blood. Further instructions for disposal will be obtained from the Health and Safety Officer (HSO).

211.9 PERSONAL PROTECTIVE EQUIPMENT (PPE)

Personal protective equipment will be chosen based on the anticipated exposure to blood or other potentially infectious materials. The protective equipment will be considered appropriate only if it does not permit blood or other potentially infectious materials to pass through or reach the employees' clothing, skin, eyes, mouth, or other mucous membranes under normal conditions of use and for the duration of time which the protective equipment will be used. This PPE will be stored or placed with all first aid equipment or kits.

All personal protective equipment will be cleaned, laundered, and disposed of by the employer at no cost to employees.

Any clothing which is penetrated by blood shall be removed immediately or as soon as feasible. PPE will be removed prior to leaving the work area.

Gloves shall be worn where it is reasonably anticipated that employees will have had contact with blood or other potentially infectious materials. Gloves will be available from the first aid kit.

Disposable gloves used during first aid and/or emergency procedures are not to be washed or decontaminated for re-use and are to be replaced as soon as practical when they become contaminated or as soon as feasible if they are torn, punctured, or when their ability to function as a barrier is compromised. Utility gloves may be decontaminated for re-use provided that the integrity of the glove is not compromised. Utility gloves will be discarded if they are cracked, peeling, torn, punctured, or exhibit other signs of deterioration or when their ability to function as a barrier is compromised.

Respirators in combination with eye protection devices, such as goggles or glasses with solid side shield, or chin length face shields, are required to be worn whenever splashes, spray, splatter, or droplets of blood or other potentially infectious materials may be generated.

Tyvek coverall (coated or uncoated), should be worn if the potential exists for blood to splash onto the first aid responders clothing.

Any PPE, soil, or small equipment that has blood on it shall be placed in a lined container and labeled. The SSO shall contact the HSO for further disposal information.

211.10 LAUNDRY PROCEDURES

Laundry contaminated with blood or other potentially infectious materials will be handled as little as possible. Such laundry will be placed in appropriately marked bags at the location where it was used. The HSO will then be notified for further instructions.

All employees who handle contaminated laundry will utilize personal protective equipment to prevent contact with blood or other potentially infectious materials.

If the laundry is being sent off-site, then the laundry service accepting the laundry is to be notified.

211.11 HEPATITIS B VACCINE

All employees who have been identified as having exposure to blood or other potentially infectious materials, or are involved with any on-site first aid case, will be offered the Hepatitis B vaccine, at no cost to the employee. The vaccine is not necessary if the employee has previously had the vaccine. The employee can request antibody testing which will show if the employee has sufficient immunity.

Employees who decline the Hepatitis B vaccine will sign a waiver which uses the wording in Form HS 211-1

Employees who initially decline the vaccine but who later wish to be immunized may do so at no cost. The HSO of each office has the responsibility for assuring that the vaccine is offered, the waivers are signed, and the policy is enforced.

211.12 POST-EXPOSURE EVALUATION AND FOLLOW-UP

When the employee incurs an exposure incident, it should be reported to the HSO using W-C incident report HS-102.

All employees who incur an exposure incident will be offered post-exposure evaluation and follow-up.

This follow-up will include the following:

- Documentation of the route of exposure and the circumstances related to the incident.
- If possible, the identification of the source individual and, if possible, the status of the source individual. The blood of the source individual will be tested (after consent is obtained) for HIV/HBV infectivity.
- Results of testing of the source individual will be made available to the exposed employee with the exposed employee informed about the applicable laws and regulations concerning disclosure of the identity and infectivity of the source individual.
- The employee will be offered the option of having their blood collected for testing of the employee's HIV/HBV serological status. The blood sample will be preserved for up to 90 days to allow the employee to decide if the blood should be tested for HIV serological status. However, if the employee decides prior to that time that testing will or will not be conducted then the appropriate action can be taken and the blood sample discarded.
- The employee will be offered post-exposure prophylaxis in accordance with the current recommendations of the U.S. Public Health Service.
- The employee will be given appropriate counseling concerning precautions to take during the period after the exposure incident. The employee will also be given

information on what potential illnesses to be alert for and to report any related experiences to appropriate personnel.

- The HSO has been designated to assure that the policy outlined here is effectively carried out as well as to maintain records related to this policy.

211.13 INTERACTION WITH HEALTH CARE PROFESSIONALS

A written opinion shall be obtained from the health care professional who evaluates employees for each W-C office. Written opinions will be obtained in the following instances:

1) When the employee is sent to obtain the Hepatitis B vaccine.

2) Whenever the employee is sent to a health care professional following an exposure incident.

Health care professionals shall be asked:

1) Whether the Hepatitis B vaccine is indicated and if the employee has received the vaccine, or for evaluation following an incident.

2) That the employee has been informed of the results of the evaluation

3) That the employee has been told about any medical conditions resulting from exposure to blood or other potentially infectious materials.

211.14 TRAINING

Training for all employees will be conducted prior to initial assignment to tasks where occupational exposure may occur. Training for employees will include the following:

1) The OSHA standard for Bloodborne Pathogens

2) Epidemiology and symptomatology of bloodborne diseases
3) Modes of transmission of bloodborne pathogens
4) The exposure Control Plan, i.e., points of the plan, lines of responsibility, how the Plan will be implemented, etc.
5) Procedures which might cause exposure to blood or other potentially infectious materials while performing first aid.
6) Control methods which will be used at the facility to control exposure to blood or other potentially infectious materials
7) Personal protective equipment available on-sites
8) Post-exposure evaluation and follow-up
9) Signs and labels used on-site
10) Hepatitis B vaccine program for W-C

The HSO is responsible for providing the training for their office.

211.15 RECORDKEEPING

All records required by the OSHA standard will be maintained by the HSO.

All employees will receive refresher training every 12 months. (Note that this training is to be conducted within one year of the employee's previous training.)

The outline for the training material is located in each office and also with the WCGI Health and Safety Office in Philadelphia, Pennsylvania.

FORM HS 211-1

TO SECTION 1910.1030
HEPATITUS B VACCINE DECLINATION (MANDATORY)

I understand that due to my occupational exposure to blood or other potentially infectious materials I may be at risk of acquiring Hepatitis B virus (HBV) infection. I have been given the opportunity to be vaccinated with Hepatitis B vaccine at no charge to myself. However, I decline Hepatitis B vaccination at this time. I understand that by declining this vaccine, I continue to be at risk of acquiring Hepatitis B, a serious disease. If in the future I continue to have occupational exposure to blood or other potentially infectious materials and I want to be vaccinated with Hepatitis B vaccine, I can receive the vaccination series at no charge to me.

Name: ______________________________ ____________
Employee Signature Date

Print: ______________________________
Employee Name

Name: ______________________________ ____________
Health and Safety Officer Signature Date

Print: ______________________________
Health and Safety Officer Name

Woodward-Clyde

Revised: 10/93

OPERATING PROCEDURE NO. HS-212

212.0 NOISE/HEARING CONSERVATION

212.1 PURPOSE

The purpose of this Operating Procedure (OP) is to establish Woodward-Clyde (W-C) procedures and responsibilities for the administration of a hearing conservation program. A proper hearing conservation program will reduce the risk of occupationally induced hearing loss and provide education and guidance for the prevention of "lifestyle" induced hearing loss.

212.2 HAZARD INFORMATION

Excessive noise exposure can cause both temporary and permanent effects on hearing. The temporary effects of excessive noise include ringing in the ears, interference with communication, and hearing threshold changes. The effect of long-term excessive noise includes varying degrees of noise induced hearing loss.

The damaging effects of noise are dependent on the noise intensity (decibels), the time of exposure, the noise frequency (Hertz), and individual susceptibility. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) set exposure limits based on exposure per day (in hours) and sound intensity (in decibels A scale or dBA). Exposures above these limits require use of hearing protection (plugs or muffs) to reduce the sound level or the use of noise engineering controls to reduce the sound level.

It is known that noise intensity above 85 dBA for prolonged periods will induce hearing loss. Eighty-five dBA represents a noise level where normal conversation is difficult and individuals will be shouting or talking into the ear of the person to be understood.

212.3 REQUIREMENTS

OSHA regulations issued in late 1981 require a hearing conservation program for workers exposed to 85 dBA as an 8-hour time-weighted average.

The OSHA regulation addresses several requirements for a good hearing conservation program. These requirements are as follows:

- Noise exposure monitoring
- Audiometric testing
- Hearing protectors
- Training programs
- Access to information
- Recordkeeping and posting

212.4 RESPONSIBILITIES

Each employee has the responsibility to comply with all aspects of this Operating Procedure. Managers with input from the Health and Safety Officer (HSO)'s and Site Safety Officer (SSO)'s are responsible for enforcing the provisions of this Operating Procedure as it applies to field work. Scheduling of audiograms (accomplished through Medical Surveillance) and training are the responsibility of the HSO and Corporate Health and Safety Officer (CHSO).

212.5 NOISE EXPOSURE MONITORING

The SSO with assistance from the HSO and/or CHSO will determine when noise monitoring is required for jobs where W-C employees are potentially exposed to excessive noise. The SSO/HSO will perform noise monitoring as necessary and make recommendations to assure compliance with Section 212.3 of this Operating Procedure. Engineering controls, ear protection, and posting may be required to comply with Section 212.3. In jobs where W-C is working in a client's noisy area, W-C personnel will comply with the client's existing hearing conservation program. If a client has a noisy area and has no hearing conservation program, W-

C will establish a plan for its employees and subcontractors to be in compliance with Section 212.3.

212.6 TRAINING

All workers required to wear hearing protectors will be trained in their proper use. In addition, all workers who may be exposed to greater than 85 dBA will be provided refresher training. This training will include at least the following: (1) Effects of noise on hearing; (2) the purpose, selection, fitting, use and care of hearing protectors; and (3) the purpose of audiometric testing and an explanation of the test procedure.

212.7 HEARING PROTECTORS

When hearing protectors are required the employee must have received training on the proper use. Proper noise reduction ratings will be applied by the HSO/CHSO to the noise in the environment.

Hearing protectors act as barriers to reduce sound entering the ear. Noise Reduction Ratings (NRR) for each product reflects the effectiveness of the protector chosen. Generally, muffs offer a greater NRR (25-30 dBA) than plugs (15-25 dBA). Comfort is an important factor when wearing ear protection over many hours; it is recommended to try different types of plugs or muffs to determine the best combination of comfort and fit.

212.8 AUDIOMETRIC TESTING

Audiograms are administered upon employment and annually/biennially thereafter. The audiograms are conducted by the medical clinics approved for W-C physicals and must meet all the applicable requirements (including Appendices C, D, and E of the OSHA Std. Title 29 Code of Federal Regulations (CFR) 1910.95). The local medical clinic in consultation with Greaney Medical will comply with applicable provisions of Title 29 CFR 1910.95(g) with regard to recordkeeping.

212.9 ACCESS TO INFORMATION, RECORDKEEPING

Each office shall have a copy of Title 29 CFR 1910.95 available for any employee requesting access to the standard. Employee training aids shall also be available to any employee. All noise monitoring data shall be retained for at least two years and Greaney Medical shall maintain the audiometric results for thirty years beyond the last date of employment.

OPERATING PROCEDURE NO. HS-213

213.0 TICKS AND TICK-BORNE DISEASES

213.1 PURPOSE

The purpose of this Operating Procedure (OP) is to provide information to Woodward-Clyde (W-C) employees regarding the diseases transmitted by ticks, particularly Lyme disease, and how to reduce employee risk.

213.2 TICK-BORNE DISEASES

Tick-borne diseases represent a significant health risk in many parts of the world. The risk to W-C field staff depends on the work location, the time of year, the clothing worn and other factors. Ticks are documented vectors of virus and bacteria for diseases such as Lyme disease (North America, Europe), Rocky Mountain Spotted Fever (North America), Encephalitis, (Asia, Africa), Boutonneuse Fever (Africa, India, Middle East), and Rickettsiosis (Asia).

While specific information in this OP is limited to Lyme disease, the risk control measures apply to other tick-borne diseases.

213.3 LYME DISEASE

Lyme disease is caused by a coiled bacteria known as a spirochete and is most commonly transferred to humans through ticks. The disease has been found in almost all U.S. states and in Europe, but is most common in locations with a mixture of wooded areas and grasslands. The Lyme disease infection is spread in the wild by tick bites on animals, particularly mice and deer, and infection can include domestic animals such as cats, dogs, and cows. While a number of ticks can transfer Lyme disease, the very small deer tick is the most common.

The tick bite is usually not painful and because of the small size of the deer tick, is often not noticed. In most cases, the tick simply draws blood for its nourishment and after a few days drops off. If the tick is infected with the Lyme disease bacteria, it may be transmitted during this feeding process.

213.3.1 Lyme Disease Symptoms

A typical early symptom of infection is a slowly expanding red rash. The rash often starts as a flat or raised red area and slowly expands after several days, with partial central clearing, resulting in a red ring appearance. While most people will develop an observable red rash, some Lyme disease victims may lack this symptom.

Other common early symptoms of Lyme disease include fatigue, headache, muscle aches, neck stiffness, fever, and swollen glands.

Later symptoms, if untreated, include joint pain and swelling, nervous system problems, heart complications, and other effects. These later symptoms usually occur one to four months after the original infection and can result in permanent health effects.

213.3.2 Lyme Disease Treatment

Lyme disease is easily treated by use of antibiotics when detected early. Individuals that develop a rash or experience other early symptoms of Lyme disease should promptly see a physician for treatment. Although the disease is more difficult to treat if further advanced, it is still is treatable using larger antibiotic (usually intravenous) doses.

213.3.3 Reducing Lyme Disease Risk

Field personnel can reduce the risk of tick-borne diseases through proper clothing, use of repellents, use of good work practices, and recognizing early symptoms.

Field personnel in grassy or wooded areas should wear long pants, long sleeved shirts (tucked in), hat, and consider taping or cinching clothing at the ankles. Work in ares of known high tick concentrations (e.g. wetland areas) should consider use of Tyvek coveralls taped at the ankles and wrists.

Follow label directions carefully for use of tick repellents as many are designed for use on clothing, not on skin. Repellent use should be in combination with proper clothing and is most recommended for the ankles and wrists.

After working in an area of possible tick exposure, it is recommended that the individual shower promptly and check for any ticks. If a tick is found on the skin, remove it promptly using tweezers or forceps, followed by disinfection with alcohol or iodine. It takes several hours for a tick to attach and feed; removing it promptly lessens the chance of being infected.

OPERATING PROCEDURE NO. HS-513

513.0 GUIDELINES FOR THE TRANSPORTATION OF HAZARDOUS MATERIALS

513.1 PURPOSE

This Operating Procedure (OP) contains Woodward-Clyde (W-C) general guidelines for meeting the U.S. Department of Transportation (DOT) regulatory requirements for the safe transportation of hazardous materials (DOT HM-181 and HM-126F) within the U.S.

The shipping of compressed gases, radioactive materials (e.g. nuclear density meters), chemicals used for field tasks (e.g. nitric acid, formaldehyde, acetone), and related hazardous materials are specifically regulated in regard to packaging, labeling, and shipping papers. It is important to note that environmental samples may also be subject to these DOT requirements. Many W-C field shipments may be exempt. However the decision that environmental samples are exempt from the DOT regulations must be made case by case, based on an understanding of the DOT regulatory requirements. The shipper may have to estimate how much of the DOT regulated hazardous material(s) is present in the environmental sample shipment. In addition to the regulatory requirements, shipping contractors (e.g. Federal Express) and/or testing laboratories may refuse the shipment if incorrectly marked or identified.

Guidelines and rules for transportation of nuclear density meters can be located with the W-C Radiation Safety Officer for each W-C office with a license for their nuclear density meter. These guidelines and rules could differ for each W-C office due to state requirements.

The level of expertise needed by the shipper of DOT hazardous material shipments varies with the specific W-C assignment. The goal of this OP is to provide limited awareness level information. W-C employees acting as the client's representative for hazardous waste shipments or regularly shipping hazardous materials will need additional information including commercially available guidebooks and training as listed in sections 513.2 and 513.4.

513.2 GENERAL AND SPECIFIC REGULATORY INFORMATION

DOT standards for transporting hazardous materials (49 Code of Federal Regulations (CFR) 171-180) are under standard HM-181. Sections of these changes are in effect presently and others go in effect through October 1, 1996. HM-181 adopts the United Nations regulations with a slight variation for U.S. only shipments.

Specific information (e.g., packaging type, hazard class, labels, shipment quantities, additional DOT regulations requirements) can be found in the following recommended references:

- DOT Hazardous Material Regulations, HM-181 (49 CFR 171 - 180)
- Hazardous Materials 181: The Guide for Shippers, Handlers, and Transporters ; J.J. Keller and Associates (phone: 414-722-2848)
- Hazardous Materials Transportation Compliance Manual ; Coastal Video Communications Corporation (phone: 800-767-7703).
- IATA Dangerous Goods Regulations, Latest Edition; IATA Publications, (phone: 800-716-6326).
- Hazardous Materials Transportation; Lion Technology Inc. (phone: 201-383-0800).

513.3 GENERAL COMPANY POLICY

Woodward-Clyde is committed to informing its employees of hazardous substances present in their places of work in accordance with the DOT's Hazardous Material Regulation (HMR). This program applies to W-C work operations where incidents could occur exposing people and property to hazardous materials while the materials are transported from one place to another.

Chemicals needed at sites (e.g. nitric acid and acetone) should be shipped from the supplier directly to the worksite whenever possible. Reshipping these chemicals from the W-C office to the worksite may require UN specification packages.

Hazardous material shipments which are covered under the DOT regulations and are over DOT placard requirements may not be transported in W-C employees personal vehicles. Hazardous materials of any amount transported in employees vehicles must be removed from the vehicle at the end of the workday and properly stored. Nuclear density meters may be transported if approved by the W-C office radiation safety program.

Further information for specific situations can be obtained from the Health and Safety Officer/Coordinator, the Corporate Health and Safety Officer, and WCGI Health and Safety Department. Also information can be received, if no one from W-C is available, from the hazardous materials transportation training companies listed in section 513.4 of this OP. There could be a fee charge for using these companies.

Pre-planning is extremely important in preparing shipments to arrive on time as needed. If shipping papers, labels, packaging, etc., are incorrect, shipments may be returned or refused by the shipping contractor. Contacting the shipping contractor or the laboratory may help in the shipment arriving without delays.

Certain shipping contractors (e.g.,Federal Express) have decided to follow International Air Transport Association (IATA) guidelines instead of HM-181 because they are more conservative. If this situation occurs, you may need to follow additional guidelines or find another shipping contractor. Again, contacting your shipping contractor in advance will make you aware of their procedures and
prevent delays or shipment refusals. An example of a shipping contractor and phone number is Federal Express; 901-369-3854.
All hazardous material shipments or transportation by air must meet IATA guidelines. The main phone number for IATA is 515-985-6332.

513.4 RESPONSIBILITIES AND TRAINING REQUIREMENTS

All W-C employees involved in preparing, loading, or shipping hazardous materials for transportation must have received W-C DOT Transportation of Hazardous Materials training in compliance with DOT HM-126F. This regulatory compliance requirements includes:

General Awareness/Familiarization Training:

Familiarity with the general requirements of the Hazardous Material Regulations of the DOT and the guidelines of IATA.

Ability to recognize and identify HAZMAT materials that are marked, labeled, or otherwise identified as prescribed by the regulations.

Function-Specific Training:

Knowledge, skills, and abilities necessary to perform the specific requirements of the shipment or situation of the employee's job function. This training must cover shipment specific situations such as enviromental samples, choices of packaging, consumer commodities, and shipping papers.

Safety Training:

Familiarity with emergency response information and measures to protect the employee from hazards associated with the hazardous materials they are shipping or transporting.

W-C General Awareness\Familiarization Training is given as part of the HAZWOPER Refresher Training or as a special training class for W-C employees who are not HAZWOPER trained. This training must be received by the Hazmat shipper prior to the job assignment and as a refresher every 2 years. Safety training will be covered by the W-C Hazwoper training or Hazard Communication training.

Corporate Regional Health and Safety Officers are responsible to make sure each W-C office under their supervision has a trained, knowledgeable person available to give guidance for hazardous material shipping situations. This training can be received from various companies outside of W-C. Suggested training companies are:

Federal Express--901-369-3854 (IATA training)
Lion Technology--201-383-0800 (DOT training)

J.J. Keller and Associates--800-767-7703 (DOT training)

513.5 Emergency Information and Telephone Contact

DOT and IATA both require a 24-hour emergency telephone contact number to a knowledgeable person written on the shipping papers of the hazardous material shipment in case of a emergency situation. This contact person must also have access to MSDS for the chemicals or materials shipped. W-C has contracted with CHEM-TEL, an emergency response communication service in Temple Terrace,
Florida. Check with your health and safety officer to see if Chem-Tel has MSDS from our company on file for the materials you are transporting. If needed, Chem-Tels' NON-emergency phone number to check if they have MSDS on file for the chemical or materials transported or shipped is: 800-979-0626, FAX: 813-979-4620. Their emergency phone number to be placed on shipping papers is; 800-255-3924.

Every W-C office may use the services of CHEM-TEL if that office has given two emergency contact telephone numbers to CHEM-TEL or has made sure CHEM-TEL has received these telephone numbers for their specific office. You can find this information by contacting CHEM-TEL or your Safety Officer. If your office is not on CHEM-TEL's emergency telephone list, you must make other arrangements in order to meet this regulatory requirement. **Placing CHEM-TEL's emergency phone number on shipping papers without supplying them with contact phone numbers is in violation of our agreement with CHEM-TEL and violates DOT requirements.**

513.6 SHIPPING PAPERS INFORMATION

All W-C personnel shipping hazardous materials as described on the DOT or IATA Hazardous Materials Table must have available all the information listed in this section for each substance shipped as a hazardous material for use on shipping papers. Documents that could be used to provide this information include, but are not limited to MSDS, current DOT Emergency Response Guidebook, and Site Safety Plans.

The minimun required shipping paper information is as follows:

Proper shipping name

Numeric Hazard Class and Division
UN or NA number
Packaging Group in Roman numerals
Total quantity of the materials
Additional information required per 49 CFR 172.203 (e.g. "RQ", technical name)
Emergency response information

OPERATING PROCEDURE NO. HS-514

514.0 UNEXPLODED ORDNANCE (UXO)

514.1 PURPOSE

The purpose of this Operating Procedure (OP) is to provide an overview of the hazards associated with UXO and to provide information on screening, recognition and avoidance of UXO. The hazards associated with work performed to detect UXO cannot be eliminated, but thorough planning and awareness of the hazards can minimize the occurrence of incidents.

514.2 SCOPE

This OP is to be used as an informational reference for work activities associated with screening for UXO. This OP is to be used in conjunction with a site specific health and safety plan and UXO work plan. The excavation, removal, detonation, storage or transportation of UXO is not covered by this OP. The goal of this OP is UXO avoidance.

514.3 RESPONSIBILITIES AND AUTHORITIES

514.3.1 Woodward-Clyde

Woodward-Clyde (W-C) is responsible for the oversight of the UXO screening. W-C can either use approved W-C personnel or contract an EOD firm to perform the screening. The determination will be made by the W-C inhouse UXO expert. In either situation, W-C will have at least one on-site person (Site Supervisor) who will verify that the UXO workplan has been approved by W-C, that the procedures for UXO survey are adhered to, and who will document that the procedures are being followed. The W-C Site Supervisor will be thoroughly familiar with the work plans prepared by W-C or the subcontractor.

514.3.2 UXO Team

The personnel (UXO Team) (either W-C or EOD subcontractor) selected to perform the UXO screening will provide the W-C inhouse UXO expert with a UXO work plan prior to any work beginning on the site. The UXO Team will consist of personnel trained to the level required by their job (see below). The UXO Team will provide UXO recognition, location and safety measures for W-C and will confirm or eliminate the suspected presence of UXO. The UXO Team will plan for and provide a site-specific health and safety briefing to all on-site project personnel that summarized the type of UXO anticipated, the survey work to be performed on-site, and any safety measures (e.g., marking of UXO) that will be used on-site.

The UXO Team is responsible for the selection, calibration and operational reliability of all instruments used for the detection of UXO.

514.4 TRAINING

Only qualified personnel shall be allowed to perform UXO screening. Qualifications will based on education, previous experience, or on-the-job training with supervision by another qualified person. All personnel engaged in UXO screening shall be thoroughly trained in explosive safety and be capable of recognizing hazardous explosive exposures. The W-C in-house UXO expert will review and approve personnel for UXO screening.

If the work will be performed at a Department of Defense (DOD) facility, the UXO team will be comprised of the UXO Supervisor (Team Leader) and the UXO Specialist(s) (Team Members[s]). The UXO Supervisor will be a graduate of the U.S. Naval EOD School, Indian Head, MD with at least ten years of combined active duty military EOD and contractor UXO experience with a minimum of three years active duty military EOD experience. The UXO Specialist will be a graduate of the U.S. Naval EOD School, Indian Head, MD with at least three years of active duty military EOD experience. Only personnel who have graduated from the US Naval EOD, Indian Head, MD are authorized to perform UXO procedures at a DOD facility.

A minimum of two people per team are required for all UXO surveys.

514.5 TYPES OF UXO

UXO, as defined in this OP, refers to anything related to munitions designed to cause damage to personnel or material through explosive force, incendiary action, or toxic effects, such as bomb, guided and ballistic missiles; artillery, mortar, and rocket ammunition; small arms ammunition; antipersonnel and antitank land mines, demolition charges; pyrotechnics; grenades, torpedoes and depth charges; containerized and uncontainerized high explosives and propellants; depleted uranium projectiles; toxic military chemical agents; and soils with sufficient concentrations of explosive constituents to present an imminent safety hazard.

As shown above, UXO can be present in a variety of forms. UXO generally is ordnance that has failed to function as designed or has been abandoned or discarded and remains unexploded. It is important to note that the type of UXO encountered can depend upon the history and background of the specific site. This OP will not attempt to list all types, but give an overview of common types. In general, UXO can be dropped, projected, thrown or placed.

514.5.1 Dropped ordnance.

Dropped ordnance (see Figure 1) is dispensed or dropped from an aircraft and is further divided into three sub groups: bombs; dispensers (which contain submunitions); and submunitions.

Bombs. Bombs come in many shapes and sizes. Generally, they consist of a metal container, a fuse and a stabilizing device. The metal container can hold an explosive or chemical substance. Colored bands around the container can indicate the contents. The U.S. and North Atlantic Treaty Organization (NATO) color code for chemical munitions is a gray background with a dark green band, however, this color code is not an absolute and can vary. The fuse is used to initiate the bomb and can be mechanical or electrical. Fuzes cannot function until they are armed. The action of the fuse can be impact (when they hit the target), proximity (when they reach a predetermined height above the target) or delay (when a specified time has elapsed). The stabilizer is a fin or parachute that stabilizes the bomb while in flight.

Dispensers. Dispensers, like bombs, are carried by aircraft. Dispensers carry smaller ordnance called submunitions (see below). Dispensers come in a variety of shapes and sizes depending on the type of submunitions inside. Dispensers can be dropped or attached. Dropped dispensers are like a bomb. They are released from the aircraft and have a container, fuse and stabilizer. The container holds submunitions. The fuse is either mechanical time or proximity. Attached dispensers are attached to the aircraft and can be reloaded and used again.

Submunitions. Submunitions are classified as either bomblets, grenades, or mines. They are small explosive-filled or chemical-filled items. Submunitions are spread by dispensers, missiles, rockets or projectiles. Submunitions are designed for saturation coverage of a large area. Submunition fuzes are impact, pressure sensitive, antidisturbance (trip wires detonate the submunition and are extended upon impact), self destruct, active life (will detonate after the active life has expired) or magnetic (receive a signal from a metallic object).

514.5.2 Projected Ordnance

All projected ordnance is fired from some type of launcher or gun tube. Projected ordnance is subdivided into five groups: projectiles; mortars; rockets; guided missiles; and rifle grenades (see Figure 2).

Projectiles. Projectiles can be filled with explosives, chemicals, white phosphorous (WP), illumination flares or submunitions. Projectiles can have impact proximity fuzing or time delay. Approaching a projectile with a proximity fuse can cause the fuse to function and the projectile will detonate.

Mortars. Mortars are like projectiles and can be filled with explosives, chemicals, WP or illumination flares. Mortars look like projectiles but are generally have a smaller diameter. Mortars have the same fuzing as projectiles.

Rockets. A rocket is a self-propelled projectile, but cannot be guided in flight. Rockets do not have a standard shape or size, they can range from 1 foot to over 9 feet in length. Rockets have a warhead, fuse, rocket motor and stabilizer. The warhead can contain explosives, chemicals, WP, illumination flares or submunitions. Usually the rocket motor will not be a hazard as the motor is usually burned out shortly after the rocket leaves the launcher.

Guided Missiles. Guided missiles contain the same components as a rocket, the main difference is that missiles are guided to their target by various systems. An example of a guided missile is the phased-array tracking radar intercept on target (PATRIOT) missile. Guided missiles use internal proximity fuzing which can detonate if approached.

Rifle Grenades. Rifle grenades look like mortars and are fired from a rifle that is equipped with a grenade launcher. Rifle grenades can be filled with high explosives, WP, chemicals, illumination flares or colored screening smoke. Rifle grenade use impact fuzing.

514.5.3 Thrown Ordnance

Thrown ordnance, also known as hand grenades, have a body, a fuse with a pull ring and safety clip and a filler (see Figure 3). The filler can be a combination of explosives and chemicals. The body can be plastic or metal. Different types of grenades include antitank (with a shaped charge inside), fragmentation, smoke (bursting or burning) and illumination (illuminating, signaling or incendiary). Grenades can be booby-trapped so that even if the ring and clip are still attached the grenade could detonate.

514.5.4 Placed Ordnance

Placed ordnance, also known as land mines, can be hidden or buried under ground (see Figure 4). Placed ordnance can be metal, plastic or even wood. Placed ordnance can be antipersonnel or antitank mines. Antipersonnel mines detonate when stepped on, when a trip wire is pulled or cut or by remote control detonation. Antitank mines are generally much larger than antipersonnel mines. Antitank mines usually are pressure or tilt-rod fuzed, but some can be magnetic-sensitive fuzed.

514.5.5 Identification.

If UXO is discovered after years of exposure, it will most likely be deteriorated making a positive identification difficult. EOD personnel have access to EOD 60 Series publications, a reference document with detailed information on the identification and function of specific ordnance. However, these documents are frequently classified and not readily available at field locations. Therefore, identification of UXO may rely heavily on experience.

If UXO is encountered, the UXO will be clearly marked by the UXO Team and the area will be evacuated.

514.6 HAZARDS OF UXO

All UXO, regardless of color coding, state of deterioration, or suspected use (e.g., training device) shall be considered armed and hazardous. Damaged UXO may have exposed components, trailing wires or breaks in integrity that render it much more sensitive than it was in its original state. The hazards associated with UXO can be divided into two groups: chemical and physical.

Chemical hazards will depend upon the type of UXO. UXO can contain explosive related chemicals or military agents.

Explosive related chemicals (lead azide and lead styphnate, trinitrotoluene, cyclonate or tetryl) are generally absorbed through the skin, although they can be inhaled if the particulate becomes airborne. Symptoms associated with exposure include dizziness, nausea and increased heart rate.

These chemicals can be lethal if ingested in large quantities. Chemicals such as nitroglycerin (found in dynamite) can become shock sensitive after time and can detonate.

Miliary agents are substances that are intended for use in military operations to kill, seriously injure or incapacitate a person through the physiological properties of the chemical. These agents can include the following:

- G-series: Non-persistent organophosphate nerve gases
- H-series: Mustard gases or blister agents
- L-series: Blister agents, organic arsenic based
- V-series: Persistent organophosphate nerve gases
- White Phosphorous (WP): WP is a chemical that ignites on contact with air.

If military agents are suspected at the site, detailed information regarding the type anticipated and routes of exposure will be sought. A decontamination plan will be written based upon the chemicals anticipated prior to work being performed at that site.

Physical hazards are associated with detonation or blast effects. These pose the risk of injury or death. Injury can range from minor cuts associated with shrapnel to severe burns from hot exhaust. Detonation can occur while approaching or handling UXO, or from a timed fuse.

514.7 SCREENING TECHNIQUES AND LIMITATIONS

The surface of a range, target area, impact area or ricochet area of a range, active or inactive, can contain UXO. A surface and subsurface survey for UXO will precede any type of activities within an area suspected of containing UXO. All footpath and/or vehicular travel areas (surface and subsurface) will be surveyed and any UXO found will be conspicuously marked and avoided. No personnel will be allowed outside of these surveyed areas. A subsurface survey is especially important as it is possible for a vehicle to travel over an UXO and cause the item to detonate or for an UXO to be struck by a drill bit, backhoe, etc. and detonate. The EOD team will identify magnetic anomaly free areas for intrusive site activities. This will be accomplished using a magnetometer with downhole monitoring capabilities.

There are various detection technologies available. Factors that could influence the type of technology used include the size of the facility, the proximity to other buildings or a town and the type of UXO. Prior to screening for UXO, the site should be surveyed for electromagnetic radiation (EMR) radio frequency (RF) transmitters (e.g., radio, radar and television transmitters) as certain types of ordnance are susceptible to EMR RF.

Low-Sensitivity Magnetometer (LSM). LSMs are geophysical instruments that are used to locate anomalies. LSMs are a non-intrusive method of UXO detection. They do not emit electromagnetic radiation. They do not detect nonferrous UXO. LSMs are used for surface detection.

High Sensitivity Magnetometer (HSM). HSMs operate on the same principle as the LSM, but have a greater detection capability. Different models are available and certain models can locate large UXO up to 20 feet underground. Other models have a detachable sensor probe which can be used in underwater and downhole detections.

Metal Detector. Metal detectors, such as the Schonstedt, have a limited capability for UXO detection. Some metal detectors, such as the Eagle Spectrum, can detect nonferrous metallic objects. However, they emit low-frequency radiation and most models can only detect to two feet below the ground surface.

514.8 GENERAL SAFETY PRECAUTIONS

Personnel working in or around a UXO area shall utilize the following safety precautions:

- All personnel not involved in UXO screening shall keep a minimum safe distance of 300 feet from the work area

- Do not carry fire or spark-producing devices on site

- Do not become careless by reason of familiarity with UXO

- Do not conduct UXO operations during electrical, sand, dust or snow storms

- Do not wear outer or undergarments made of wool, silk, or synthetic textiles such as rayon and nylon while working in areas suspected to contain UXO. These materials can generate sufficient static charge to initiate explosives

- All field personnel are responsible for reporting a suspected or potential dangerous situation to the UXO Team. This includes the presence of a strong chemical odor, the visual observance of smoke or fire or a suspected UXO item not identified by the UXO Team

- All UXO work shall be performed under an approved UXO work plan

- An evacuation plan will be prepared prior to beginning any UXO work. This plan will detail the emergency signal for operational shut down and evacuation, give the prearranged safe distance and emergency meeting areas

- Communications should be maintained and the work party must have a system for a rapid and clear distress call back to command post

- Check to insure that all preplanning information is correct

- Thoroughly understand tasks to be performed

- Thoroughly brief all team members on all aspects of the tasks

514.9 EMERGENCY EQUIPMENT

Provisions should be made to have appropriate emergency equipment available and in proper working condition. This equipment may include:

- First aid kits;
- Eye wash kits - fill and pressurize;
- Fire extinguisher;
- Emergency oxygen;
- Splints;
- Stretcher;
- Blankets; and
- Life vests.

Equipment should be checked before commencing site investigation activities, and defective equipment repaired or replaced before performing site investigation. Provisions should be made for redundant or back-up safety equipment.

514.10 EMERGENCY PROCEDURES

There are three methods available to protect personnel in the event that UXO is discovered: evacuation, isolation and barricade. This OP calls for the evacuation of all nonessential personnel. The UXO Team will be responsible for the safe evacuation of all personnel in the area. The distance to evacuate is dependant upon the estimated weight of explosives of the UXO. The minimum safe distance is 300 feet. Once personnel are safely evacuated, the UXO Team Supervisor will contact the base or local EOD team and notify them of the type and number of UXO found. W-C personnel and the UXO Team will NOT attempt to excavate, remove, detonate, store or transport any UXO.

514.11 REFERENCES

FM 21-16	FIELD MANUAL NO. 21-16, UNEXPLODED ORDNANCE PROCEDURES, HEADQUARTERS, DEPARTMENT OF THE ARMY
ETL 385-1-1	SAFETY CONCEPTS AND BASIC CONSIDERATION FOR UNEXPLODED ORDNANCE OPERATIONS (draft), DEPARTMENT OF THE ARMY, U.S. ARMY CORPS OF ENGINEERS
ETL 385-1-2	GENERIC SCOPE OF WORK FOR ORDNANCE AVOIDANCE OPERATIONS (draft), DEPARTMENT OF THE ARMY, U.S. ARMY CORPS OF ENGINEERS

ATTACHMENT C

Documentation Forms

SAFETY BRIEFING AND COMPLIANCE AGREEMENT

Date/Time: ______________________ W-C Project Name: ______________________
Site Location: ______________________ W-C Project No.: ______________________
Site Safety Officer: ______________________ Project Manager: ______________________
Activity: ______________________ Subsite Name: ______________________

In compliance with the Health and Safety Plan/SHERP, a safety briefing was held for personnel assigned to the field work on the above project and activity. The following topics were covered during the safety briefing:

____ Project description and Scheduled field activities
____ Personnel assignments and responsibilities
____ Chemical hazards, identification, and precautions
____ Physical hazards, identification, and precautions
____ Biological hazards, identification, and precautions
____ Hazard assessment by task
____ Standard operating procedures, site procedures/prohibitions
____ Levels of protection and PPE
____ Air monitoring requirements
____ Decontamination requirements and procedures
____ Work zones and communication systems
____ Emergency response procedures
____

I have received a copy of the Health and Safety Plan/SHERP and attended a safety briefing. I agree to abide by its provisions and to aid the Site Safety Officer in its implementation. I understand it is in the best interest of myself and my co-workers to ensure that site operations are conducted in the safest manner possible. I affirm that my safety training and medical are current and in compliance with OSHA regulations.

Name	**Signature**	**Company**

Name	Signature	Company

SAFETY MEETING FORM

Date/Time: ______________________ W-C Project Name: ______________________

Site Location: ______________________ W-C Project No.: ______________________

Site Safety Officer: ______________________ Project Manager: ______________________

Activity: ______________________ Subsite Name: ______________________

In compliance with the SHERP, a safety meeting was held and the following topic(s) was/were covered:

____

____

Name	Signature	Company

Name	Signature	Company

FORM HS-102

W-C HEALTH AND SAFETY INCIDENT REPORT

Project Name: ____________________

Project Number: ____________________

Date of Incident: ____________________

Time of Incident: ____________________

Location: ____________________

____

TYPE OF INCIDENT (Check all applicable items)

☐ Illness ☐ Fire, explosion, flash

☐ Injury ☐ Unexpected exposure

☐ Property Damage ☐ Vehicular Accident

☐ Health & Safety Infraction

☐ Other (describe) ____________________

DESCRIPTION OF INCIDENT (Describe what happened and possible cause. Identify individual involved, witnesses, and their affiliations; and describe emergency or corrective action taken. Attach additional sheets, drawings, or photographs as needed.)

Reporter: ____________________ ____________________ ____________________

Print Name Signature Date

Reporter must deliver this report to the Operating Unit Health & Safety Officer within 24 hours of the reported incident for medical treatment cases and within five days for other incidents.

Reviewed by: ____________________ ____________________

Operating Unit Health & Safety Officer Date

Distribution by HSO:

- WCGI Corporate Health and Safety Manager
- Corporate Health and Safety Officer
- Project Manager
- Personnel Office (medical treatment cases only)

U.S. ARMY ABBREVIATED GROUND ACCIDENT REPORT *(AGAR)*

For use of this form, see AR 385-40 and DA Pamphlet 385-40; the proponent agency is OCSA

REQUIREMENT CONTROL SYMBOL
CSOCS-308

1. TIME & DATE OF ACCIDENT | a. Yr | b. Mth | c. Day | d. Time | 2.PERIOD OF DAY ☐ Day ☐ Night | 3. ACDT CLASS | 4. ACDT OCCURRED DURING: ☐ Combat ☐ Non-Combat

5. UNIT IDENTIFICATION | a. UIC *(6-digit Code)* | b. Name of Unit | c. Unit's Branch | d. MACOM

6. LOCATION OF ACCIDENT | a. Exact Location *(Detailed enough to locate site)* | b. Type Location

c. State/County | d. ☐ Off Post ☐ On Post Name: | 7. EXPLOSIVES/AMMO | a. Present ☐ Yes ☐ No | b. Involved ☐ Yes ☐ No

8. MISSION | a. Briefly describe the mission | b. METL Task? ☐ Yes ☐ No

9. VEHICLE/EQUIPMENT/MATERIEL INVOLVED | Materiel Failure/Malfunction Information

a. Type of Item (Nomenclature)	b. Model #	c. Ownership	d. Estimated Cost of Damage	e. Vehicle Collision	f. Failure Mode	g. Part Nomenclature	h. Part #	i. Part NSN	j. Part Manufacturer Code	k. EIR/QDR Submitted
#1										☐ Yes ☐ No
#2										☐ Yes ☐ No

10. WHY DID THE MATERIEL FAIL/MALFUNCTION? *(Check the root cause(s) in Block a.In Block b,explain how the root cause(s) led to the materiel*

a.	LEADER *(Not ready, willing to enforce standards)*		STDS/PROCEDURES *(Not clear, Not practical)*			SUPPORT *(Shortcomings in type, capability, amount or condition of equip/supplies/services/facilities)*		
☐	Direct Supervision	☐	AR	☐	SOP	☐	Equip/Materiel improperly designed	☐ Inadequate Manufacture
☐	Unit Command Supervision	☐	TM	☐	Other	☐	Equip/Materiel not provided	☐ Inadequate Maintenance
☐	Higher Command Supervision	☐	FM	☐	None exists	☐	Inadequate Facilities/Services	☐ Other

b. Describe how the materiel failed/malfunctioned and explain why *(root cause)*

11. NAME (Last, First, MI) (Include Address & UIC if different than Blks 5a &b.)

12. SOCIAL SECURITY #

13. PERSONNEL CLASSIFICATION | 14. MOS | 15.DUTY STATUS ☐ On-duty ☐ Off-duty

16. AGE | 17. SEX | 18. PAY GRADE | 19. FLIGHT STATUS ☐ Yes ☐ No

20. MOST SEVERE INJURY *(See instructions)* | a. Degree | b. Type | c. Body Part | d. Cause

21. DAYS HOSPITALIZED

ACTIVITY OF INDIVIDUAL *Provide code (from list in instructions) and describe in space below.*

23. CODE

24. SPECIFIC DESCRIPTION OF ACTIVITY/TASK

22. WORKDAYS

a. Lost

b. Restricted

25. PERSONAL PROTECTIVE EQUIP

26. ALCOHOL/DRUGS CAUSE/CONT ☐ Yes ☐ No ☐ Unk

27. EQUIP THIS PERSON WAS ASSOCIATED WITH? *(Enter item No. from Blk 9a)*

a. Required	b.Type of equip	c. Available	d. Used	28.LICENSED TO OPERATE EQUIP	29. HRS ON DUTY	30.HRS SLEEP	31.TACTICAL TRAINING	32. TYPE TRAINING FACILITY	33.LAST TRAINING	34.FIELD TRAINING EXERCISE	35.NIGHT VISION SYSTEM USED
☐ Yes ☐ No	#1 ______ #2 ______	#1 No #2 No	#1 N #2 N	☐ Yes ☐ No			☐ Yes ☐ No			☐ Yes If Yes, provide name: ☐ No	☐ Yes If Yes, provide name: ☐ No

36. DID INDIVIDUAL MAKE A MISTAKE THAT CAUSED/CONTRIBUTED TO ACCIDENT? *In Blk a., indicate if individual made a mistake. If yes provide the code (from instructions) in Blk b. and describe in Blk c.*

a. Mistake ☐ Yes ☐ No

b. Code

c. Tell what the mistake was and how it caused/contributed to the accident

DA FORM 285-AB-R, JUL 94

USAPPC V2.00

37. WHY WAS THE MISTAKE MADE *(ROOT CAUSE)(Check the root cause(s) in Blk a. In Blk b. tell how the root cause(s) led to the mistake.)*

a.	LEADER *(Not ready, willing to enforce standards)*		TRAINING *(Insufficient in Content/Amount)*		STDS/PROCEDURES *(Not clear/Not practical)*				SUPPORT *(Shortcomings in type, capability, amount or condition of equip/supplies/services/facilities)*				INDIVIDUAL *(Mistake due to own personal factors)*		
	Direct Supervision		School		AR		SOP		Equip/Materiel improperly designed		Inadequate Manufacture		Poor/Bad attitude		Fatigue
	Unit Command Supervision		Unit		TM		Other		Equip/Materiel not provided		Inadequate Maintenance		Overconfident		Alcohol, Drugs
	Higher Command Supervision		Experience, OJT		FM		None exists		Inadequate Facilities/Services		Other		In a hurry		Fear/Excitement

b. Describe root cause(s) *(reason)* and tell how it/they caused the mistake

38. ENVIRONMENTAL CONDITIONS

a. Present:

#1 ______ ☐ Yes ☐ No ☐ Unk

#2 ______ ☐ Yes ☐ No ☐ Unk

#3 ______ ☐ Yes ☐ No ☐ Unk

39. PROVIDE BRIEF SYNOPSIS OF ACDT *(Use additional sheets if required)(Explain sequence of events, tell how acdt happened.)*

40. CORRECTIVE ACTION(S) TAKEN OR PLANNED

41. POINT OF CONTACT FOR INFORMATION ON THE ACCIDENT

a. Name (Last, First, MI)

b. Telephone # DSN: ______

COM:

42. COMMAND REVIEW a. Name

b. Signature

c. Rank

d. Date

43. SAFTEY OFFICE REVIEW

a. Name

b. Date

REVERSE OF DA FORM 285-AB-R, JUL 94

U.S. ARMY ACCIDENT REPORT INDEX A For use of this form, see AR 385-40 and DA Pamphlet 385-40; the proponent agency is OCSA	*REQUIREMENTS CONTROL SYMBOL CSOCS-308*

1. DATE OF ACCIDENT *(YYMMDD)*

2. TAB	Information	Encl	Not Applic	See Remarks
1	Serious Incident/Casualty Report			
2	Copy of Orders Appointing Investigating Board			
3	Map of Accident Site			
4	Diagrams and/or Photographs			
5	Certificate of Damage/ECOD			
6	Copy of Deficiency Reports			
7	Copy of Directives, Regulations, Etc.			
8	Special Technical Reports and Laboratory Analysis			
9	Copy of Uncorrected Fault Record			
10	Copy of Equipment Modification Record *(DA Form 2408-5)*			
11	Weather Data			
12	Medical Data *(Autopsy, Toxicology, AFIP, etc.)*			
13	Other *(Specify)*			
14	Other *(Specify)*			
15	Other *(Specify)*			
16	Other *(Specify)*			
17	Other *(Specify)*			
18	Other *(Specify)*			

3. REMARKS

U.S. ARMY ACCIDENT REPORT **INDEX B** For use of this form, see AR 385-40 and DA Pamphlet 385-40; the proponent agency is OCSA	*REQUIREMENTS CONTROL SYMBOL* *CSOCS-308*

1. DATE OF ACCIDENT *(YYMMDD)*

2. TAB	Title	Encl	Not Appl	See Remarks
A	Statement of Reveiwing Officials *(DA Form 285-O)*			
B	U.S. Army Accident Report *(DA Form 285)*			
C	Findings and Recommendations			
D	Narrative of Accident			
E	Summary of Witness Interviews *(DA Form 285-W)*			

3. REMARKS

4. BOARD MEMBERS

a. President *(Name and Signature)*	SSN		Address and Tel No.
	Grade	Br	
b. Recorder *(Name and Signature)*	SSN		Address and Tel No.
	Grade	Br	
c. Flight Surgeon *(Name and Signature)*	SSN		Address and Tel No.
	Grade	Br	
d. Instructor Pilot *(Name and Signature)*	SSN		Address and Tel No.
	Grade	Br	
e. Maint Officer *(Name and Signature)*	SSN		Address and Tel No.
	Grade	Br	
f. Other *(Name and Signature)*	SSN		Address and Tel No.
	Grade	Br	

DA FORM 285-B-R, JUL 94

USAPPC V1.00

U.S. ARMY ACCIDENT REPORT **STATEMENT OF REVIEWING OFFICIALS** For use of this form, see AR 385-40 and DA Pamphlet 385-40; the proponent agency is OCSA	*REQUIREMENTS CONTROL SYMBOL* *CSOCS-308*

1. REVIEWING OFFICIALS COMMENTS

2. APPROVING AUTHORITY COMMENTS

a. Signature

3. DEPARTMENT OF ARMY REVIEW

a. Signature

4. DATE OF ACCIDENT *(YYMMDD)*

DA FORM 285-O-R, JUL 94

USAPPC V2.00