HEALTH AND SAFETY PLAN (HASP)

Site: WILLIAMSBURG WORKS FORMER MANUFACTURED GAS PLANT

Location: BROOKLYN, NEW YORK

Date Prepared: FEBRUARY 2008

Revision: 0

Project Description: SUBSURFACE SOIL SAMPLING, SURFACE SOIL SAMPLING, GROUNDWATER SAMPLING AND SEDIMENT SAMPLING

Potential Waste types: Dense non-aqueous phase liquid (DNAPL) tar, tar-impacted soil and groundwater

Characteristics: Volatile Compounds, Toxic

Unusual Site Features: The Williamsburg Works Former Manufactured Gas Plant site is developed with commercial and industrial buildings, and a garage.

Status: Manufacturing land use. Utilities are located within the street right-of-ways and on privately-owned parcels.

Background Review: Site Records Review

Overall Hazard: Low

NATIONAL GRID USA (NGRID) CORPORATION, NATIONAL GRID USA (NGRID) CORPORATION CONTRACTORS AND SUBCONTRACTORS DO NOT GUARANTEE THE HEALTH OR SAFETY OF ANY PERSON ENTERING THIS SITE. DUE TO THE NATURE OF THIS SITE AND THE ACTIVITY OCCURRING THEREON, IT IS NOT POSSIBLE TO DISCOVER, EVALUATE, AND PROVIDE PROTECTION FOR ALL POSSIBLE HAZARDS THAT MAY BE ENCOUNTERED. STRICT ADHERENCE TO THE HEALTH AND SAFETY GUIDELINES SET FORTH HEREIN WILL REDUCE, BUT NOT ELIMINATE, THE POTENTIAL FOR INJURY AT THIS SITE. THE HEALTH AND SAFETY GUIDANCE IN THIS PLAN WAS PREPARED TO SERVE AS AN EXAMPLE TO POTENTIAL CONTRACTORS AND SUBCONTRACTORS THAT MAY WORK AT THIS SITE AND SHOULD NOT BE USED ON ANY SPECIFIC PROJECT WITHOUT PRIOR RESEARCH AND EVALUATION BY TRAINED HEALTH AND SAFETY SPECIALISTS.
CONTRACTOR CERTIFICATIONS

By their signature, the undersigned hereby certify that this HASP has been reviewed and approved for use at the National Grid USA (NGRID), formerly KeySpan Corporation Williamsburg Works Former Manufactured Gas Plant Site located in Brooklyn, New York.

_________________________________________  ______________________________
PROJECT MANAGER  DATE

_________________________________________  ______________________________
SITE SAFETY OFFICER  DATE

_________________________________________  ______________________________
CORPORATE ENVIRONMENTAL AND SAFETY MANAGER  DATE
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# Health and Safety Plan

## Williamsburg Works Former MGP

### Remedial Investigation

### Brooklyn, New York

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Appendix H – Lock Out/Tag Out Program
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1.0 INTRODUCTION

1.1 Purpose

This Health and Safety Plan (HASP) addresses the health and safety practices that will be employed by workers participating in investigation activities at the Williamsburg Works Former Manufactured Gas Plant (MGP) Site (Site) that are under the direction of the Consultant. This work will be performed on behalf of National Grid USA (NGRID), formerly KeySpan Corporation at the Site located in the Williamsburg neighborhood of Brooklyn, New York. The HASP takes into account the specific hazards inherent to the Site, and presents procedures to be followed by the Consultant, Contractor, Subcontractor(s), and all site visitors in order to avoid and if necessary, protect against health and/or safety hazards.

Activities performed under this HASP will comply with applicable parts of OSHA Regulations, primarily 29 CFR Parts 1910 and 1926 and attached NGRID policies and procedures. A copy this HASP will be maintained at the Site for the duration of work.

All workers who may participate in activities at the Site are required to comply with the provisions specified in this HASP. All site visitors who enter designated work zones must also comply with this HASP. Refusal or failure to comply with the HASP or violation of any safety procedures by field personnel and/or subcontractors performing work covered by this HASP may result in immediate removal from the Site following consultation with the Contractor.

1.2 Scope of Work

This HASP addresses all general activities listed below:

- Mobilization/Demobilization
  - Mobilization/demobilization of equipment and supplies
  - Establishment of site security, work zones, and staging areas

- Pre-Investigation Activities
  - Location of all utilities to and from the Site
  - Location and protection of all active utility lines on the Site

- Investigation Activities
  - Surface soil sample collection
  - Test pit installation and sample collection
  - Subsurface soil boring installation and sample collection
  - Monitoring well and temporary groundwater monitoring point installation and sample collection
Sediment sample collection
Air monitoring
Investigation-derived waste handling and storage activities
2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This section includes the project organization and structure, and establishes the specific chain-of-command for responsibilities and communications. The organizational structure shall be reviewed and updated as necessary to reflect the current status of project operations.

2.1 National Grid USA

NGRID will have final responsibility and authority for all aspects of the project, and is also responsible for approving all changes to this HASP.

A NGRID project-specific organization chart with contact information is included in Appendix A.

2.2 Consultant

Consultant provides general health and safety oversight as NGRID Agent. The Consultant also conducts perimeter air monitoring and work zone monitoring for Consultant employees. The Consultant will monitor daily operations and will serve as the Contractor’s primary point of contact with NGRID and regulatory agencies for health-and-safety related matters. Consultant health-and-safety roles for this project include:

- Project Manager
- Site Safety Officer
- Corporate Environmental Safety Manager

The Consultant’s health-and-safety roles and responsibilities are structured the same as the Contractors. Details of these roles are presented below in Section 2.3.

<table>
<thead>
<tr>
<th>Task</th>
<th>Consultant</th>
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<tbody>
<tr>
<td>General Health-and-Safety Oversight of The Williamsburg Works Former MGP Site Remedial Investigation</td>
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</table>

A Consultant project-specific organization chart with contact information is included in Appendix A.
2.3 Contractor

Contractor is responsible for all work detailed in the project work plan and/or Contractor Statement of Work. The Contractor is also responsible for the health and safety of Contractor and Subcontractor employees, and conducts work zone monitoring for Contractor and Subcontractor workers. Specific Contractor health and safety roles include:

Project Manager – responsibilities include the following:

- Ensures implementation of this program
- Conducts periodic inspections
- Participates in incident investigations
- Ensures the HASP has all of the required approvals before any site work is conducted
- Ensures that the Site Safety Officer is informed of project changes which require modifications of the site health and safety plan
- Has overall project responsibility for Project Health and Safety.

Site Safety Officer (SSO) - responsibilities include the following:

- Ensures that the HASP is implemented and that all health-and-safety activities identified in site safety plans are conducted and/or implemented
- Ensures that field work conducted safely and enforces site health and safety rules
- Ensures that adequate communication between field crews and emergency response personnel is maintained
- Ensures that field site personnel are medically cleared and adequately trained and qualified to work at the Site and that proper personal protective equipment is utilized by field teams
- Investigate and report all accidents/incidents to the PM and to the Corporate Environmental and Safety Manager (CESM)
- Conducts and documents daily safety briefings
- Stops work if necessary
- Identifies operational changes which require modifications to health-and-safety procedures and site safety plans, and ensures that the procedure modifications are implemented and documented through changes to the HASP, with CESM approval
- Directs and coordinates health-and-safety monitoring activities
- Evaluates air monitoring data relative to site and activity-specific action levels
- Ensures that monitoring instruments are calibrated
- Reports to the CESM to provide summaries of field operations and progress
Conducts routine safety inspections of their work areas
Conducts incident investigations and together with the CESM, prepares appropriate reports (i.e., OSHA 300 Report)
Maintains files on all personal monitoring results, laboratory reports, calculations, and air sampling data sheets
Ensure that all necessary information including emergency phone numbers, hospital directions, and warning signs are kept posted in an area accessible to all site employees
Maintain a daily list of workers and visitors present on the Site.

Corporate Environmental and Safety Manager (CESM) - responsibilities include the following:

- Provides for the development and approval of the HASP
- Serves as the primary contact to review health and safety matters that may arise
- Approves revised or new safety protocols for field operations
- Coordinates revisions of this HASP with field personnel
- Coordinates upgrading or downgrading of personal protective equipment with the SSO
- Maintains a copy of fit test certification, documents of medical clearance, and exposure reports from site activities.
- Assists in the investigation of all accidents/incidents.

Site Personnel - responsibilities include the following:

- Reports any unsafe or potentially hazardous conditions to the SSO
- Maintains knowledge of the information, instructions and emergency response actions contained in the HASP
- Complies with rules, regulations and procedures as set forth in the HASP and any revisions
- Prevents admittance to work sites by unauthorized personnel
- Inspect all tools and equipment, including personal protective equipment (PPE), prior to use.

A Contractor project-specific organization chart with contact information is included in Appendix A.
3.0  SITE HISTORY AND PROJECT DESCRIPTION

3.1  Location
The Williamsburg Works Former MGP site is located in an industrial and commercial section of the Williamsburg neighborhood of Brooklyn, New York. Figure 1 in Appendix B shows the location of the Site. The Site is bordered by North 12th Street to the northwest, Wythe Avenue to the southwest, North 11th Street to the southeast, and the East River to the northeast.

3.2  Site History and Current Site Conditions
The site history of the Williamsburg Works Former MGP and surrounding area was developed through the review of available Sanborn Fire Insurance (Sanborn) Maps.

3.2.1  MGP History
The Williamsburgh Gas Light Company was incorporated in 1850 (Murphy, 1995). The Williamsburg MGP is first shown on the 1887 Sanborn Map. The MGP gas production facilities were isolated to the 2 North 11th Street and 20 and 21 North 12th Street properties and consisted of coal gas production facilities including a retort house, an engine room, a meter house, and a condenser house. Gas storage and purification facilities included three gas holders, a governor house, a purifying house, two tar tanks, scrubbers and lime houses. By 1905 a gas holder was constructed at 35 Kent Avenue. These structures are shown on Plate 1. Based upon their age of construction of these holders were likely pit style holders with sub-grade foundations.

In 1895, the Williamsburgh Gas Light Company and others merged to form the Brooklyn Union Gas Company, a predecessor to NGRID. The 1905 Sanborn indicates that the MGP was referred to as the Brooklyn Union Gas Williamsburg Branch.

According to 1905 Sanborn maps, the gas production facilities at 2 North 11th Street remained relatively unchanged with the exception of the addition of iron tanks and a pump house. One circular gas tank, a generator house, a condenser house, and exhauster houses were noted at 20 North 11th Street. Purifying houses were noted at 21 North 12th Street. By 1905 a gas holder was constructed at 35 Kent Avenue. By 1916, the MGP appears to have converted to water gas production as evidenced by the addition of generators and conversion of the retort house to a generator house at 20 North 11th Street. An additional gas holder was noted on the 35 Kent Avenue property (Plate 1).

The Williamsburg Former MGP ceased operation prior to 1941. The MGP structures were dismantled and vacant lots are shown in the 1941 Sanborn map.
3.2.2 Post MGP History
The Williamsburg MGP was subdivided and redeveloped for commercial, industrial and manufacturing uses. A brief history of the post-MGP use was developed from available Sanborn maps and is presented below by current parcel address and tax lot.

- **2 North 11th Street [Block 2287 Lot 30]**: The property was used for oil truck parking from 1978 until 1982. The current warehouse building was constructed in 1985 and used for lumber storage from 1988 until 1995 according to Sanborn maps.

- **20 North 12th Street [Block 2287 Lot 16]**: In 1965 a repair shop, office and scrap metal storage were on the property. By 1978 the property and buildings were vacant except for the office. In 1983 the buildings had been demolished and the property was used for parking. The current warehouse building was constructed in 1985 and used for lumber storage from 1988 until 1995 according to Sanborn maps.

- **21 North 12th Street [Block 2287 Lot 1]**: A warehouse/industrial building was constructed by 1951 and was occupied by the Ferro-Co. Corp. for sheet metal product manufacturing. By 1965, the building was occupied by Commercial Corrugated Container Corp. By 1978, the property was occupied by a New York City sanitation garage which currently occupies the site according to Sanborn map information.

- **35 Kent Avenue [Block 2288 Lot 1]**: The property was developed as a garage in 1949. The garage had a gasoline storage tank as part of the operations according to Sanborn maps. Colonial Tempered Glass currently operates the garage.

3.2.3 Current Site Conditions
The current site conditions and the surrounding area are shown on the aerial photograph in Plate 1 of the Work Plan. As discussed above in the site history, the site was subdivided into four parcels. As shown in the aerial photograph, the majority of the Williamsburg former MGP Site is either paved or developed with buildings. The site conditions of each parcel are summarized below.

**Williamsburg Former MGP**

<table>
<thead>
<tr>
<th>Address</th>
<th>Current Owner</th>
<th>Block</th>
<th>Lot</th>
<th>Land Use Description</th>
</tr>
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<tr>
<td>2 North 11th Street</td>
<td>10th Street, LLC.</td>
<td>2287</td>
<td>30</td>
<td>Warehouse</td>
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<tr>
<td>Brooklyn, NY 11211</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>20 North 12th Street</td>
<td>10th Street, LLC.</td>
<td>2287</td>
<td>16</td>
<td>Warehouse</td>
</tr>
</tbody>
</table>
The Williamsburg MGP and surrounding area are zoned for manufacturing (M3-1), as a result the site is surrounded by commercial and manufacturing businesses. The Williamsburg MGP is bordered by the East River to the northwest, North 12th Street, a Bay Side Oil terminal to the northeast and by warehouses to the southeast and southwest. Kent Avenue bisects the Williamsburg former MGP.

The Williamsburg former MGP is developed with buildings that are secured with locked entrances or brick walls with gates.

### 3.3 Project Description

National Grid USA will retain a consultant and other contractors as specified in Section 2 of the HASP to perform a Remedial Investigation program at the Williamsburg Works Former MGP Site in the Williamsburg neighborhood of Brooklyn, New York. This Remedial Investigation was prepared to investigate the potential impacts to the Site from the manufacture of and storage of gas at the Williamsburg Works Former MGP.

The purpose of the Remedial Investigation program is to evaluate the nature and extent of chemical compounds within soils and groundwater that may be associated with the operation of the Williamsburg Works Former MGP and will also evaluate if human health or the fish and wildlife resources are or may be exposed to any identified impacts.

The scope of the Remedial Investigation sampling program is presented in the Draft Williamsburg Works Former MGP Remedial Investigation Work Plan dated January 2008. A summary of the Remedial Investigation will include the following tasks:

- Site Mobilization
- Site Utility Survey
- Subsurface Soil Boring Installation and Soil Sample Collection
- Surface Soil Sample Collection
- Test Pit Installation and Soil Sample Collection
- Monitoring Well and Temporary Groundwater Monitoring Point Installation and Groundwater Sample Collection
- Sediment Sample Collection
Survey

The selected contractor will sample subsurface soils and install monitoring wells and temporary groundwater monitoring points. Soil borings, monitoring wells and temporary groundwater monitoring points are located within the Williamsburg Works Former MGP and outside of the MGP footprint within New York City street rights-of-ways (ROWs).
4.0 POTENTIAL SITE HAZARDS

This section presents an assessment of potential chemical, physical, and biological hazards that may be encountered during the project work. This section also includes an activity hazard analysis (AHA) to assess and control potential site hazards for each general project task. A more detailed Contractor Project specific AHA is included in Appendix C, which addresses the health and safety hazards of each specific project task or operation and includes requirements and procedures for worker protection. The following appendices include information on additional programs, which will be used to mitigate potential hazards:

Appendix D - Hazard Communication Program
Appendix E - Cold Stress Program
Appendix F – Heat Stress Program
Appendix G – Personal Protective Equipment Program
Appendix H – Lock Out / Tag Out Program
Appendix I – Confined Space / Hot Work Permitting Procedure
Appendix J- Incident Reporting
Appendix K Addendum

4.1 Chemical Hazards

The characteristics of compounds that may be encountered at the Site are discussed below in the following subsections for informational purposes. Adherence to the safety and health guidelines in this HASP should reduce the potential for exposure to the compounds discussed below. Chemical characteristics and potential exposure information for the compounds that may be encountered during site activities are presented in Table 4-1 below. Material safety data sheets (MSDS) for commonly used compounds and compounds that may be encountered during the Remedial Investigation activities are located in Appendix K.

4.1.1 Volatile Organic Compounds (VOCs)

Volatile organic chemicals (VOCs), such as benzene, toluene, ethyl benzene, and xylene (BTEX) are potentially present within subsurface soils and groundwater at the Site because of its former use for manufactured gas manufacture and storage, oil truck parking, New York City sanitation garage and a garage. In some cases, the chemical components may be present in non-aqueous phase liquids (NAPL) such as fuels, oils, or tar within subsurface soils at the Site. These compounds generally have a depressant effect on the central nervous system (CNS), may cause chronic liver and kidney damage, and some are suspected human carcinogens. Benzene is a known human carcinogen. Acute exposure may include headache, dizziness, nausea, and skin and eye irritation.
The primary route of exposure to VOCs is through inhalation and therefore air monitoring and respiratory protection is the primary control against exposure to VOCs. Air monitoring will be completed as specified in Section 8.0 to minimize airborne exposures. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the Remedial Investigation Work Plan and Appendix K of the HASP. Exposure through direct contact is possible and will be minimized through the use of PPE as prescribed in Section 6.0.

4.1.2 Coal Tar and Oil Products
Coal tar and petroleum products contain semi-volatile organic compounds (SVOCs). SVOCs consist of a mixture of acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, benzo(e)pyrene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methyl naphthalene, naphthalene, phenanthrene, phenols, pyrene and other compounds.

Coal tar products, petroleum products, and other SVOCs are potentially present within subsurface soils and groundwater at the site. Coal tar products within subsurface soils may have been associated with the former gas storage. Petroleum products within subsurface soils could be associated with the former used truck sales.

Coal tar products such as those listed above may cause contact dermatitis. Direct contact can be irritating to the skin and produce itching, burning, swelling and redness. Direct contact or exposure to the vapors may be irritating to the eyes. Conjunctivitis may result from prolonged exposure. Coal tar is considered to be very toxic, if ingested. High levels of exposure to coal tar, though not anticipated during work activities conducted during this project, may increase the risk of cancer including lung, kidney, and skin cancer. Naphthalene is also an eye and skin irritant and can cause nausea, headache, fever anemia, liver damage, vomiting, convulsions, and coma. Poisoning may occur by ingestion of large doses, inhalation, or skin absorption.

The major route of exposure of SVOCs during work activities to be conducted at this Site is through direct contact. Exposure is most likely when handling soil, and groundwater samples. Exposure through direct contact is possible and will be minimized through the use of PPE as prescribed in Section 6.0. Inhalation of SVOCs may occur when the soil is disturbed causing respirable and nuisance dust particles to become airborne or through the volatilization of naphthalene. Air monitoring will be completed as specified in Section 8.0 to minimize airborne exposures. Community air monitoring of the area...
immediately surrounding the work zone will be completed in accordance with the Remedial Investigation Work Plan and Appendix K of this HASP.

4.1.3 **Heavy Metals**

The subsurface soil may contain elevated levels of metals including: arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, thallium, and zinc.

As with SVOCs, the primary route of metal exposure is through inhalation of dust particles when subsurface soils are disturbed and become airborne. Air monitoring will be completed as specified in Section 8.0 to minimize airborne exposures during subsurface soil investigations. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the Remedial Investigation Work Plan and Appendix K of this HASP.

4.1.4 **Asbestos-Containing Materials**

Asbestos-containing materials (ACM) can be present at investigation sites in the form of demolition debris, ACM pipe insulation, and asbestos cement pipe. Chronic exposure to asbestos may cause asbestosis and mesothelioma. The primary route of exposure for asbestos is inhalation during the disturbance and/or removal of asbestos from the pipe insulation and cement pipes.

Asbestos is strictly regulated under OSHA 29 CFR 1910.1001/1926.1101. Employees that may be potentially exposed to ACM must participate in a medical surveillance program, have specific training in the hazards and controls of exposure to asbestos and wear respirators with high-efficiency particulate air (HEPA) filters. All work must be conducted in demarcated regulated areas to minimize the amount of people within the exposure area. Employers must conduct air sampling and provide signs and labels regarding the presence of asbestos.

4.1.5 **Polychlorinated Biphenyls**

It is not likely that polychlorinated biphenyls (PCBs) are of concern based on previous land uses at the Site. PCBs have historically been used from a number of sources including, but not limited to; electrical systems, hydraulic oils, lubricants, cutting oils, printer’s ink, and asphalt. Exposure to PCBs can occur through unbroken skin without immediate pain or irritation. Acute affects of PCB exposure can include eye, skin, nose, and throat irritation. Chronic effects of PCB exposure can include skin swelling and redness, gastro-intestinal disturbances, and neurological effects such as headache, dizziness, nervousness and numbness of extremities. PCBs are suspected human carcinogens that can cause liver cancer. PCBs can accumulate in fatty tissues and result
in health effects after the initial exposure has occurred. The primary route of exposure for PCBs is inhalation, dermal contact, and ingestion.

4.1.6 Cyanide
Cyanide compounds are common by-products of manufactured gas production but are also used in rat poisons, silver and metal polish, photographic solutions, fumigating solutions, and electroplating solutions. Hydrogen cyanide is toxic because it is a chemical asphyxiant. It replaces the oxygen in the blood and thereby suffocates the cells. Ferrocyanides (which are associated with purifier waste from gas manufacture) are not considered toxic because the hydrogen cyanide ion is bound tightly to the iron and cannot therefore replace the oxygen. It takes a great amount of heat and/or acid to release hydrogen cyanide gas from the ferrocyanide molecule. Air monitoring will be completed as specified in Section 8.0 to minimize airborne exposures during subsurface soil investigations.

4.1.7 Hydrogen Sulfide
Hydrogen sulfide is a by-product of manufactured gas production and is also associated with the breakdown of sewage by bacteria in sewer pipes. Exposure to lower concentrations can result in eye irritation, a sore throat and cough, shortness of breath, and fluid in the lungs. These symptoms usually go away in a few weeks. Long-term, low-level exposure may result in fatigue, loss of appetite, headaches, irritability, poor memory, and dizziness. Breathing very high levels (>800 ppm) of hydrogen sulfide can cause death within just a few breaths. The primary route of exposure is through inhalation, and therefore respiratory protection is the primary control against exposure to hydrogen sulfide. Air monitoring will be completed as specified in Section 8.0 to minimize airborne exposures during subsurface soil investigations.

4.1.8 Evaluation of Organic Vapor Exposure
Air monitoring reduces the risk of overexposure by indicating when action levels have been exceeded and when PPE must be upgraded or changed. Action levels for volatile organic compounds and associated contingency plans for the work zone are discussed within Section 8.0 of this Health and Safety Plan. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the Remedial Investigation Work Plan and Appendix K of this HASP.

Exposure to organic vapors shall be evaluated and/or controlled by:

- Monitoring air concentrations for organic vapors in the breathing zone with a photoionization detector (PID) or a flame ionizing detector (FID)
When possible, engineering control measures will be utilized to suppress the volatile organic vapors. Engineering methods can include utilizing a fan to promote air circulation, utilizing volatile suppressant foam, providing artificial ground cover, or covering up the impacted material with a tarp to mitigate volatile odors.

When volatile suppression engineering controls are not effective and organic vapor meters indicate concentrations above the action levels, then appropriate respiratory protection (i.e. air purifying respirator with organic vapor cartridge) will be employed.
<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS #</th>
<th>ACGIH TLV</th>
<th>OSHA PEL</th>
<th>Route of Exposure</th>
<th>Symptoms of Exposure</th>
<th>Target Organs</th>
<th>Physical Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos</td>
<td>1332-21-4</td>
<td>0.1 f/cc</td>
<td>0.1 f/cc over 8 hr period or 1.0 f/cc over 30 min.</td>
<td>Inhalation Ingestion Skin Contact</td>
<td>Asbestosis (chronic exposure); mesothelioma, breathing difficulty, interstitial fibrosis’ restricted pulmonary function, finger clubbing; irritate eyes, potential carcinogen</td>
<td>Respiratory system, eyes</td>
<td>White, greenish, blue, or gray-green fibrous solids FP: NA IP: NA LEL: NA UEL: NA VP: 0 mm</td>
</tr>
<tr>
<td>Arsenic</td>
<td>7440-38-2</td>
<td>0.01 mg/m³</td>
<td>0.01 mg/m³ A.L. 0.5mg/m3</td>
<td>Inhalation Skin Absorption Ingestion Skin Contact</td>
<td>Ulceration of nasal septum, dermatitis, GI disturbances, peripheral neuropathy, respiratory irritation, hyper pigmentation of skin, potential carcinogen</td>
<td>Liver, kidneys, skin, lungs, lymphatic system</td>
<td>Metal: Silver-gray or tin-white, brittle, odorless solid FP: NA IP: NA LEL: NA UEL: NA VP: 0 mm</td>
</tr>
<tr>
<td>Benzene</td>
<td>71-43-2</td>
<td>0.5 ppm (Skin) 1 ppm TWA 5 ppm STEL</td>
<td>Inhalation Skin Absorption Ingestion Skin Contact</td>
<td>Irritation of eyes, skin, nose, respiratory system, giddiness, headache, nausea; staggering gait, fatigue, anorexia, weakness, dermatitis, bone marrow depression, potential carcinogen</td>
<td>Eyes, skin, CNS, bone marrow, blood</td>
<td></td>
<td>FP: 12°C IP: 9.24 eV LEL: 1.2% UEL:7.8% VP: 75 mm</td>
</tr>
<tr>
<td>Chromium (Chromic Acid and Chromates)</td>
<td>1333-82-0</td>
<td>0.05 mg/m³</td>
<td>0.1 mg/m³</td>
<td>Inhalation Ingestion Skin Contact</td>
<td>Irritates respiratory system, nasal, septum perforation, liver and kidney damage, leucocytosis (increased blood leucocytes), leukopenia (reduced blood leucocytes), moncytosis (increased monocytes), Eosinophilia, eye injury, conjunctivitis, skin ulcer, sensitivity dermatitis, potential carcinogen</td>
<td>Blood, respiratory system, liver, kidney, eyes, skin, lung cancer</td>
<td>FP:NA IP:NA VP: Very Low LEL: NA UEL: NA</td>
</tr>
<tr>
<td>Ethyl benzene</td>
<td>100-41-4</td>
<td>100 ppm</td>
<td>100 ppm</td>
<td>Inhalation Ingestion Skin Contact</td>
<td>Eye, skin, mucous membrane irritation; headache; dermatitis, narcosis; coma</td>
<td>Eyes, skin, respiratory system, CNS</td>
<td>FP: 55°F IP: 8.76 eV LEL: 0.8% UEL:6.7% VP: 7 mm</td>
</tr>
<tr>
<td>Compound</td>
<td>CAS #</td>
<td>ACGIH TLV</td>
<td>OSHA PEL</td>
<td>Route of Exposure</td>
<td>Symptoms of Exposure</td>
<td>Target Organs</td>
<td>Physical Data</td>
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</tr>
<tr>
<td>Hydrogen cyanide</td>
<td>74-90-8</td>
<td>4.7 ppm (5 mg/m³) STEL [skin]</td>
<td>10 ppm (11 mg/m³) [skin]</td>
<td>Inhalation Ingestion Absorption Skin/Eye Contact</td>
<td>Asphyxia; weakness, headache, confusion; nausea, vomiting; increased rate and depth of respiration or respiration slow and gasping; thyroid, blood changes</td>
<td>CNS, CVS, thyroid, blood</td>
<td>Colorless or pale-blue liquid or gas (above 78°F) with a bitter, almond-like odor. VP: 630 mmHg IP: 13.60 eV</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>7783-06-4</td>
<td>10 ppm TWA, 15 ppm STEL</td>
<td>20 ppm C, 50 ppm [10-min. Maximum peak]</td>
<td>Inhalation Skin/Eye Contact</td>
<td>Irritation eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, fatigue, irritability, insomnia; gastrointestinal disturbance; liquid: frostbite</td>
<td>Eyes, respiratory system, CNS</td>
<td>Colorless gas with a strong odor of rotten eggs. VP: 17.6 atm IP: 10.46 eV</td>
</tr>
<tr>
<td>Lead</td>
<td>7439-92-1</td>
<td>0.050 mg/m³</td>
<td>0.05 mg/m³</td>
<td>Inhalation</td>
<td>Weakness, insomnia; facial pallor; pal eye, anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis of wrist and ankles; irritates eyes, hypotension</td>
<td>Eyes, GI tract, CNS, kidneys, blood, gingival tissue</td>
<td>A heavy, ductile, soft, gray solid. FP: NA IP: NA LEL: NA UEL: NA VP: 0 mm</td>
</tr>
<tr>
<td>Mercury</td>
<td>7439-97-6</td>
<td>0.025 mg/m³</td>
<td>0.10 mg/m³</td>
<td>Inhalation Ingestion Skin Contact Skin Absorption</td>
<td>Irritates eyes and skin, chest pain, cough, difficulty breathing, bronchitis, pneumonitis, tremor, insomnia, irritability, indecision, headache, fatigue, weakness, stomatitis, salivation, Gastrointestinal disturbance, weight loss, proteinuria</td>
<td>Eyes, skin, respiratory tract, central nervous system</td>
<td>Silver-white, heavy odorless liquid. FP: NA IP: unknown LEL: NA UEL:NA VP: 0.0012 mm</td>
</tr>
<tr>
<td>Compound</td>
<td>CAS #</td>
<td>ACGIH TLV</td>
<td>OSHA PEL</td>
<td>Route of Exposure</td>
<td>Symptoms of Exposure</td>
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</tr>
<tr>
<td>PAH’s as Coal tar pitch Volatiles (CTPV)</td>
<td>65996-93-2</td>
<td>0.2 mg/m³</td>
<td>0.2 mg/m³</td>
<td>Inhalation Skin contact Ingestion</td>
<td>Irritant to eyes, swelling, acne contact dermatitis, chronic bronchitis</td>
<td>Respiratory system, CNS, liver, kidneys, skin, bladder, carc</td>
<td>Black or dark brown amorphous residue.</td>
</tr>
<tr>
<td>PCBs</td>
<td>11097-69-1</td>
<td>0.5 mg/m³ (Skin)</td>
<td>0.5 mg/m³ (Skin)</td>
<td>Inhalation Skin Absorption Ingestion Skin Contact</td>
<td>Irritate eyes; chloracne; liver damage;</td>
<td>Skin, eyes, liver, reproductive system</td>
<td>Colorless liquid or solid with a mild, hydro-carbon odor VP = 0.00006 mm</td>
</tr>
<tr>
<td>Phenol</td>
<td>108-95-2</td>
<td>10 ppm (skin)</td>
<td>5 ppm (19 mg/m³) [skin]</td>
<td>Inhalation Skin Absorption Ingestion Skin Contact</td>
<td>Irritates eyes, nose, throat, visual disturbance, headache, chills, fever, breathing difficulty, bronchitis, metallic taste, garlic breath, GI disturbance, dermatitis, eye and skin burns,</td>
<td>Eyes, skin, respiratory system, liver, kidneys</td>
<td>Colorless to light pink crystalline solid with sweet, acrid odor. FP:175 °F IP:8.5 LEL:1.8% UEL:8.6% VP:0.4 mm</td>
</tr>
<tr>
<td>Selenium</td>
<td>7782-49-2</td>
<td>0.2 mg/m³</td>
<td>0.2 mg/m³</td>
<td>Inhalation Ingestion Skin Contact</td>
<td>Irritant to eyes, skin, nose and throat, visual disturbance, headache, chills, fever, breathing difficulty, bronchitis, metallic taste, garlic breath, GI disturbance, dermatitis, eye and skin burns,</td>
<td>Eyes, skin, respiratory system, liver, kidneys, blood spleen</td>
<td>Amorphous or crystalline, red to gray solid FP: NA IP: NA LEL: NA UEL: NA VP:0 mm</td>
</tr>
<tr>
<td>Toluene</td>
<td>108-88-3</td>
<td>50 ppm</td>
<td>200 ppm</td>
<td>Inhalation Skin Absorption Ingestion Skin Contact</td>
<td>Eye, nose irritation; fatigue, weakness, confusion, euphoria, dizziness, headache; dilated pupils, tearing of eyes; nervousness, muscle fatigue, insomnia, tingling in limbs; dermatitis</td>
<td>Eyes, skin, respiratory system, CNS, liver, kidneys</td>
<td>FP: 40°F IP: 8.82 eV LEL:1.1% UEL:7.1% VP:21 mm</td>
</tr>
<tr>
<td>Xylene</td>
<td>1330-20-7</td>
<td>100 ppm</td>
<td>100 ppm</td>
<td>Inhalation Skin Absorption Ingestion Skin Contact</td>
<td>Eye, skin, nose, throat irritation; dizziness, excitement, drowsiness; incoordination, staggering gait; corneal damage; appetite loss, nausea, vomiting, abdominal</td>
<td>Eyes, skin, respiratory system, CNS, GI tract, blood, liver, kidneys</td>
<td>FP: 90°F IP: 8.56 eV LEL:0.9% UEL:6.7% VP:9 mm</td>
</tr>
</tbody>
</table>
### Table 4-1
**Chemical Data**

<table>
<thead>
<tr>
<th>Compound</th>
<th>CAS #</th>
<th>ACGIH TLV</th>
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<th>Route of Exposure</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>pain; dermatitis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Abbreviations
- C = ceiling limit, not to be exceeded
- CNS = Central Nervous System
- CVS = Cardiovascular System
- eV = electron volt
- FP = Flash point
- IP = Ionization Potential
- GI = Gastro-intestinal
- A.L. = Action Level
- LEL = Lower explosive limit
- mm = millimeter
- ppm = parts per million
- Skin = significant route of exposure
- STEL = Short-term exposure limit (15 minutes)
- TWA = Time-weighted average (8 hours)
- UEL = Upper explosive limit
- VP = vapor pressure approximately 68° F in mm Hg (mercury)
4.1.9 Evaluation of Respirable Dust Inhalation

Inhalation of respirable dust containing metals, crystalline silica, asbestos, and SVOCs is possible when surrounding ground cover is disturbed by heavy equipment, conducting demolition work, or using power tools on surfaces that contain these materials. Contaminated particulate matter (soil, pavement, lead paint, insulation, etc.) becomes suspended in air due to a combination of factors including lack of vegetative cover and/or dry or dusty conditions. Air monitoring reduces the risk of overexposure to respirable dust inhalation by indicating when action levels have been exceeded and when PPE must be upgraded or changed. Action levels for respirable dust and associated contingency plans for the work zone and perimeter of the Site are discussed within Section 8.0 of this HASP. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the Remedial Investigation Work Plan and Appendix K of this HASP.

Control of respirable dust shall be conducted at this Site as follows:

- When possible, dust control measures will be utilized to suppress the dust. These methods include wetting down the area, providing artificial ground cover, or covering up the material with a tarp.
- When dust suppression is not possible and respirable dust meters indicate concentrations above the action levels, a HEPA Filter must be used to prevent against inhalation of contaminated dusts.

4.1.10 Evaluation of Skin Contact and Absorption

Skin contact by contaminants may be controlled by use of proper hygiene practices, PPE, and good housekeeping procedures. The proper PPE (e.g., Tyvek® gloves, safety glasses) as described in Section 6.0 will be worn for all activities where contact with potential contaminated media or materials are expected.

4.1.11 Other Chemical Hazards

Chemicals not identified in this HASP may be used during the Remedial Investigation activities. Prior to the initiation of any on-site tasks, each Contractor, Subcontractor, or Consultant shall provide MSDS’s to the SSO for each of the chemicals to be used. The MSDS’s will be maintained at the Site by the SSO and all site workers and visitors who may potentially be exposed to the chemicals will be made aware of these hazards and the location of the on-site MSDS’s during a hazard briefing session by the SSO. MSDS of commonly used compounds are located in Appendix K.
4.2 Physical Hazards

4.2.1 High Loss Potential Physical Hazards
Activities to be conducted at the Site may involve operations that have the potential for a serious injury to occur, and can include the following:

- Lockout/Tag out
- Heavy Equipment Operation
- Excavation and Trenching
- Confined Space Entry
- Line Breaking
- Work within a Temporary Structure

Subsurface utilities will likely be located in the vicinity of the subsurface soil borings.

4.2.1.1 Lockout-Tag out
Site personnel will assume that all electrical equipment at surface, subsurface, and overhead locations is energized, until the equipment has been designated as de-energized by a NGRID representative. If the equipment cannot be de-energized, then work will stop and the SSO will consult with the PM and CESM. The Contractor will notify NGRID prior to working adjacent to this equipment, and will verify that the equipment is energized or de-energized in the vicinity of the excavation location. The Control of Hazardous Energy Program “Lock Out/Tag Out” is included in Appendix H.

All power lines, which have been indicated by NGRID to be de-energized must be locked out, such that the lines cannot be energized when personnel are working near them. The lines shall not be unlocked and re-energized until the Contractor notifies NGRID that they have completed work in the area and that all personnel are clear of the area. NGRID representatives will thoroughly familiarize Contractor personnel with site-specific lockout/tagout procedures during the site orientation. The lockout procedures must be equivalent in effectiveness to those found in Appendix H.

If power lines cannot be de-energized, the SSO will consult with the local utility provider safety personnel to determine the safe working distance from the energized line. Work tasks will only commence after determination that a safe working distance can be maintained and all personnel working in the area have been informed of the limitation.

4.2.1.2 Heavy Equipment Operation
Heavy equipment will be operated under the following conditions:
The operation of heavy equipment will be limited to authorized personnel specifically trained in its operation. Subcontractor site supervisors must provide this information to the SSO.

- Equipment shall be inspected daily to ensure that there are no exposed belts, fans, etc.
- When not in use, hydraulic and pneumatic components shall be left in down or “dead” position.
- Roll-over protection shall be provided on hilly terrain.
- Maintain all emergency shut-offs in sound working condition.
- The operator will use the safety devices provided with the equipment, including seat belts. Backup warning indicators and horns will be operable at all times.
- While in operation, all personnel not directly required in the area will keep a safe distance from the equipment.
- Personnel directly involved in activity will avoid moving in the path of operating equipment or any portion thereof. Areas blinded from the operator's vision will be avoided. Spotters will be used when personnel may be in areas where the operator’s view is obstructed.
- Additional riders will not be allowed on equipment unless it is specifically designed for that purpose.

4.2.1.3 Excavation and Trenching

The safety requirements for each excavation must be determined by a competent person who is capable of identifying existing and predictable hazards and work conditions that are unsanitary, hazardous, or dangerous to employees. The competent person must also have the authorization to take prompt corrective measures to eliminate unsatisfactory conditions.

Subsurface utilities will likely be located in the vicinity of the Remedial Investigation points.

The following are general requirements for work activities in and around excavations:

- Prior to initiation of any excavation activity (or ground intrusive activity, such as drilling), the location of underground installations will be determined. The New York State one-call center will be contacted by the Contractor/Subcontractor a minimum of 72 hours prior to excavation activities. It may also be necessary to temporarily support underground utilities during
excavation. When excavations approach the estimated location of underground installations, the exact location of the underground installations shall be determined by means that are safe to workers, i.e., hand dig, test pits, etc.

- All excavations will be inspected daily by the competent person prior to commencement of work activities. Evidence of cave-ins, slides, sloughing, or surface cracks or excavations will be cause for work to cease until necessary precautions are taken to safeguard employees.
- Excavated and other materials or equipment that could fall or roll into the excavation shall be placed at least 5 feet from the edge of the excavation.
- Vehicular traffic and heavy equipment shall remain at least four feet from the face of the excavation.
- All excavation operations will cease immediately during hazardous weather conditions such as high winds, heavy rain, lightning and heavy snow.

### 4.2.1.4 Excavation Entry Safety

Personnel entering a trench or excavation that is greater than 4-feet deep shall implement the following procedures:

- The sides of all excavations in which personnel will be exposed to the danger of moving ground or potential cave-in will be adequately sloped, shored or contained within a trench box, or similar support structure designed and sealed by a professional engineer.
- The air in the excavation will be tested for oxygen deficiency, explosivity, organic vapors, carbon monoxide and hydrogen sulfide. The bottom, middle, top and corners of the excavation will be tested prior to entry and continuously during excavation entry.
- Ramps or ladders will be used to provide access and sufficient egress to the excavation. Ladders must be supplied for every 25 feet of lateral travel. Ladders must be securely anchored at the top or bottom and must extend at least 3 feet above the ground surface. A competent person is required to design ramps (those used exclusively for employee access/egress). Such ramps are constructed of wood, steel or earth. Structural ramps, used for vehicle/equipment access (steel or wood) must be designed by a competent person qualified in structural design. Vehicle ramps built of earth are not considered “structural ramps.”
- Employees shall not work in excavations where there is an accumulation of water or in excavations where water is accumulating unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation.
- Emergency rescue equipment such as breathing apparatus, a safety harness
and line, or a basket stretcher shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation.

4.2.1.5 Working within a Temporary Enclosure
Any work conducted within a temporary enclosure shall employ work zone and ambient monitoring in accordance with the Air Monitoring Plan and Section 8.0 of this HASP. If internal combustion engine equipment is used within the temporary enclosure, engineering controls or additional air monitoring parameters will need to be evaluated. If monitoring indicates the enclosure atmosphere meets the definition of a Permit Required Confined Space (PRCS), then the procedures of Appendix I will apply in accordance with OSHA 1910.146 and 1910.134.

4.2.2 Line Breaking
During line breaking activities, the potential exists for exposure to suspect asbestos containing materials (ACM). If suspect ACM is encountered, work will stop and will not resume until asbestos trained personnel have been upgraded to the proper PPE, and water is available to keep the work area and the suspect ACM wetted. All workers are to have completed asbestos awareness training prior to working with suspect ACM. The project management team (NGRID Project Manager, Consultant Project Manager, and Contractor Project Manager and CESM) is to be notified if suspect ACM is encountered.

4.2.3 Fire and Explosion
Subsurface utilities including gas lines and electrical lines may be located in the vicinity of the subsurface soil borings.

When conducting excavating activities, the opportunity of encountering fire and explosion hazards also exists from contamination in the soils and the possibility of free product in the underground structures and pipelines. Additionally, the use of a diesel–powered excavating equipment could present the possibility of encountering fire and explosion hazards. Prevention and management of fire and explosion potential is addressed in the Contractor Project Specific AHA included in Appendix C of this HASP. All Contractor and Subcontractor activities shall conform with all applicable state, federal, and local regulations pertaining to fire and explosion prevention procedures.

4.2.4 Cold Stress
At certain times of the year, workers may be exposed to the hazards of working in cold environments. Potential hazards in cold environments include frostbite, trench foot or immersion foot, hypothermia as well as slippery surfaces, brittle equipment, poor judgment and unauthorized procedural changes. The procedures to be followed are found in Appendix E, the Cold Stress Program.
4.2.5 Heat Stress
Heat stress is a significant potential hazard, which is greatly exacerbated with the use of PPE in hot environments. The potential hazards of working in hot environments include dehydration, cramps, heat rash, heat exhaustion, and heat stroke. A heat stress prevention program will be implemented when ambient temperatures exceed 70°F for personnel wearing chemical protective clothing. The procedures to be followed are found in Appendix F, the Heat Stress Program.

4.2.6 Noise
Noise is a potential hazard associated with the operation of heavy equipment, power tools, pumps and generators. Site workers who will perform suspected high noise tasks and operations for short durations (less than 1 hour) shall wear earplugs. If deemed necessary by the SSO, the CESM will be consulted on the need for additional hearing protection and the need to monitor sound levels for site activities. Other workers who do not need to be in proximity of the noise should distance themselves from the equipment generating the noise.

4.2.7 Hand and Power Tools
In order to complete the various tasks for the project, personnel will utilize hand and power tools. The use of hand and power tools can present a variety of hazards, including physical harm from being struck by flying objects, being cut or struck by the tool, fire, and electrocution. Work gloves, safety glasses, and hard hats will be worn by the operating personnel at all times when utilizing hand and power tools and Ground Fault Circuit Interrupter GFCI-equipped circuits will be used for all power tools.

4.2.8 Slips, Trips, and Falls
Working in and around the Site will pose slip, trip, and fall hazards due to slippery surfaces that may be oil covered, or from surfaces that are wet from rain or ice. Excavation at the Site will cause uneven footing in the trenches and around the spoil piles. Contractors shall employ good work practice and housekeeping procedures to minimize the potential for slip, trip, and fall hazards.

4.2.9 Manual Lifting
Manual lifting of heavy objects such as sections of pipe may be required. Failure to follow proper lifting technique can result in back injuries and strains. Site workers should use power equipment to lift heavy loads when ever possible and should evaluate loads before trying to lift them (i.e., they should be able to easily tip the load and then return it to its original position). Carrying heavy loads with a buddy and proper lifting techniques include: 1) make sure footing is solid, 2) make back straight with no curving or slouching, 3) center body over feet, 4) grasp the object firmly and as close to your
body as possible, 5) lift with legs, and 6) turn with your feet, don’t twist. In addition, hand digging may present lifting/ergonomic hazards.

4.2.10 Steam, Heat, Splashing
Exposure to steam/heat/splashing hazards can occur during steam cleaning activities. Exposure to steam/heat/splashing can result in scalding/burns, eye injury, and puncture wounds. Proper PPE will be worn during all steam cleaning activities including rain gear or Tyvek®, hardhat equipped with splashguard, and water resistant gloves and boots.

4.3 Biological Hazards
During the course of the project, there is a potential for workers to come into contact with biological hazards such as animals, insects, plants, and sewage. Workers should be aware of these potential hazards that are discussed below.

4.3.1 Animals
During the conduct of site operations, wild animals such as stray dogs or cats, raccoons, and rats may be encountered. Workers shall use discretion and avoid all contact with wild animals. If these animals present a problem, efforts will be made to remove these animals from the Site by contacting a licensed animal control technician.

4.3.2 Insects
Insects, including bees, wasps, hornets, mosquitoes, ticks, and spiders, may be present at the Site making the chance of a bite possible. Some individuals may have a severe allergic reaction to an insect bite or sting that can result in a life threatening condition. Some insect bites can transmit diseases such as Lyme Disease or a virus such as West Nile; any individuals who have been bitten or stung by an insect should notify the SSO. The following is a list of preventive measures:

- Apply insect repellent prior to performing any field work and as often as needed throughout the work shift
- Wear proper protective clothing (work boots, socks and light colored pants)
- When walking in wooded areas, avoid contact with bushes, tall grass, or brush as much as possible
- Field personnel who may have insect allergies shall have bee sting allergy medication on site and should provide this information to the SSO prior to commencing work.

4.3.2.1 Lyme Disease
Lyme disease is caused by infection from a deer tick that carries a spirochete. During the painless tick bite, the spirochete may be transmitted into the bloodstream often after
feeding on the host for 12 to 24 hours. The ticks that cause the disease are often no bigger than a poppy seed or a comma in newsprint. The peak months for human infection are from May to September.

Symptoms appear in three stages. First symptoms usually appear from 2 days to a few weeks after a person is bitten by an infected tick. Symptoms usually consist of a ring-like red rash on the skin where the tick was attached. The rash is often bulls-eye like with red on the outside and clear in the center. The rash may be warm, itchy, tender, and/or “doughy.” Unfortunately, this rash appears in only 60 to 80% of infected persons. An infected person also has flu-like symptoms of a stiff neck, chills, fever, sore throat, headache, fatigue and joint pain. These symptoms often disappear after a few weeks. The second stage symptoms, which occur weeks to months later include meningitis, severe headache, drooping of the muscles on the face, called Bell’s Pals, encephalitis, numbness, withdrawal and lethargy. These symptoms may last for several weeks to several months. Third stage symptoms, which occur months or years later include arthritis, heart problems, and loss of memory. The third stage symptoms may mimic multiple sclerosis and Alzheimer’s disease.

It is recommended that personnel check themselves when in areas that could harbor deer ticks, wear light color clothing and visually check themselves and their buddy when coming from wooded or vegetated areas. If a tick is found biting an individual, the SSO should be contacted immediately. The tick can be removed by pulling gently at the head with tweezers. If tweezers are not available, cover your fingers (e.g., tissue paper) and use to grasp the tick. It is important to grasp the tick as close to the site of attachment and use a firm steady pull to remove it. Wash hands immediately after with soap and water. The affected area should then be disinfected with an antiseptic wipe. All mouth parts must be removed from the skin. If the tick is removed with breaking off the mouth parts, an irritation or infection may occur. Also, the organism that is causing the disease can still enter the body through the skin. The employee will be offered the option for medical treatment by a physician, which typically involves antibiotics. If personnel feel sick or have signs similar to those above, they should notify the SSO immediately.

Treatment with antibiotics is effective and recovery is usually complete. In the first stage antibiotics are usually given orally. Second and third stage treatment, however is prolonged and recovery may take longer. Antibiotic treatment is usually provided intravenously for second and third stage Lyme disease.
4.3.2.2 West Nile Virus
West Nile Virus (WNV) is a mosquito-borne infection transmitted through the bite of an infected mosquito. The symptoms of WNV can be asymptomatic (no symptoms) or in more serious cases can lead to West Nile fever. West Nile Fever can include fever, headache, tiredness, body ache, an occasional rash on the trunk of the body, and swollen lymph glands. In severe cases, people have developed West Nile encephalitis or meningitis which symptoms include fever, headache, neck stiffness, tremors, coma and in some cases death. The incubation period for the disease is usually 2 to 15 days. The symptoms can range from a few days to several weeks.

Since the initial outbreak in 1999, the virus has spread rapidly throughout New York State. There are about 65 different species of mosquitoes in New York State, but only a small percentage has been associated with the WNV. Most mosquitoes are not infected and the chance of infection from a mosquito bite of an on-site worker is very small. All residents of areas where virus activity has been identified are at risk of getting WNV, but those of the highest risk for becoming seriously ill from WNV are people are over 50 and individuals with some immunocompromised person (transplant patients).

The following precautions will be used to help reduce the risk of mosquito bites:

- Reduce mosquito-breeding areas by making sure wheelbarrows, buckets, and other containers are turned upside down when not used so that they do not collect standing water.
- Wear shoes, long pants with bottoms tucked into boots or socks, and a long-sleeved shirt when outdoors for long periods of time, or when many mosquitoes are most active (between dawn and dusk).
- Use mosquito repellant according to the manufacturer’s directions when outdoors for long periods of time and when mosquitoes are most active.

4.3.3 Plants
The potential for contact with poisonous plants exists when performing fieldwork in undeveloped and wooded areas. Poison ivy, sumac, and oak may be present on site. Poison ivy can be found as vines on tree trunks or as upright bushes. Poison ivy consists of three leaflets with notched edges. Two leaflets form a pair on opposite sides of the stalk, and the third leaflet stands by itself at the tip. Poison ivy is red in the early spring and turns shiny green later in the spring. Poison sumac can be present in the form of a flat-topped shrub or tree. It has fern-like leaves, which are velvet “down.” Poison sumac has white, “hairy” berry clusters. Poison oak can be present as a sparsingly branched shrub. Poison oak is similar to poison ivy in that it has the same leaflet configuration;
however, the leaves have slightly deeper notches. Prophylactic application of Tecnu® may prevent the occurrence of exposure symptoms. Post exposure over the counter products are available and should be identified at the local pharmacist. Susceptible individuals should identify themselves to the SSO.

Contact with poison ivy, sumac, or oak may lead to a skin rash, characterized by reddened, itchy, blistering skin which needs first aid treatment. If you believe you have contacted one of these plants, immediately wash skin thoroughly with soap and water, taking care not to touch your face or other body parts.

4.3.4 Blood Poisoning
Blood poisoning is a term used to indicate a large number of bacteria present in the circulating blood. The most common symptom of blood poisoning is the reddening of skin which advances toward the heart. For example, if the point of contact is the hand, then a red line will appear at the hand and extend up the arm towards the heart.

Signs and symptoms include swelling, stiffness and tenderness in the affect area, fatigue chills and fever, pustules, abscesses. If allowed to progress without treatment, the organisms may multiply and cause an overwhelming infection which can lead to death.

Personal protective equipment shall be worn to prevent direct contact with equipment that may be contaminated with bacteria such as well caps and soil.

4.4 Hazard Analysis
This section includes an AHA to assess and control potential site hazards for each general project task. A more detailed Contractor Project-specific AHA is included in Appendix C, which addresses the health and safety hazards of each specific project task or operation and includes requirements and procedures for worker protection.
## Health and Safety Plan
### Williamsburg Works Former MGP
#### Remedial Investigation
##### Brooklyn, New York

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>POTENTIAL HAZARDS</th>
<th>CONTROLS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity: Site Mobilization and Utility Clearance</strong></td>
<td>Biological Hazards.</td>
<td>Proper clothes, body inspections, insect repellent.</td>
</tr>
<tr>
<td>Site Mobilization/Activity</td>
<td>Slip, Trip, Fall Hazards</td>
<td>Identify and repair potential tripping hazards.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintain safe and orderly work areas.</td>
</tr>
<tr>
<td>Traffic Hazards</td>
<td></td>
<td>Use traffic cones, signage, and traffic safety vests in accordance with New York City Traffic Regulations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use a traffic spotter.</td>
</tr>
<tr>
<td>Adverse Weather</td>
<td></td>
<td>Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.</td>
</tr>
<tr>
<td>Noise</td>
<td></td>
<td>Distancing form noise, hearing protection</td>
</tr>
<tr>
<td>Heat/Cold Stress</td>
<td></td>
<td>Acclimatization, work/rest regimes, drinking warm/cold fluids.</td>
</tr>
</tbody>
</table>

| **Activity: Test Pit Installation and Sample Collection** | Heavy Equipment / Proximity to Heavy Equipment | Distancing, safe work practices, inspections, wear hearing protection. |
| Test Pit Installation and Sample Collection | Adverse Weather | Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc. |
| | Heat/Cold Stress | Acclimatization, work/rest regimes, drinking warm/cold fluids. |
| | Slip/Trip/Fall | Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards. |
| | Noise | Distancing form noise, hearing protection |
| | Tool Use | Use proper guarding, inspections, wear safety glasses with side shields, hearing protection. |
| | Contaminant Contact | Wear protective coveralls (e.g., Tyvek®) (if needed) with shoe covers, nitrile gloves, and safety glasses when handling samples. Dispose of gloves after sampling. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP. |
## Health and Safety Plan
**Williamsburg Works Former MGP**  
**Remedial Investigation**  
**Brooklyn, New York**

<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>POTENTIAL HAZARDS</th>
<th>CONTROLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure to vapors from contaminated soils</td>
<td>Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide and hydrogen cyanide), and dust monitor to monitor the workzone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist, then upgrade to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of the HASP. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the RI Work Plan and Appendix K of this HASP.</td>
<td></td>
</tr>
</tbody>
</table>

**Activity: Subsurface Boring Installation and Sample Collection**

<table>
<thead>
<tr>
<th>Subsurface Boring Installation and Sample Collection</th>
<th>Heavy Equipment / Proximity to Heavy Equipment</th>
<th>Adverse Weather</th>
<th>Heat/Cold Stress</th>
<th>Slip/Trip/Fall</th>
<th>Noise</th>
<th>Tool Use</th>
<th>Contaminant Contact</th>
<th>Exposure to vapors from contaminated soils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distancing, safe work practices, inspections, wear hearing protection.</td>
<td>Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.</td>
<td>Acclimatization, work/rest regimes, drinking warm/cold fluids.</td>
<td>Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.</td>
<td>Distancing from noise, hearing protection</td>
<td>Use proper guarding, inspections, wear safety glasses with side shields, hearing protection.</td>
<td>Wear protective coveralls (e.g., Tyvek®) (if needed) with shoe covers, nitrile gloves, and safety glasses when handling samples. Dispose of gloves after sampling. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.</td>
<td>Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide and hydrogen cyanide), and dust monitor to monitor the workzone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist, then upgrade to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of the HASP. Community air monitoring of the area immediately surrounding the work zone will be completed in accordance with the RI Work Plan and Appendix K of this HASP.</td>
</tr>
</tbody>
</table>
**Activity: Sediment Sample Collection**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Interaction</th>
<th>Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving barge to exploration locations; set up barge to sample by lowering anchors.</td>
<td>Interaction with other boat traffic. Drowning.</td>
<td>Wear PFD. Follow USGC Safe Boating Practices.</td>
</tr>
<tr>
<td>Advancing borings and sampling.</td>
<td>Subsurface hazards (utilities especially).</td>
<td>Review available utility plans and evaluate geophysical survey data obtained during bathymetry survey. Visually confirm clearance from known utilities.</td>
</tr>
<tr>
<td></td>
<td>Contact with equipment, especially moving parts. Overhead hazard (rods).</td>
<td>Stay alert and maintain suitable clearance from moving and overhead equipment. Do not wear loose clothing, jewelry, or equipment, which could get caught by moving equipment. Inspect equipment daily. Train all personnel on use of emergency shutoff switches.</td>
</tr>
<tr>
<td></td>
<td>Weather related equipment hazards (slippage in rain, lightning).</td>
<td>Cease operations prior to and during electrical storms. Cease operations if equipment cannot be operated safely under wet conditions.</td>
</tr>
<tr>
<td></td>
<td>Slip/trip/fall.</td>
<td>Keep trafficked areas on boat or barge free of slip/trip/fall hazards.</td>
</tr>
<tr>
<td></td>
<td>Drowning.</td>
<td>Wear PFD.</td>
</tr>
<tr>
<td></td>
<td>Loud noise (outboard motor, generator, VC sampler).</td>
<td>Use hearing protection during the operation of equipment that produces loud noise.</td>
</tr>
<tr>
<td></td>
<td>Contact with contaminated surface water or sediments.</td>
<td>Wear protective coveralls (e.g., Tyvek® or equivalent) with shoe covers, nitrile gloves, safety glasses, face shield when handling samples. Dispose of gloves after sampling. If exposed to the sediments or surface waters of the East River, wash the exposed skin immediately with anti-bacterial wipes/gel and wash with soap and water. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.</td>
</tr>
<tr>
<td></td>
<td>Exposure to vapors from contaminated sediments.</td>
<td>Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide, and hydrogen cyanide) to monitor the works zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist then change to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of this HASP.</td>
</tr>
<tr>
<td>Lift and secure anchors. Relocate to next exploration location.</td>
<td>Heavy lifting. Slip/Trip/Fall. Drowning.</td>
<td>Use proper lifting technique. Stay alert to moving or overhead equipment. Keep trafficked areas on boat or barge free of slip/trip/fall hazards. Wear PFD. Anchoring equipment and boat deck will be rinsed to remove accumulated sediments prior to demobilization at the end of the day.</td>
</tr>
<tr>
<td>WORK TASK</td>
<td>POTENTIAL HAZARDS</td>
<td>CONTROLS</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Activity: Sediment Core Handling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opening Cores/Collecting Samples</td>
<td>Cuts or abrasions (cutting aluminum, lexan, or acetate core barrel).</td>
<td>Wear Kevlar or leather gloves over nitrile gloves.</td>
</tr>
<tr>
<td></td>
<td>Loud noise (generator).</td>
<td>Use hearing protection if working near the generator. Stage generator away from work area.</td>
</tr>
<tr>
<td></td>
<td>Electrical Hand Tools (cutting aluminum, lexan, or acetate core barrel).</td>
<td>Ensure electrical equipment is connected to a Ground Fault Circuit Interrupter (GFCI).</td>
</tr>
<tr>
<td></td>
<td>Weather related equipment hazards (slippage in rain, lightning).</td>
<td>Cease operations prior to and during electrical storms. Cease operations if equipment cannot be operated safely under wet conditions.</td>
</tr>
<tr>
<td></td>
<td>Slip/trip/fall.</td>
<td>Keep trafficked areas on boat or barge free of slip/trip/fall hazards.</td>
</tr>
<tr>
<td></td>
<td>Loud noise (outboard motor, generator, VC sampler).</td>
<td>Use hearing protection during the operation of equipment that produces loud noise.</td>
</tr>
<tr>
<td></td>
<td>Contaminant contact.</td>
<td>Wear protective coveralls or aprons (e.g., Tyvek®) with shoe covers, nitrile gloves, safety glasses, and face shield when handling samples. Dispose of gloves after sampling. If exposed to the sediments or surface waters of the East River, wash the exposed skin immediately with anti-bacterial wipes/ gel and wash with soap and water. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.</td>
</tr>
<tr>
<td></td>
<td>Exposure to vapors from contaminated sediments</td>
<td>Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit and hydrogen cyanide) to monitor the works zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist then change to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of this HASP.</td>
</tr>
<tr>
<td></td>
<td>Heavy lifting. Slip/Trip/Fall. Drowning.</td>
<td>Use proper lifting technique. Stay alert to moving or overhead equipment. Keep trafficked areas free of slip/trip/fall hazards.</td>
</tr>
</tbody>
</table>
5.0 TRAINING

5.1 General Health and Safety Training
In accordance with 29 CFR 1910.120, hazardous waste site workers shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations unless otherwise noted in the above reference. At a minimum, the training shall have consisted of instruction in the topics outlined in the standard. Personnel who have not met the requirements for initial training shall not be allowed to work in any site activities in which they may be exposed to hazards (chemical or physical). Proof of training shall be submitted to the SSO prior to the start of field activities.

5.2 Annual Eight-Hour Refresher Training
Annual eight-hour refresher training will be required of all hazardous waste site field personnel in order to maintain their qualifications for fieldwork. The training will cover a review of 29 CFR 1910.120 requirements and related company programs and procedures. Proof of current 8-hour refresher training shall be submitted to the SSO prior to the start of field activities.

5.3 Supervisor Training
Personnel acting in a supervisory capacity shall have received 8 hours of instruction in addition to the initial 40 hours training.

5.4 Site Safety Officer (SSO)
The SSO shall have completed the following training and work experience prior to the commencement of site activities:

- One year of construction experience
- 40-Hour Hazardous Materials training course
- Training specific to work activities (i.e., excavation and trenching activities, lock out/tag out, etc.

5.5 Site-Specific Training
Prior to commencement of field activities, the SSO will ensure all field personnel assigned to the project will have completed training that will specifically address the activities, procedures, monitoring, and equipment used in the site operations. It will include site and facility layout, hazards and emergency services at the Site and will highlight all provisions contained within this HASP. This training will also allow field workers to clarify anything they do not understand and to reinforce their responsibilities.
regarding safety and operations for their particular activity. Personnel that have not received site-specific training will not be allowed on site.

5.6 **On-Site Safety Briefings**

Project personnel and visitors will be given health and safety briefings daily by the SSO to assist site personnel in safely conducting work activities. The briefings will include information on new operations to be conducted, changes in work practices or changes in the site's environmental conditions, as well as periodic reinforcement of previously discussed topics. The briefings will also provide a forum to facilitate conformance with safety requirements and to identify performance deficiencies related to safety during daily activities or as a result of safety inspections. The meetings will also be an opportunity to periodically update the crews on monitoring results.

5.7 **First Aid and CPR**

The SSO will identify individuals certified in first aid and CPR, or identify individuals for such training in order to ensure that emergency medical treatment is available during field activities. The training will be consistent with the requirements of the American Red Cross Association and will include training on blood borne pathogens.

5.8 **Hazard Communication**

Hazard communication training will be provided in accordance with the requirements contained in the Hazard Communication Program in Appendix D.
6.0 PERSONAL PROTECTIVE EQUIPMENT

The PPE specified in Table 6-1 represents PPE selection required by 29 CFR 1910.132, and is based on the AHA of Section 4. Specific information on the selection rationale for each activity can be found under Appendix G - Personal Protective Equipment (PPE) Program.

The PPE program addresses elements, such as PPE selection based on site hazards, use and limitations, donning and doffing procedures, maintenance and storage, decontamination and disposal, training and proper fitting, inspection procedures prior to/during/and after use, evaluation of the effectiveness of the PPE program, and limitations during temperature extremes, heat stress, and other appropriate medical considerations.

A summary of PPE for each level of protection is as follows:

<table>
<thead>
<tr>
<th>Safety Equipment</th>
<th>Level A</th>
<th>Level B</th>
<th>Level C</th>
<th>Level D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tyvek® suit or work overalls</td>
<td></td>
<td></td>
<td></td>
<td>•</td>
</tr>
<tr>
<td>Hard hats with splash shields and/or safety glasses</td>
<td></td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel-toe boots with over boots</td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical-resistant gloves as appropriate for work being performed and materials handled</td>
<td></td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disposable Respirator/ Half- or full-face respirators as approved by the CESM/SSO</td>
<td></td>
<td></td>
<td>•</td>
<td></td>
</tr>
<tr>
<td>Tyvek® splash-resistant suit or chemical resistant clothing appropriate for the work being performed or materials handled</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td></td>
</tr>
<tr>
<td>Chemical-resistant clothing</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td></td>
</tr>
<tr>
<td>Pressure-demand, full-face SCBA or pressure-demand supplied air respirator with escape SCBA</td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inner and outer chemical-resistant gloves</td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical-resistant safety boots or shoes</td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two-way radio</td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fully encapsulating chemical-resistant suit</td>
<td>•</td>
<td>•</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6-1 describes the anticipated task-specific PPE. For activities not covered by Table 6-1, the SSO/CESM will revise the hazard assessment and select the PPE using the information provided in Appendix G.
### 6.1 **PPE Abbreviations and Selection**

<table>
<thead>
<tr>
<th>HEAD PROTECTION</th>
<th>EYE/FACE PROTECTION</th>
<th>RESPIRATORY PROTECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH = Hard Hat</td>
<td>PFS = Plastic Face shield</td>
<td>Level D = No respiratory protection required</td>
</tr>
<tr>
<td>HEARING PROTECTION</td>
<td>SG = ANSI approved safety</td>
<td>Level C = Half face or full face air purifying respirator</td>
</tr>
<tr>
<td>EP = ear plugs</td>
<td>glasses with side shields</td>
<td>with approved cartridges (HEPA filter/organic vapor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cartridge)</td>
</tr>
<tr>
<td>BODY PROTECTION</td>
<td></td>
<td>Level B = Full face air supplied respirator with escape</td>
</tr>
<tr>
<td>NEWS = Leather Work</td>
<td>Poly = Polyethylene coated</td>
<td>bottle</td>
</tr>
<tr>
<td>HAND PROTECTION</td>
<td>Gloves</td>
<td></td>
</tr>
<tr>
<td>Nit = Nitrile Gloves</td>
<td>coveralls or apron</td>
<td></td>
</tr>
<tr>
<td>FOOT PROTECTION</td>
<td>WC = Work clothes</td>
<td></td>
</tr>
<tr>
<td>STB = Leather work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boots with steel toe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6.1-PERSONAL PROTECTIVE EQUIPMENT SELECTION

<table>
<thead>
<tr>
<th>TASK</th>
<th>HEAD</th>
<th>EYE/FACE</th>
<th>FEET</th>
<th>HANDS</th>
<th>BODY</th>
<th>HEARING</th>
<th>RESPIRATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mobilization/Demobilization</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobilization/ demobilization of equipment and supplies</td>
<td>HH as needed</td>
<td>SG as needed</td>
<td>STB</td>
<td>LWG as needed</td>
<td>WC</td>
<td>EP as needed</td>
<td>Level D</td>
</tr>
<tr>
<td>Establishment of site security, work zones and staging area</td>
<td>HH as needed</td>
<td>SG as needed</td>
<td>STB</td>
<td>LWG as needed</td>
<td>WC</td>
<td>EP as needed</td>
<td>Level D</td>
</tr>
<tr>
<td>Locate all utilities to and from the site</td>
<td>HH as needed</td>
<td>SG as needed</td>
<td>STB</td>
<td>LWG as needed</td>
<td>WC</td>
<td>EP as needed</td>
<td>Level D</td>
</tr>
<tr>
<td>Locate all active utility lines on site</td>
<td>HH as needed</td>
<td>SG as needed</td>
<td>STB</td>
<td>LWG as needed</td>
<td>WC</td>
<td>EP as needed</td>
<td>Level D</td>
</tr>
<tr>
<td><strong>Remedial Investigation Activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Soil Sampling</td>
<td>HH as needed</td>
<td>SG</td>
<td>STB, OB as needed</td>
<td>Nit</td>
<td>WC</td>
<td>EP as needed</td>
<td>Level D</td>
</tr>
<tr>
<td>Test Pit Installation and Sampling</td>
<td>HH</td>
<td>SG</td>
<td>STB, OB as needed</td>
<td>Nit</td>
<td>WC</td>
<td>EP</td>
<td>Level D initially, Level C-If action levels exceeded (see Section 8 of HASP)</td>
</tr>
<tr>
<td>Subsurface Soil Boring and Monitoring Well Installation and Sampling</td>
<td>HH</td>
<td>SG</td>
<td>STB, OB as needed</td>
<td>Nit</td>
<td>WC, Poly as needed</td>
<td>EP</td>
<td>Level D initially, Level C-If action levels exceeded (see Section 8 of HASP)</td>
</tr>
<tr>
<td>Sediment Sampling</td>
<td>HH</td>
<td>SG</td>
<td>STB, OB as needed</td>
<td>Nit</td>
<td>WC, Poly as needed</td>
<td>EP</td>
<td>Level D initially, Level C-If action levels exceeded (see Section 8 of HASP)</td>
</tr>
<tr>
<td>Survey</td>
<td>HH as needed</td>
<td>SG as needed</td>
<td>STB</td>
<td>LWG as needed</td>
<td>WC</td>
<td>EP as needed</td>
<td>Level D</td>
</tr>
<tr>
<td>Monitoring Well Development</td>
<td>HH as needed</td>
<td>SG as needed</td>
<td>STB</td>
<td>Nit</td>
<td>WC</td>
<td>EP as needed</td>
<td>Level D</td>
</tr>
</tbody>
</table>
## Health and Safety Plan
**Williamsburg Works Former MGP**  
**Remedial Investigation**  
**Brooklyn, New York**

<table>
<thead>
<tr>
<th>TASK</th>
<th>HEAD</th>
<th>EYE/FACE</th>
<th>FEET</th>
<th>HANDS</th>
<th>BODY</th>
<th>HEARING</th>
<th>RESPIRATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater Sampling</td>
<td>HH as needed</td>
<td>SG</td>
<td>STB, OB as needed</td>
<td>Nit</td>
<td>WC, Poly as needed</td>
<td>EP as needed</td>
<td>Level D</td>
</tr>
<tr>
<td>Waste Handling</td>
<td>HH</td>
<td>SG</td>
<td>STB, OB as needed</td>
<td>LWG and Nit as needed</td>
<td>WC, Poly as needed</td>
<td>EP as needed</td>
<td>Level D initially, Level C-If action levels exceeded (see Section 8 of HASP)</td>
</tr>
</tbody>
</table>
7.0 MEDICAL SURVEILLANCE

All personnel performing field work where potential exposure to contaminants exists at the Site are required to have passed a complete medical surveillance examination in accordance with 29 CFR 1910.120(f) and, where applicable, expanded health standards.

7.1 Medical Surveillance Requirements

A physician's medical release for work will be confirmed by the SSO before a worker can enter the exclusion zone. The examination will be taken annually at a minimum and upon termination of hazardous waste site work if the last examination was not taken within the previous six months. Additional medical testing may be required by the CESM in consultation with the SSO if an over-exposure or accident occurs, if an employee exhibits symptoms of exposure, or if other site conditions warrant further medical surveillance.
8.0 MONITORING

Monitoring shall be performed to identify and quantify airborne levels of hazardous substances and safety and health hazards in order to determine the appropriate level of worker protection needed on site.

The Consultant conducts perimeter air monitoring, and work zone monitoring for Consultant employees. The Consultant will monitor and document daily site conditions and operations on NGRID’s behalf.

The Contractor is responsible for the health and safety of Contractor and Subcontractor employees, and conducts work zone monitoring for Contractor and Subcontractor workers.

The Contractor is required to provide the following equipment for health and safety monitoring of its personnel:

- Photoionization Detector (PID), or Flame Ionization Detector (FID),
- Particulate Meter (PM-10 capable)
- Multiple gas Meter with Combustible Gas Indicator (CGI)/Oxygen (O₂) / H₂S / HCN sensors
- Dräger Chip Measurement System (CMS) (or equivalent instrument)
- Sound Level Meter if deemed necessary by the SSO and CESM (type to be appropriate to the activities performed)

The Consultant and Contractor will adopt the air monitoring action levels and contingency plan presented within the Table 8-1 below. In the event that a Contractor has a more stringent action level requirement than the HASP, the Contractor will notify NGRID and the Consultant SSO and the CESM to rectify the action level discrepancy.

The perimeter air monitoring will be conducted during subsurface soil boring installations to conform to the community air monitoring plan (CAMP) guidelines presented by the New York State Department of Health in Appendix 1A of the Draft New York State Department of Conservation DER-10 Technical Guidance for Site Investigation and Remediation. The CAMP is located in Appendix K.

Total volatile organic compounds (VOCs), respirable particulate matter, and odor will be monitored during all intrusive subsurface soil activities in accordance with the CAMP.

Table 8-1 provides a summary of real time air monitoring action levels and contingency plans for work zone activities.
### TABLE 8-1: Work Zone Air Monitoring Action Levels

<table>
<thead>
<tr>
<th>Air Monitoring Instrument</th>
<th>Monitoring Location</th>
<th>Action Level</th>
<th>Site Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>PID/FID</td>
<td>Breathing Zone</td>
<td>0 - 10 ppm</td>
<td>No respiratory protection is required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 - 250 ppm</td>
<td>Stop work, withdrawal from work area, institute engineering controls, if levels persist Upgrade to Level C.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 250 ppm</td>
<td>Stop work, withdraw from work area; notify SSO &amp; CESM.</td>
</tr>
<tr>
<td>Oxygen meter (O2)</td>
<td>Breathing Zone</td>
<td>&lt;19.5%</td>
<td>Stop work; withdraw from work area; ventilate area, notify SSO &amp; CESM.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;22%</td>
<td>Stop work; withdraw from work area; notify SSO &amp; CESM.</td>
</tr>
<tr>
<td>Hydrogen Sulfide (H2S)</td>
<td>Breathing Zone</td>
<td>&lt;5 ppm</td>
<td>No respiratory protection is required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;5 ppm</td>
<td>Stop work, cover excavation, withdraw from work area, institute engineering controls, and notify SSO &amp; CESM.</td>
</tr>
<tr>
<td>Hydrogen Cyanide (HCN)</td>
<td>Breathing Zone</td>
<td>&lt;1.0 ppm</td>
<td>Run CMS Dräger tube, continue monitoring with real time meter, and continue work if CMS Dräger Tube Reading is less than 2ppm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0&lt; HCN &lt;2.0 ppm</td>
<td>Run CMS Dräger tube and confirm concentration is less than 2.0 ppm, notify SSO and CESM. Run CMS Dräger tube for sulfur dioxide, hydrogen sulfide, and phosphine chip potential interferences. Continue to monitor with real time meter.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;2.0 ppm</td>
<td>Stop work, and move (with continuous HCN monitoring meter) at least 25 feet upwind of the excavation until continuous meter reads less than 1 ppm, Notify SSO &amp; CESM. Run CMS Dräger hydrogen cyanide chip and re-evaluate activity, continue monitoring with a real time meter, resume work if concentrations read less than 1.0 ppm.</td>
</tr>
<tr>
<td>Combustible Gas Indicator (CGI)</td>
<td>Excavation/ Work Zone</td>
<td>&lt; 10 % Lower Explosive Limit (LEL)</td>
<td>Investigate possible causes, allow excavation to ventilate; use caution during procedures.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 10% LEL</td>
<td>Stop work; allow excavation, borehole to ventilate to &lt; 10% LEL; if ventilation does not result in a decrease to &lt; 10% LEL, withdraw from work area; notify SSO &amp; CESM.</td>
</tr>
<tr>
<td>Particulate Meter</td>
<td>Excavation/ Work Zone</td>
<td>0.150 ug/m³</td>
<td>Implement work practices to reduce/minimize airborne dust generation, e.g., spray/misting of soil with water.</td>
</tr>
</tbody>
</table>

Carry cellular telephones for communication in a designated area away from subsurface investigation and sampling activities. Cellular phone use will not be permitted in the Exclusion Zone while work is being conducted in Level C PPE.
9.0 SITE CONTROL MEASURES

9.1 Site Zones

Site zones are intended to control the potential spread of contamination and to assure that only authorized individuals are permitted into potentially hazardous areas. A three-zone approach will be utilized. It shall include an Exclusion Zone (EZ), Contamination Reduction Zone (CRZ), and a Support Zone (SZ). Specific zones shall be established on the work site when operations begin for each task requiring such delineation (i.e. drilling, construction, excavation, trenching in impacted areas of the Site). Maps depicting the zones will be available at the Site.

This project is being conducted under the requirements of 29 CFR 1910.120, and any personnel working in an area where the potential for exposure to site contaminants exists, will only be allowed access after proper training and medical documentation as required by NGRID. These records are maintained by the CESM, and copies are provided to the SSO prior to mobilization for project activities.

The following shall be used for guidance in revising these preliminary zone designations, if necessary.

**Support Zone** - The SZ is an uncontaminated area that will be the field support area for most operations. The SZ provides for field team communications and staging for medical emergency. Appropriate sanitary facilities and safety equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged/decontaminated and labeled samples.

**Contamination Reduction Zone** - The CRZ is established between the EZ and the SZ. The CRZ contains the contamination reduction corridor and provides an area for decontamination of personnel and portable hand-held equipment, tools and heavy equipment. A personnel decontamination area will be prepared at each exclusion zone. The CRZ will be used for Exclusion Zone entry and egress in addition to access for heavy equipment and emergency support services.

**Exclusion Zone** - All activities which may involve exposure to site contaminants, hazardous materials and/or conditions should be considered an exclusion zone. This zone will be clearly delineated by cones, tapes or other means. The SSO may establish more than one EZ where different levels of protection may be employed or different hazards exist. The size of the EZ shall be determined by the site SSO allowing adequate space for the activity to be completed, field members and emergency equipment.

9.2 Communications

The following communications equipment shall be specified as appropriate:
• Telephones - A cellular telephone will be located in the SZ for communication with emergency support services/facilities and the home office. Personnel in the EZ can carry cellular telephones for communication in a designated area way from subsurface investigation and sampling activities. Cellular phone use will not be permitted in the EZ while work is being conducted in Level C PPE.

• Hand Signals - Hand signals shall be used by field teams along with the buddy system. They shall be known by the entire field team before operations commence and their use covered during site-specific training. Typical hand signals are the following:

<table>
<thead>
<tr>
<th>Signal</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand gripping throat</td>
<td>Out of air, can't breathe</td>
</tr>
<tr>
<td>Grip on a partner's wrist or placement of both hands around a partner's waist</td>
<td>Leave area immediately, no debate</td>
</tr>
<tr>
<td>Hands on top of head</td>
<td>Need assistance</td>
</tr>
<tr>
<td>Thumbs up</td>
<td>Okay, I’m all right, I understand.</td>
</tr>
<tr>
<td>Thumbs down</td>
<td>No, negative.</td>
</tr>
</tbody>
</table>
10.0 DECONTAMINATION

PPE helps prevent the wearer from becoming contaminated or inhaling contaminants, and good work practices help reduce contamination on protective clothing, instruments, and equipment. Even with these safeguards, contamination may occur. Harmful materials can be transferred to clean areas, exposing unprotected personnel. To prevent such occurrences, the following contamination reduction and decontamination procedures have been developed.

10.1 Minimization of Contact with Contaminants

During completion of all site activities, personnel should attempt to minimize the degree of contact with contaminated materials. This involves a conscientious effort to keep "clean" during site activities. All personnel should minimize kneeling, splash generation, and other physical contact with contamination. This may ultimately minimize the degree of decontamination required and the generation of waste materials from site operations.

10.2 Personnel Decontamination

Personnel hygiene, coupled with diligent decontamination, will significantly reduce the potential for exposure. Consideration will be given to prevailing wind directions so that the decontamination line, the support zone, and contamination reduction zone exit is upwind from the exclusion zone and the first station of the decontamination line. Decontamination will be performed by removing all PPE used in EZ and placing in drums/trash cans at CRZ. Disinfecting hand wipes shall be available for wiping hands and face. For Level D Decontamination, personnel should wash and rinse gloves, and use anti bacterial wipes/gel and wash and rinse hands and face with potable water.

For Level C Decontamination, personnel should wash and rinse gloves and over boots, remove boot covers, remove outer gloves, remove Tyvek® splash-resistant suit or chemical resistant clothing, wash inner gloves, remove respirator, rinse inner gloves, remove inner gloves and wash and rinse hands and face.

If exposed to subsurface soils, wash with soap and water.

10.3 Emergency Decontamination

If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination, wrap injured personnel with clean garments/blankets to avoid contaminating other personnel or transporting equipment. If the injured person can be moved, he/she will be moved to the exclusion zone boundary and decontaminated by site personnel as described above before emergency responders handle the victim. If the person cannot be moved because of the extent of the injury (a back or neck injury) provisions shall be made to ensure that emergency response personnel will be able to
respond to victim without being exposed to potentially hazardous atmospheric conditions. The only time an injured person should be removed is if the worker’s life is threatened to a greater degree than if he/she is left in the spot where the accident occurred. If emergency response personnel have to enter hazardous conditions to respond to victim this should communicated when the emergency call is made and responders can come prepared in appropriate PPE. If the potential for inhalation hazards exist, such as with an open excavation, this area will be covered with plastic sheeting, or similar controls, to eliminate any potential inhalation hazards. All emergency personnel are to be immediately informed of the injured person's condition, potential contaminants, and provided with all pertinent chemical data.

10.4 Hand Held Equipment Decontamination
Hand held equipment includes all monitoring instruments, samples, hand tools, and notebooks. The hand held equipment is dropped at the first decontamination station to be decontaminated by one of the decontamination team members. These items must be decontaminated or discarded as waste prior to removal from the exclusion zone.

To aid in decontamination, monitoring instruments can be sealed in plastic bags or wrapped in polyethylene. This will also protect the instruments against contaminants. The instruments will be wiped clean using antibacterial wipes and paper towels if contamination is visually evident.

Decontamination procedures for sampling equipment, hand tools, etc., shall include the use of steam cleaning or a detergent wash, as appropriate for the site conditions. The standard decontamination procedures will be used as presented in the Williamsburg Works Former MGP Remedial Investigation Work Plan. All liquids generated in the decontamination will be stored at the Site in drums and then disposed of at an approved facility in accordance with federal, state and local regulations. Personnel performing this task will wear the proper PPE as prescribed in Table 6-1.

10.5 Heavy Equipment Decontamination
Decontamination of chemically contaminated heavy equipment will be accomplished using high -pressure steam or dry decontaminated with brushes and shovels. Decontamination shall take place on a decontamination pad and all liquids used in the decontamination procedure will be collected. Vehicles or equipment brought into an exclusion zone will be treated as contaminated, and will be decontaminated prior to removal. All liquids used in the decontamination procedure will be stored at the Site drums and then disposed of at an approved facility in accordance with federal, state and local regulations. Personnel performing this task will wear the proper PPE as prescribed in Table 6-1.
11.0 EMERGENCY RESPONSE PLAN

This section establishes procedures and provides information for use during a project emergency. Emergencies happen unexpectedly and quickly, and require an immediate response; therefore, contingency planning and advanced training of staff are essential. Specific elements of emergency support procedures which are addressed in the following subsections include communications, local emergency support units, preparation for medical emergencies, first aid for injuries incurred on-site, record keeping, and emergency site evacuation procedures.

11.1 Pre-emergency Planning

Before the field activities begin, the local emergency response personnel may be notified by NGRID of the schedule for field activities and about the materials that are thought to exist on the Site so that they will be able to respond quickly and effectively in the event of a fire, explosion, or other emergency.

In order to be able to deal with any emergency that might occur during remedial activities at the Site, emergency telephone numbers will be readily available in the SSO vehicle or construction office. These telephone numbers are presented in Appendix A. A hospital route map will also be readily available at the Site, and is in Appendix B as Figure 2.

11.2 Roles and Responsibilities

11.2.1 Corporate Environmental and Safety Manager (CESM)

The CESM oversees and approves the Emergency Response Plan and performs audits to determine that the plan is in effect and that all pre-emergency requirements are met. The CESM acts as a liaison to applicable regulatory agencies and notifies OSHA of reportable accidents.

11.2.2 Site Safety Officer (SSO)

The SSO is responsible for ensuring that all personnel are evacuated safely and that machinery and processes are shut down or stabilized in the event of a stop work order or evacuation. The SSO is required to immediately notify the Consultant and NGRID Project Managers, and CESM of any fatalities or injuries requiring more than basic first aid treatment. The CESM will notify OSHA within the required time frame if a reportable incident has occurred. The CESM will be notified of all OSHA recordable injuries, fires, spills, releases or equipment damage in excess of $500 within 24 hours.

The SSO also serves as the Emergency Coordinator. In the event of an emergency, the Emergency Coordinator, with NGRID representatives, shall make contact with Local Emergency Response personnel. In these contacts, the Emergency Coordinator will inform response personnel about the nature of work on the Site, the type of contaminants
and associated health or safety effects, and the nature of the emergency, particularly if it is related to exposure to contaminants.

The Emergency Coordinator shall review this plan and verify emergency phone numbers, identify hospital routes, and shall ensure the appropriate emergency equipment is available and in working order prior to beginning work on site.

The Emergency Coordinator shall implement the Emergency Response Plan whenever conditions at the Site warrant such action.

11.2.3 Site Personnel
Site personnel are responsible for knowing the Emergency Response Plan and the procedures contained herein. Personnel are expected to notify the Emergency Coordinator of situations that could constitute a site emergency.

11.3 Evacuation Routes and Procedures
All project personnel will be instructed on proper emergency response procedures and locations of emergency telephone numbers during the initial site safety meeting. If an emergency occurs at the work area, including but not limited to fire, explosion, or significant release of toxic gas into the atmosphere, immediate evacuation of all personnel is necessary due to an immediate or impending danger. All heavy equipment will be shut down and all personnel will evacuate the work areas and assemble at a pre-determined location.

11.4 Contingency Plans

11.4.1 Fire Prevention and Protection
In the event of a fire or explosion, procedures will include immediately evacuating the work area. The Emergency Coordinator will immediately notify the local fire and police departments. No personnel will fight a fire beyond the stage where it can be put out with a portable extinguisher (incipient stage).

Fires will be prevented by adhering to the following precautions:

- Good housekeeping and storage of materials
- Storage of flammable liquids and gases away from oxidizers
- No smoking in the exclusion zone or any work area
- No hot work without a properly executed hot work permit
- Shutting off engines to refuel
- Grounding and bonding metal containers during transfer of flammable liquids
- Use of UL approved flammable storage cans
- Fire extinguishers rated at least 10 pounds ABC located on all heavy equipment, in all trailers and near all hot work activities
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- Monthly inspections of all fire extinguishers.

The SSO is responsible for the maintenance of fire prevention and/or control equipment. The SSO is responsible for the control of fuel source hazards.

### 11.4.2 Overt Chemical Exposure
The following are standard procedures to treat chemical exposures. Other, specific procedures detailed on the Material Safety Data Sheet will be followed as necessary. If first aid or emergency medical treatment is necessary the Emergency Coordinator will contact the appropriate emergency facilities.

<table>
<thead>
<tr>
<th>SKIN AND EYE CONTACT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use copious amounts of soap and water. Wash/rinse affected areas thoroughly, then provide appropriate medical attention. Eyes should be rinsed for 15 minutes upon chemical contamination. Skin should also be rinsed for 15 minutes if contact with caustics, acids or hydrogen peroxide occurs. Transport to hospital or local medical provider.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INHALATION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move to fresh air. Decontaminate. Transport to hospital or local medical provider.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INGESTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decontaminate and transport to emergency medical facility.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PUNCTURE WOUND OR LACERATION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decontaminate and transport to emergency medical facility.</td>
</tr>
</tbody>
</table>

### 11.4.3 Decontamination during Medical Emergencies
If emergency life-saving first aid and/or medical treatment are required, normal decontamination procedures may need to be abbreviated or postponed. The SSO or designee will accompany contaminated victims to the medical facility to advise on matters involving decontamination, when necessary. The outer garments can be removed if they do not cause delays, interfere with treatment or aggravate the problem. Respiratory equipment must always be removed. Protective clothing can be cut away. If the outer contaminated garments cannot be safely removed on site, a plastic barrier between the injured individual and clean surfaces should be used to help prevent contamination of the inside of ambulances and/or medical personnel. Outer garments may then be removed at the medical facility. No attempt will be made to wash or rinse the victim if his/her injuries are life threatening, unless it is known that the individual has been contaminated with an extremely toxic or corrosive material which could also cause severe injury or loss of life to emergency response personnel. For minor medical problems or injuries, the normal decontamination procedures will be followed.

### 11.4.4 Adverse Weather Conditions
In the event of adverse weather conditions, the SSO will determine if work can continue without potentially risking the safety of all field workers. Some of the items to be considered prior to determining if work should continue are:
Potential for heat stress and heat-related injuries
Potential for cold stress and cold-related injuries
Treacherous weather-related working conditions (hail, rain, snow, ice, high winds)
Limited visibility (fog)
Potential for electrical storms
Earthquakes
Other major incidents.

Site activities will be limited to daylight hours, or when suitable artificial light is provided, and acceptable weather conditions prevail. The SSO will determine the need to cease field operations or observe daily weather reports and evacuate, if necessary, in case of severe inclement weather conditions.

When severe weather has passed, the SSO will direct all contractors to inspect project equipment to ensure its readiness for operation prior to commencing field activities.

11.4.5 Spill Control and Response
All small hazardous spills/environmental releases shall be contained as close to the source as possible. Whenever possible, the MSDS will be consulted to assist in determining the best means of containment and cleanup. For small spills, absorbent materials such as sand, sawdust, or commercial sorbents should be placed directly on the substance to contain the spill and aid recovery. Any acid or caustic spills should be diluted or neutralized carefully prior to attempting recovery. Berms of earthen or sorbent materials can be used to contain the leading edge of the spills. Drains or drainage areas should be blocked. All spill containment materials will be properly disposed. An exclusion zone of 50 to 100 feet around the spill area should be established depending on the size and type of the spill.

Refueling of sampling equipment will be done with NFPA-approved safety cans and by approved USCG refueling methods. Fuel will be stored in containers meeting applicable fuel storage safety regulations.

The Emergency Coordinator should take the following steps:

1. Determine the nature, identity and amounts of major spill components
2. Make sure all unnecessary persons are removed from the spill area
3. Notify appropriate response teams and authorities
4. Use proper PPE in consultation with the SSO and information provided on the MSDS for the spilled material
5. If a flammable liquid, gas or vapor is involved, remove all ignition sources and use non-sparking and/or explosive proof equipment to contain or clean up the spill (diesel only vehicles, air operated pumps, etc.)
6. If possible, try to stop the leak with appropriate material
7. Remove all surrounding materials that can react or compound with the spill
8. Notify the NGRID Project Manager.

11.5 Emergency Contact Information

<table>
<thead>
<tr>
<th>Medical Emergencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Medical Services (NYC Fire Department)</td>
</tr>
<tr>
<td>Emergency</td>
</tr>
<tr>
<td>All other communications</td>
</tr>
</tbody>
</table>

| Nearest Emergency Room (Woodhull Medical and Mental Health Center) | (718) 963-8000 |

<table>
<thead>
<tr>
<th>Fire and Rescue Emergencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency</td>
</tr>
<tr>
<td>All other communications</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Police Emergencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYC Police Department</td>
</tr>
<tr>
<td>Emergency</td>
</tr>
<tr>
<td>All other communications</td>
</tr>
<tr>
<td>Switchboard</td>
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<table>
<thead>
<tr>
<th>Utility Emergencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric (Con Edison)</td>
</tr>
<tr>
<td>Water/Sewer (NYC Dept of Environmental Protection)</td>
</tr>
<tr>
<td>Natural Gas (NGRID)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>National Grid USA Site Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracey Bell-Project Manager</td>
</tr>
<tr>
<td>Andrew Prophete- Senior Engineer</td>
</tr>
<tr>
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<td></td>
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<table>
<thead>
<tr>
<th>Underground Utilities (New York City One Call Center)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spill Incident</td>
</tr>
<tr>
<td>New York State Department of Environmental Conservation</td>
</tr>
<tr>
<td>National Response Center</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>National Information Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemtrec</td>
</tr>
<tr>
<td>Poison Control Center</td>
</tr>
</tbody>
</table>
11.6 Emergency Equipment
The following minimum emergency equipment shall be kept and maintained at the Site.

- Industrial first aid kit
- Portable eye washes
- ABC-rated fire extinguishers (one per vehicle and heavy equipment [drill rig and sample vessel])
- Absorbent material [Sorbent pads and booms]
- Bloodborne pathogen kit.

In case of minor injuries, on-site care shall be administered with the Site first aid kit. The first aid kit will include at a minimum the items specified in Appendix J of this HASP. A first aid kit will be kept in a waterproof container at the Site. In addition, eye wash, antibacterial wipes/gel, soap, and potable water will be kept at the Site.

For serious injuries that can not be treated with the first aid kit, call 911 and request emergency medical assistance. Seriously injured persons should not be moved, unless they are in immediate danger.

11.7 Postings
The following information shall be posted or be readily visible and available at the Site:

- Emergency telephone numbers
- Hospital Route Map

The expected travel time from the Site to the nearest hospital is approximately 10 minutes, depending on local traffic conditions.

11.8 Restoration and Salvage
After an emergency, prompt restoration of utilities, fire protection equipment, medical supplies and other equipment will reduce the possibility of further losses. Some of the items that may need to be addressed are:

- Refilling fire extinguishers
- Refilling medical supplies
- Recharging eyewashes and/or showers
- Replenishing spill control supplies
- Replacing used air horns
12.0 LOGS, REPORTS, AND RECORD KEEPING

The following is a summary of required health and safety logs, reports, and record keeping. The SSO will maintain an on-site file for all the following logs, reports, and records. The CESM or designee will maintain a parallel file off-site.

12.1 Medical and Training Records
Copies or verification of training (40 hour, 8 hour, supervisor, and site-specific training) and medical clearance for hazardous waste site work and respirator use will be maintained by the CESM and copies provided to the SSO prior to the initiation of work on site.

12.2 On-Site Log
A log of personnel on site each day will be kept by the SSO in a field logbook.

12.3 Exposure Records
All personal monitoring results, laboratory reports, calculations, and air sampling data sheets will be maintained by the SSO during site work. At the end of the project they may be maintained in employee files if deemed necessary by the CESM.

12.4 Accident/Incident Reports
The incident reporting and investigation during site work will follow the Incident Reporting Program in Appendix J.

12.5 OSHA Form 300
An OSHA Form 300 will be maintained at the Contractor or Consultant home office. The SSO may retain a copy of the OSHA Form 300 on site. All recordable injuries or illnesses will be recorded on this form. The incident report form referenced in Appendix J meets the requirements of the OSHA Form 101(supplemental record) and must be maintained with the OSHA Form 300 for all recordable injuries or illnesses.

12.6 Hazard Communication Program/MSDS
Material Safety Data Sheets (MSDSs) will be obtained for applicable substances and included in the site hazard communication file. The hazard communication program will be maintained on site in accordance with 29 CFR 1910.1200 and the Hazard Communication Program in Appendix D.

12.7 Work Permits
All work permits, including confined space entry, hot work, lockout/tagout, and line-breaking permits will be maintained in the project files. Copies of the work permits shall also be provided to the SSO, and the NGRID Project Manager.
13.0 FIELD PERSONNEL REVIEW

This form serves as documentation that field personnel have read, or have been informed of, and understand the provisions of this HASP for the Williamsburg Works Former MGP site. It is maintained on site by the SSO as a project record. Each field team member shall sign this section after training on the contents of this HASP has been completed. Site workers must sign this form after site-specific training is completed and before being permitted to work on site.

I have read, or have been informed of, the Health and Safety Plan and understand the information presented. I have also completed site-specific training for the work detailed in the project Work Plan. I will comply with the provisions contained therein.

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<th>PRINT NAME</th>
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APPENDIX A

ORGANIZATIONAL STRUCTURE/
CONTACT INFORMATION
<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Contact Information</th>
</tr>
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<tbody>
<tr>
<td>Tracey Bell</td>
<td>Manager Environmental Asset</td>
<td>Office: (718) 403-3053 Mobile: (917) 866-9207 E-mail: <a href="mailto:Tracey.Bell@us.ngrid.com">Tracey.Bell@us.ngrid.com</a></td>
</tr>
<tr>
<td></td>
<td>Management</td>
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<tr>
<td>Andrew Prophete</td>
<td>Senior Environmental Field</td>
<td>Office: (718) 403-1048 Mobile: (516) 790-1654 E-mail: <a href="mailto:Andrew.Prophete@us.ngrid.com">Andrew.Prophete@us.ngrid.com</a></td>
</tr>
<tr>
<td></td>
<td>Coordinator</td>
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</table>
## Selected Consultant
### Project Team Contact Information

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td></td>
<td>Project Manager</td>
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## Selected Boring Subcontractor
### Contact Information

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<tr>
<th>Name</th>
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<tr>
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<td>Office: Mobile: E-mail:</td>
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<td>Office: Mobile: E-mail:</td>
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# Selected Test Pit Subcontractor
## Contact Information

<table>
<thead>
<tr>
<th>Name</th>
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Selected Sediment Coring Subcontractor
Contact Information

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<th>Name</th>
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<tr>
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<td>Office: Mobile: E-mail:</td>
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<td>Field Team Leader/Site Safety Officer (SSO)</td>
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<td>Office: Mobile: E-mail:</td>
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<tr>
<td>Corporate Environmental Safety Manager (CESM)</td>
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<td>Office: Mobile: E-mail:</td>
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APPENDIX B

SITE-SPECIFIC INFORMATION
APPENDIX C

PROJECT SPECIFIC
ACTIVITY HAZARD ANALYSIS
<table>
<thead>
<tr>
<th>WORK TASK</th>
<th>POTENTIAL HAZARDS</th>
<th>CONTROLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITY: Mobilization and Utility Clearance</td>
<td>Biological Hazards.</td>
<td>Proper clothes, body inspections, insect repellant.</td>
</tr>
<tr>
<td>Site Mobilization/Activity</td>
<td>Slip, Trip, Fall Hazards</td>
<td>Identify and repair potential tripping hazards. Maintain safe and orderly work areas.</td>
</tr>
<tr>
<td></td>
<td>Traffic Hazards</td>
<td>Use traffic cones, signage, and traffic safety vests in accordance with New York City Traffic Regulations. Use a traffic spotter</td>
</tr>
<tr>
<td></td>
<td>Adverse Weather</td>
<td>Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.</td>
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<tr>
<td></td>
<td>Noise</td>
<td>Distancing from noise, hearing protection</td>
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<tr>
<td></td>
<td>Heat/Cold Stress</td>
<td>Acclimatization, work/rest regimes, drinking warm/cold fluids.</td>
</tr>
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**Protective Equipment:** Safety glasses and steel-toe boots. Hard hat and leather work gloves as needed.
### Activity: Subsurface Boring and Monitoring Well Installation and Sample Collection

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<thead>
<tr>
<th>WORK TASK</th>
<th>POTENTIAL HAZARDS</th>
<th>CONTROLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subsurface Boring and Monitoring Well Installation and Sample Collection</td>
<td>Heavy Equipment / Proximity to Heavy Equipment</td>
<td>Distancing, safe work practices, inspections, wear hearing protection.</td>
</tr>
<tr>
<td>Adverse Weather</td>
<td>Monitor weather daily. Discontinue work as necessary based on lightning, limited visibility, impaired mobility, etc.</td>
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<tr>
<td>Heat/Cold Stress</td>
<td>Acclimatization, work/rest regimes, drinking warm/cold fluids.</td>
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</tr>
<tr>
<td>Slip/Trip/Fall</td>
<td>Maintain safe and orderly work areas. Unloading areas should be on even terrain. Identify and repair potential tripping hazards.</td>
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<tr>
<td>Noise</td>
<td>Distancing from noise, hearing protection</td>
<td></td>
</tr>
<tr>
<td>Tool Use</td>
<td>Use proper guarding, inspections, wear safety glasses with side shields, hearing protection.</td>
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</tr>
<tr>
<td>Contaminant Contact</td>
<td>Wear protective coveralls (e.g., Tyvek®) (if needed) with shoe covers, nitrile gloves, and safety glasses when handling samples. Dispose of gloves after sampling. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.</td>
<td></td>
</tr>
<tr>
<td>Exposure to vapors from contaminated soils</td>
<td>Use work zone air monitoring equipment including photo-ionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, and hydrogen cyanide), and dust monitor to monitor the works zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist, then upgrade to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of the HASP.</td>
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**Protective Equipment:** Hardhat, safety glasses, steel toe boots, nitrile gloves, protective coveralls. Ability to upgrade to half or full face respirator with HEPA/organic vapor cartridge if work zone action level is exceeded.
## Activity: Sediment Sample Collection

<table>
<thead>
<tr>
<th>Activity</th>
<th>Interaction/Condition</th>
<th>Safety Precautions/Action</th>
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<tbody>
<tr>
<td>Moving barge to exploration locations; set up barge to sample by lowering anchors.</td>
<td>Interaction with other boat traffic. Drowning.</td>
<td>Wear PFD. Follow USGC Safe Boating Practices.</td>
</tr>
<tr>
<td>Advancing borings and sampling.</td>
<td>Subsurface hazards (utilities especially).</td>
<td>Review available utility plans and evaluate geophysical survey data obtained during bathymetry survey. Visually confirm clearance from known utilities.</td>
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<td>Contact with equipment, especially moving parts. Overhead hazard (rods).</td>
<td>Stay alert and maintain suitable clearance from moving and overhead equipment. Do not wear loose clothing, jewelry, or equipment, which could get caught by moving equipment. Inspect equipment daily. Train all personnel on use of emergency shutoff switches.</td>
</tr>
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<td></td>
<td>Weather related equipment hazards (slippage in rain, lightning).</td>
<td>Cease operations prior to and during electrical storms. Cease operations if equipment cannot be operated safely under wet conditions.</td>
</tr>
<tr>
<td></td>
<td>Slip/trip/fall.</td>
<td>Keep trafficked areas on boat or barge free of slip/trip/fall hazards.</td>
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<tr>
<td></td>
<td>Drowning.</td>
<td>Wear PFD.</td>
</tr>
<tr>
<td></td>
<td>Loud noise (outboard motor, generator, VC sampler).</td>
<td>Use hearing protection during the operation of equipment that produces loud noise.</td>
</tr>
<tr>
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<td>Contact with contaminated surface water or sediments.</td>
<td>Wear protective coveralls (e.g., Tyvek® or equivalent) with shoe covers, nitrile gloves, safety glasses, face shield when handling samples. Dispose of gloves after sampling. If exposed to the sediments or surface waters of the East River, wash the exposed skin immediately with anti-bacterial wipes/gel and wash with soap and water. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.</td>
</tr>
<tr>
<td></td>
<td>Exposure to vapors from contaminated sediments.</td>
<td>Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit, hydrogen sulfide, and hydrogen cyanide) to monitor the works zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist then change to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of this HASP.</td>
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<td></td>
<td>Lift and secure anchors. Relocate to next exploration location.</td>
<td>Use proper lifting technique. Stay alert to moving or overhead equipment. Keep trafficked areas on boat or barge free of slip/trip/fall hazards. Wear PFD. Anchoring equipment and boat deck will be rinsed to remove accumulated sediments prior to demobilization at the end of the day.</td>
</tr>
<tr>
<td></td>
<td>Heavy lifting. Slip/Trip/Fall. Drowning.</td>
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<tr>
<td>WORK TASK</td>
<td>POTENTIAL HAZARDS</td>
<td>CONTROLS</td>
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</tr>
<tr>
<td>Activity: Sediment Core Handling</td>
<td>Cuts or abrasions (cutting aluminum, lexan, or acetate core barrel).</td>
<td>Wear Kevlar or leather gloves over nitrile gloves.</td>
</tr>
<tr>
<td>Opening Cores/Collecting Samples</td>
<td>Loud noise (generator).</td>
<td>Use hearing protection if working near the generator. Stage generator away from work area.</td>
</tr>
<tr>
<td>Electrical Hand Tools (cutting aluminum, lexan, or acetate core barrel).</td>
<td>Weather related equipment hazards (slippage in rain, lightning).</td>
<td>Ensure electrical equipment is connected to a Ground Fault Circuit Interrupter (GFCI).</td>
</tr>
<tr>
<td>Slip/trip/fall.</td>
<td></td>
<td>Cease operations prior to and during electrical storms. Cease operations if equipment cannot be operated safely under wet conditions.</td>
</tr>
<tr>
<td>Loud noise (outboard motor, generator, VC sampler).</td>
<td></td>
<td>Use hearing protection during the operation of equipment that produces loud noise.</td>
</tr>
<tr>
<td>Contaminant contact.</td>
<td></td>
<td>Wear protective coveralls or aprons (e.g., Tyvek®) with shoe covers, nitrile gloves, safety glasses, and face shield when handling samples. Dispose of gloves after sampling. If exposed to the sediments or surface waters of the East River, wash the exposed skin immediately with anti-bacterial wipes/gel and wash with soap and water. Personal protective equipment will be decontaminated and disposed of in general accordance with Section 10 of this HASP.</td>
</tr>
<tr>
<td>Exposure to vapors from contaminated sediments</td>
<td></td>
<td>Use work zone air monitoring equipment including photoionization detector and multiple gas meter (that monitors % oxygen, lower explosive limit and hydrogen cyanide) to monitor the works zone as specified in Section 8.0 of the HASP. If air monitoring action levels are exceeded, then engineering controls will be implemented. If excursions of the action levels persist then change to half or full face respirator with HEPA/organic vapor cartridge as indicated in Section 6.0 of this HASP.</td>
</tr>
<tr>
<td>Heavy lifting. Slip/Trip/Fall. Drowning.</td>
<td></td>
<td>Use proper lifting technique. Stay alert to moving or overhead equipment. Keep trafficked areas free of slip/trip/fall hazards.</td>
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</tbody>
</table>

Protective Equipment: Hardhat, safety glasses, steel toe boots, nitrile gloves, protective coveralls. Ability to upgrade to half or full face respirator with HEPA/organic vapor cartridge if work zone action level is exceeded.
APPENDIX D

HAZARD COMMUNICATION PROGRAM
1.0 POLICY AND PURPOSE

It is the policy of the Consultant to furnish employees with a working environment safe from recognized hazards. This program is designed to provide the Consultant compliance with OSHA’s Federal Hazard Communication Standard (29 CFR 1910.1200 and 1926.59).

The Consultant Hazard Communication (HAZCOM) Program has been compiled to provide guidelines for assisting this corporation in meeting the requirements of OSHA’s Hazard Communication Standard. This program addresses the evaluation of potential Consultant workplace hazards and communication of pertinent hazard information to Consultant employees.

The CONTRACTOR must develop a HAZCOM for CONTRACTOR employees and SUBCONTRACTORS.

Although most CONTRACTOR field projects do not involve the use of hazardous substances, it is imperative that all hazardous materials be managed in accordance with this program. This applies to any usage of hazardous materials regardless of volume. The Contractor shall generate a list of chemicals that are anticipated to be used during work activities.

2.0 SCOPE

In accordance with 29 CFR 1910.1200 and 1926.59, this program applies to any potentially hazardous chemical which is known to be present in the workplace in such a manner that employees may potentially be exposed under normal conditions of use. This program also addresses chemicals that may be constituents of waste that may be encountered on a typical Consultant job site.

3.0 LOCATION OF WRITTEN PROGRAM

A complete original of this written program is located with the Consultant Corporate Health and Safety Specialist (CHSS) and with each Consultant Office/Branch Manager.

4.0 RESPONSIBILITIES

Overall coordination and implementation of Consultant HAZCOM Program is the responsibility of the CHSS. Any questions, comments, or suggestions relating to Consultant HAZCOM Program should be directed to the CHSS.

The following subsections delineate the responsibilities of personnel as required for successful implementation of this program.
**Corporate Health and Safety Specialist (CHSS)**

The CHSS shall:

- Develop and oversee implementation of the written HAZCOM Program
- At a minimum, determine that field personnel engaged in hazardous waste operations receive OSHA 40-hour Health and Safety Training, 24-hour supervised on-the-job training, 8-hour Supervisory Training, and annual 8-hour Retraining as required by OSHA (29 CFR 1910.120 and 29 CFR 1926.65).

**Office/Branch Managers**

The Office/Branch Managers shall:

- Determine that all new employees at their office/branch receive training in accordance with the HAZCOM Program within 30 days of hire or prior to performing field work (whichever is sooner)
- Maintain at the office/branch an inventory of Material Safety Data Sheets (MSDSs) as available for all hazardous materials with which employees have the potential of coming into contact while on the job
- Determine that MSDSs are made readily available for employee review upon request by the employee
- Determine that label and warning protocol for hazardous materials is complied with.

**Supervisors (Project Managers and/or Field Team Leaders)**

Supervisors shall:

- Develop and oversee completeness of site-specific HASPs for their projects
- Implement the hazard communication programs and HASPs for their projects
- Determine that field personnel are familiar with the HAZCOM Program regarding chemical use and potential chemical exposures in the field
- Determine that employees working on their project sites are familiar with site-specific HASPs and perform in compliance with the requirements of those HASPs.

**Employee**

It is the employee’s responsibility to:

- Read the HAZCOM procedure within 30 days of employment by the Consultant or prior to performing field work for CONSULTANT (whichever is sooner)
- Gain familiarization with MSDSs of those hazardous materials which they use or may be exposed to
- Utilize information and measures as learned from the HAZCOM Program, including associated training and professional experiences, to protect themselves from adverse exposure to hazardous materials.
5.0 PROGRAM REQUIREMENTS

Material Safety Data Sheets (MSDSs) and Chemical List

Complete sets of MSDSs for chemicals specific to each office/branch are maintained by the Consultant Office/Branch Manager and made readily available for review upon request by any employee.

A list of chemicals potentially used/encountered by Consultant personnel at offices/branches involved in hazardous waste operations is provided in Table 11-1. Note that Table 11-1 is not necessarily complete.

MSDSs are available for the listed chemicals described below.

- MSDSs for chemicals that are typically used for decontamination and/or sample preservation are compiled. Supplies of these chemicals are generally kept in Consultant field equipment storerooms.
- MSDSs for chemicals and materials that may be encountered on typical Consultant job sites are compiled. These MSDSs are typically included in site-specific Health and Safety Plans. MSDSs should be reviewed prior to performing fieldwork on those sites.
- MSDSs for chemicals used for Photoionization detector (PID) soil gas instrument and standards are compiled. These chemicals are generally kept in small quantities to be used only by soil gas instrument technical personnel.

In addition, the consultant maintains an a comprehensive collection of MSDSs as printed by Genium Publishing Corporation and as obtained from manufacturers of products received at Consultants office are available for use by employees by request to the CHSS. This MSDS collection is updated periodically.

TABLE 11-1
CHEMICAL LIST

<table>
<thead>
<tr>
<th>DECONTAMINATION AND/OR PRESERVATION CHEMICALS (Field/Storeroom Personnel)</th>
<th>*Amount Stored</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>2 liters</td>
<td>Field Equipment Room Flammable Storage Cabinet</td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>2 liters</td>
<td>Field Equipment Room Flammable Storage Cabinet</td>
</tr>
<tr>
<td>1-Butanol (n-Butyl Alcohol)</td>
<td>0.5 liter</td>
<td>Field Equipment Room Flammable Storage Cabinet</td>
</tr>
<tr>
<td>Hexane</td>
<td>0.5 liter</td>
<td>Field Equipment Room Flammable Storage Cabinet</td>
</tr>
<tr>
<td>Hydrochloric Acid</td>
<td>0.5 liter</td>
<td>Field Equipment Room Corrosive Storage Cabinet</td>
</tr>
<tr>
<td>Chemical</td>
<td>*Amount Stored</td>
<td>Location</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>Methanol</td>
<td>40 liters</td>
<td>Field Equipment Room Flammable Storage Cabinet</td>
</tr>
<tr>
<td>Nitric Acid</td>
<td>15 liters</td>
<td>Field Equipment Room Corrosive Storage Cabinet</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>1 kg</td>
<td>Field Equipment Room Corrosive Storage Cabinet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(separated from acids)</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>0.5 liter</td>
<td>Field Equipment Room Corrosive Storage Cabinet</td>
</tr>
</tbody>
</table>

**CHEMICALS POTENTIALLY ENCOUNTERED ON TYPICAL JOB SITES**

Benzene  
Coal Tar Creosote  
Coal Tar Pitch  
Cresol  
Cyanide  
1,1-Dichloroethylene  
1,2-Dichloroethylene (both isomers)  
Ethyl benzene  
Gasoline  
Naphtha (Coal Tar)  
Naphthalene and related PAHs  
Pentachlorophenol  
Perchloroethylene  
Polychlorinated Biphenyls  
Styrene  
1,1,2,2-Tetrachloroethane  
Tetraethyl Lead  
Toluene  
1,1,1-Trichloroethane (methyl chloroform)  
Trichloroethylene  
Xylene

**SOIL GAS STANDARD CHEMICALS (used by soil gas personnel only)**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>*Amount Stored</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stored for Occasional or Potential Future Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>10 grams</td>
<td>Field Equipment Room Refrigerator</td>
</tr>
<tr>
<td>1,1-Dichloroethylene</td>
<td>10 grams</td>
<td>Field Equipment Room Refrigerator</td>
</tr>
<tr>
<td>1,2-Dichloroethylene (both isomers)</td>
<td>14 grams</td>
<td>Field Equipment Room Refrigerator</td>
</tr>
<tr>
<td>Ethyl benzene</td>
<td>10 grams</td>
<td>Field Equipment Room Refrigerator</td>
</tr>
<tr>
<td>Perchloroethylene</td>
<td>10 grams</td>
<td>Field Equipment Room</td>
</tr>
</tbody>
</table>


**SOIL GAS STANDARD CHEMICALS (used by soil gas personnel only)**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>*Amount Stored</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stored for Occasional or Potential Future Use</strong></td>
<td></td>
<td><strong>Refrigerator</strong></td>
</tr>
<tr>
<td>Toluene</td>
<td>10 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>10 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>Xylenes (o, m, &amp; p)</td>
<td>6 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td>1 gram</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>Bromoform</td>
<td>5 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>2-Chloroethyl vinyl ether</td>
<td>5 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>Dibromochloromethane</td>
<td>1 gram</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>5 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>1,2-Dichloropropane</td>
<td>5 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>1,3-Dichloropropene</td>
<td>2 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>Styrene</td>
<td>2 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>1,1,2,2-Tetrachloroethane</td>
<td>2 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>1,1,1-Trichloroethane</td>
<td>2 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>1,1,2-Trichloroethane</td>
<td>5 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>Trichlorofluoromethane</td>
<td>5 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
<tr>
<td>1,2,4-Trimethylbenzene</td>
<td>2 grams</td>
<td>Field Equipment Room</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refrigerator</td>
</tr>
</tbody>
</table>

* Amounts stored are based on typical field equipment room inventory (Glastonbury Office). Actual amounts may vary depending on facility location and project requirements.

** Soil gas standard chemicals are used for field testing/calibration of soil gas, field, analytical equipment.
**LABELS AND WARNINGS**

The Consultant labeling system for containers of hazardous materials is as follows:

- Containers are labeled, tagged, or marked in a legible fashion, with the identity of the hazardous materials contained therein.
- Containers are labeled, tagged, or marked in a legible fashion with the appropriate hazard warnings. This warning may be of any type of message, words, pictures or symbols that convey the hazards of the chemical.
- All required container labels, tags and/or markings are legible.
- Labels are affixed to the container itself (vs. lid). Note that lids may also be labeled, but not in lieu of container labeling.

The Consultant field equipment room maintenance technician is responsible that the Consultant labeling system is complied with at his/her office location. Project Managers and Field Team Leaders are responsible for determining that the Consultant labeling system is complied with for the field portion of their projects.

**TRAINING**

The Consultant Office/Branch Manager is responsible for determining that the HAZCOM Training Program is complied by personnel employed at their office/branch.

The Consultant’s HAZCOM Program training requirements are listed below:

- Newly hired employees who may use or be exposed to hazardous materials will be required to familiarize themselves with the HAZCOM Program, and with the MSDSs associated with their job function.
- Selected employees will be required to attend a HAZCOM Program classroom training session. Training shall provide information on:
  - The physical and health hazards of the chemicals in the work area.
  - Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area.
  - Measures employees can take to protect themselves from these hazards.
  - The details of the HAZCOM Program, including an explanation of MSDSs and CONSULTANTs container labeling system.

- As required to achieve compliance with OSHA 1910.120 and 1926.65, technical staff engaged in hazardous waste operations will be provided with OSHA 40-hour HAZWOPER safety training, 24 hours of on-the-job training, and annual 8-hour HAZWOPER refresher courses.

**6.0 MULTI-EMPLOYER WORK PLACES**

The Consultant is obligated to provide the identity of any hazardous materials/conditions to other employers sharing the same workplace whose employees may be exposed. Likewise, all employers sharing the same workplace with the Consultant shall be obligated to identify all
hazardous materials/conditions to which employees may be exposed. The employer sharing space with the Consultant will be required by the Consultant Project Manager to:

- Determine that a mutual exchange of this information occurs, and that health and safety hazards are minimized.
- Provide to project employees, as part of the subcontractor HASP, MSDSs of identified hazardous materials to which they may be exposed.
- Conform in full to the requirements of 29 CFR 1910.1200 and 29 CFR 1926.59, applicable HASPs, and established work procedures.

These obligations may be accomplished via the exchange of written HAZCOM Programs, project HASPs, or MSDSs as appropriate.

7.0 BIENNIAL REVIEW

This program will be formally reviewed by the Consultant CHSS and company management on a biennial basis or more frequently if the CHSS deems it necessary to promote personnel safety. The program will be revised as necessary for continuing compliance with the OSHA Federal Hazard Communication Standard.
APPENDIX E

COLD STRESS PROGRAM
1.0 PURPOSE & INTRODUCTION

The purpose of this document is to educate the employee about exposure to cold environments and the effects of hypothermia and other cold-related injuries. Through proper use of Personal Protective Equipment (PPE), engineering and administrative controls; and education, cold injury, both to the extremities and the body's core temperature, can be prevented.

2.0 SCOPE

This program is intended for use by employees engaged in work with the potential for exposure to cold environments. This program will be reviewed annually by the Health and Safety Division. Training will be provided annually to all those potentially affected, and will include this written program.

3.0 WORKING IN COLD ENVIRONMENTS

1. Metabolic Responses

The human body is designed to function best at a rectal temperature of 99-100F. The body maintains this temperature in two ways: by gaining heat from food and muscular work; or, by losing it through radiation and sweating. By constricting blood vessels of the skin and/or shivering, the body uses its first line of cold defense.

Temperature control of the body is better understood by dividing the body into two main parts: the shell; and, the core. The shell is comprised of the skin, capillaries, nerves, muscles and fat. Other internal organs such as the heart, lungs, brain and kidneys make up the core.

During exposure to cold, the skin is first affected. Blood in the peripheral capillaries is cooled, sending a signal to a portion of the brain called the hypothalamus. Regulating body temperature is one of the many basic body functions of the hypothalamus. Acting like a thermostat, adjustments are performed in order to maintain normal body temperatures. When a chill signal is received, two processes are begun by the hypothalamus: conserve heat already in the body; and, generate new heat.

Heat conservation is performed through constriction of the blood vessels in the skin (shell), thus reducing heat loss from the shell and acting as an insulator for the core. Sweat glands are also inhibited, thus preventing heat loss by evaporation.

Additional fuel for the body is provided in the form of glucose. Glucose causes the heart to beat faster, sending oxygen and glucose-rich blood to the tissue where needed. In an attempt to produce heat, the muscles rapidly contract. This process is better known as “shivering,” and generates heat similarly to that created by strenuous activity, raising the body’s metabolic rate.

During physical activity and fatigue, the body is more prone to heat loss. As exhaustion approaches, blood vessels can suddenly enlarge, resulting in rapid loss of heat. Exposure to extreme cold causes nerve pulses to be slowed, resulting in fumbling, sluggish and clumsy reactions.
4.0 COLD INJURIES

Cold injuries are classified into two categories: local; or, general. Local injuries include frostbite, frostnip, chilblain and trenchfoot. General injuries include hypothermia and blood vessel abnormalities (genetically or chemically induced). Major factors contributing to cold injury are exposure to humidity and high winds; contact with wetness or metal; inadequate clothing; age; and, general health. Allergies, vascular disease, excessive smoking and/or drinking, and certain drugs and medicines are physical conditions that can compound the effects of exposure to a cold environment.

1. Hypothermia

Hypothermia is a condition of reduced body temperature. Most cases develop in air temperatures between 30-50°F, not taking wind-chill factor in consideration.

Symptoms of hypothermia are uncontrolled shivering and the sensation of cold. The heartbeat slows and sometimes becomes irregular, weakening the pulse and changing blood pressure. Changes in the body chemistry cause severe shaking or rigid muscles; vague or slow slurred speech; memory lapses; incoherence; and, drowsiness. Cool skin, slow irregular breathing, low blood pressure, apparent exhaustion, and fatigue after rest can be seen before complete collapse.

As the core temperature drops, the victim can become listless, confused, and make little or no effort to keep warm. Pain in the extremities can be the first warning of dangerous exposure to cold. Severe shivering must be taken as a sign of danger. At a core body temperature of about 85°F, serious problems develop due to significant drops in blood pressure, pulse rate and respiration. In some cases, the victim may die.

Sedative drugs and alcohol increase the risk of hypothermia. Sedative drugs interfere with the transmission of impulses to the brain. Alcohol dilates blood vessels near the skin's surface, increasing heat loss and lowering body temperature.

Table I provides information on the onset of hypothermia and metabolic responses at different body temperatures.

2. Raynaud’s Phenomenon

Raynaud's Phenomenon is the abnormal constriction of the blood vessels of the fingers on exposure to cold temperatures, resulting in blanching of the ends of the fingers. Numbness, itching, tingling or a burning sensation may occur during related attacks. The disease is also associated with the use of vibrating hand tools in a condition sometimes called White Finger Disease. Persistent cold sensitivity, ulceration and amputations can occur in severe cases.

3. Acrocyanosis

Acrocyanosis is caused by exposure to the cold and reduces the level of hemoglobin in the blood, resulting in a slightly blue, purple or gray coloring of the hands and/or feet.
4. **Frostbite**

Frostbite is the freezing of the body tissues due to exposure to extremely low temperatures, resulting in damage to and loss of tissue. Frostbite occurs because of inadequate circulation and/or insulation, resulting in freezing of fluids around the cells of the body tissues. Most vulnerable parts of the body are the nose, cheeks, ears, fingers and toes.

Frostbite can affect outer layers of skin or can include the tissues beneath. Damage can be serious, with permanent loss of movement in the affected parts, scarring, necrotic tissue, and amputation are all possibilities. Skin and nails that slough off can grow back.

The freezing point of the skin is about 30F. As wind velocity increases, heat loss is greater and frostbite will set in more rapidly.

There are three (3) degrees of frostbite: first degree, freezing without blistering and peeling; second degree, freezing with blistering and peeling; and, third degree, freezing with death of skin tissues and possibly the deeper tissues.

The following are symptoms of frostbite:

a. Skin changes color to white or grayish-yellow, progresses to reddish-violet, and finally turns black as the tissue dies;

b. Pain may be felt at first, but subsides;

c. Blisters may appear;

d. Affected part is cold and numb.

The first symptom of frostbite is usually an uncomfortable sensation of coldness followed by numbness. Tingling, stinging, cramping and aching feelings will be experienced by the victim. Frostbite of the outer layer of the skin has a waxy or whitish look and is firm to the touch. Cases of deep frostbite cause severe injury. The tissues are cold, pale and solid. The victim is often unaware of the frostbite until someone else observes these symptoms. It is therefore important to use the "buddy system" when working in cold environments, so that any symptoms of overexposure can be noted.

Table II describes the cooling power of wind on exposed flesh. This information can be used as a guide for determining equivalent chill temperatures when the wind is present in cold environments.

5. **Trench Foot and Chilblains**

Trench foot is swelling of the foot caused by long, continuous exposure to cold without freezing, combined with persistent dampness or immersion in water. Edema (swelling), tingling, itching and severe pain occurs, followed by blistering, necrotic tissue and ulcerations. Chilblains have similar symptoms as trench foot, except that other areas of the body are affected.
6. **Frostnip**

Frostnip occurs when the face or extremities are exposed to a cold wind, causing the skin to turn white.

5.0 **PREVENTION OF COLD STRESS**

Cold Stress can be prevented through a combination of various factors: acclimation; water and salt displacement; medical screening, proper clothing selection; and, training and education. Through the use of engineering controls, work practices, work/rest schedules, environmental monitoring and consideration of the wind-chill temperature, the employee can be protected.

1. **Acclimatization**

Acclimation can be achieved to some degree. Sufficient exposure to cold causes the body to undergo changes to increase comfort and reduce the risk of injury. But, these changes are minor and require repeated exposure to cold and uncomfortable temperatures to induce them.

2. **Dehydration**

The dryness of cold air causes the body to lose a significant amount of water through the skin and lungs. It is essential that caffeine-free, non-alcoholic beverages be available at the worksite for fluid replacement. Dehydration also increases the risk of injury due to cold and affects blood flow to the extremities.

3. **Diet**

A well-balanced diet is important for employees working in cold environments. Diets restricted only to certain foods may not provide the necessary elements for the body to withstand cold stress, leaving the worker vulnerable.

4. **Control Measures**

When the wind chill factor results in an equivalent temperature of -26F, continuous exposure of the skin will not be permitted. Any worker exposed to temperatures of 36F or less that becomes immersed in water will be given dry clothing immediately and treated for hypothermia at the local hospital if any symptoms of hyperthermia are present. Notification of this incident will be provided to the Health and Safety Division immediately after sending the worker to the hospital.

5. **Engineering Controls**

The following are some ways that environmental controls can be used to reduce the effects of a cold environment:

a. General or spot heating should be used to increase temperature in certain areas in the workplace;
b. Warm air jets, radiant heaters or contact warm plates can be used to warm the worker's hands if fine work is to be performed with bare hands for 10 to 20 minutes or more;

c. Shield the work area if air velocity at the work site is increased by wind, draft or ventilating equipment;

d. Metal handles of tools and control bars should be covered with thermal insulating material at temperatures below 30F;

e. Unprotected metal chair seats will not be used in cold environments;

f. When appropriate and feasible, equipment and processes will be substituted, isolated, relocated, or redesigned;

g. Power tools, hoists, cranes or lifting aids will be used to reduce the metabolic workload;

h. Heated warming shelters will be made available for continuous work being performed in an equivalent temperature of 20F or below. Workers will be encouraged to use the shelters regularly.

6. Administrative Work Practice Controls

Work practices and guidelines can be designed and developed to reduce exposure to cold stress. Some of these may include:

a. Work-rest schedules to reduce the peak of cold stress;

b. Enforce scheduled breaks;

c. Enforce intake of warm caffeine-free, non-alcoholic beverages;

d. Schedule work that has potential exposure to cold stress for the warmest part of the day;

e. Move work to warmer areas, whenever possible;

f. Assign extra workers for high-demand tasks;

g. Provide relief workers for other workers needing breaks;

h. Teach basic principles of recognizing and preventing cold stress;

i. Use the buddy system for work at 10F or below, and keep within eyeshot;

j. Allow new employees to adjust to the conditions before they work full-time in cold environments;

k. Minimize sitting and standing in one place for long periods of time;
1. Include weight and bulkiness of clothing when estimating work performance requirements and weights to be lifted;

Table III provides a work/warm-up schedule for cold environments, with wind chill taken into account.

7. Special Considerations

Older workers and workers with circulatory problems should be extra careful in cold environments. Sufficient sleep and good nutrition are important preventive measures for maintenance tolerance to the cold. Double shifts and overtime work should be avoided when working in cold environments.

If any of the following symptoms are observed on site, the affected worker will immediately go to warm shelter:

- Onset of heavy shivering;
- Frostnip;
- Feeling of excessive fatigue;
- Drowsiness;
- Euphoria.

After entering the warm shelter, the outer layer of clothing should be removed. If the clothing is wet from sweat and perspiration, dry clothing should be provided. If this is not feasible, then the clothing should be loosened to allow sweat to evaporate.

Anyone working in cold environments and on prescribed medication should consult their physician concerning any possible side effects due to cold stress. Those individuals suffering from diseases and/or taking medication that interferes with normal body temperature regulation or reduces the tolerance to cold will not be allowed to work in temperatures of 30°F or below.
6.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

In choosing PPE for cold environments, it is important to maintain airspace between the body and outer layer of clothing to retain body heat. The more air pockets, the better the insulation. The clothing should also allow for the evaporation of sweat if the skin is wet.

The most important parts of the body to protect are the feet, hands, head and face. Hands and feet become cooled most easily, because of their distance from the heart. Keeping the head covered is equally important. As much as 40% of body heat loss is through the head when it is exposed.

Ideal clothing for exposure to cold environments is made of cotton. Cotton picks up sweat off the body and brings it to the surface. Loosely fitted clothing also aids in sweat evaporation. Recommended clothing may include the following:

a. Polypropylene under shirt and shorts under thermal underwear (preferably two-piece);
b. Wool socks;
c. Wool or thermal pants, lapped over boot tops to keep out snow and water;
d. Suspenders (belts can constrict and reduce circulation);
e. Insulated work boots, preferably waterproof. Safety toe, if necessary;
f. Wool or cotton shirt;
g. Parka;
h. Knit cap/hard hat liner;
i. Wool mittens or gloves (depending on the dexterity required);
j. Face mask or scarf.

Dirty or greasy clothing loses much of its insulation value. Dirty clothing crushes air pockets, allowing air to escape more easily. Also, denim is not a good protective fabric. It is loosely woven and allows water to penetrate and wind to blow away body heat.
### TABLE I
Progressive Clinical Presentation of Hypothermia*

<table>
<thead>
<tr>
<th>Core Temperature</th>
<th>Clinical Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.6</td>
<td>99.6</td>
</tr>
<tr>
<td>37</td>
<td>98.6</td>
</tr>
<tr>
<td>36</td>
<td>96.8</td>
</tr>
<tr>
<td>35</td>
<td>95.0</td>
</tr>
<tr>
<td>34</td>
<td>93.2</td>
</tr>
<tr>
<td>33</td>
<td>91.4</td>
</tr>
<tr>
<td>32</td>
<td>89.6</td>
</tr>
<tr>
<td>31</td>
<td>87.8</td>
</tr>
<tr>
<td>30</td>
<td>86.0</td>
</tr>
<tr>
<td>29</td>
<td>84.2</td>
</tr>
<tr>
<td>28</td>
<td>82.4</td>
</tr>
<tr>
<td>27</td>
<td>80.6</td>
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<tr>
<td>26</td>
<td>78.8</td>
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<tr>
<td>25</td>
<td>77.0</td>
</tr>
<tr>
<td>24</td>
<td>75.2</td>
</tr>
<tr>
<td>22</td>
<td>71.6</td>
</tr>
<tr>
<td>20</td>
<td>68.0</td>
</tr>
<tr>
<td>18</td>
<td>64.4</td>
</tr>
<tr>
<td>17</td>
<td>62.6</td>
</tr>
<tr>
<td>9</td>
<td>48.2</td>
</tr>
</tbody>
</table>

TABLE II
Cooling Power of Wind on Exposed Flesh as Equivalent Temperature (under calm conditions)*

<table>
<thead>
<tr>
<th>Estimated Wind Speed (mph)</th>
<th>Actual Temperature Reading (Degrees Fahrenheit)</th>
<th>Equivalent Chill Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50  40  30  20  10  0 -10 -20 -30 -40 -50 -60</td>
<td>Calm  50  40  30  20  10  0 -10 -20 -30 -40 -50 -60</td>
</tr>
<tr>
<td>5</td>
<td>48  37  27  16  6  -5  -15  -26  -36  -47  -57  -68</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>40  28  16  4  -9  -24  -33  -46  -58  -70  -83  -95</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>32  18  4  -10  -25  -39  -53  -67  -82  -96  -110  -121</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>30  16  0  -15  -29  -44  -59  -74  -88  -104  -118  -133</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>27  11  -4  -20  -35  -51  -67  -82  -98  -113  -129  -145</td>
<td></td>
</tr>
<tr>
<td>(Wind speeds greater than 40 mph have little additional effect).</td>
<td>LITTLE DANGER In &lt; hr with dry skin. Maximum danger of false sense of security.</td>
<td>INCREASING DANGER Danger from freezing of exposed flesh within one minute.</td>
</tr>
</tbody>
</table>

Trenchfoot and immersion foot may occur at any point on this chart.

* Developed by the U.S. Army Research Institute of Environmental Medicine, Natick, MA

Note #1: Wind speeds greater than 40 mph have little additional effect.

Note #2: Trenchfoot and immersion foot may occur at any point on this chart
<table>
<thead>
<tr>
<th>Air Temp.-Sunny Sky</th>
<th>No Noticeable Wind</th>
<th>5 mph Wind</th>
<th>10 mph Wind</th>
<th>15 mph Wind</th>
<th>20 mph Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C (approx)</td>
<td>°F (approx)</td>
<td>Max. Work Period</td>
<td>No. of Breaks</td>
<td>Max. Work Period</td>
<td>No. of Breaks</td>
</tr>
<tr>
<td>-26° to -28°</td>
<td>-15° to -19°</td>
<td>(Norm. Breaks) 1</td>
<td>75 min. 2</td>
<td>55 min. 3</td>
<td>40 min. 4</td>
</tr>
<tr>
<td>-29° to -31°</td>
<td>-20° to -24°</td>
<td>(Norm. Breaks) 1</td>
<td>75 min. 2</td>
<td>55 min. 3</td>
<td>40 min. 4</td>
</tr>
<tr>
<td>-32° to -34°</td>
<td>-25° to -29°</td>
<td>75 min 2</td>
<td>55 min. 3</td>
<td>40 min. 4</td>
<td>30 min. 5</td>
</tr>
<tr>
<td>-35° to -37°</td>
<td>-30° to -34°</td>
<td>55 min. 3</td>
<td>40 min. 4</td>
<td>30 min. 5</td>
<td>(Norm. Breaks)</td>
</tr>
<tr>
<td>-38° to -39°</td>
<td>-35° to -39°</td>
<td>40 min. 4</td>
<td>30 min. 5</td>
<td>(Norm. Breaks)</td>
<td></td>
</tr>
<tr>
<td>-40° to -42°</td>
<td>-40° to -44°</td>
<td>30 min. 5</td>
<td>(Norm. Breaks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-43° &amp; below</td>
<td>-45° &amp; below</td>
<td>No-emergency work should cease</td>
<td>(Norm. Breaks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Notes for TABLE III:

1. Schedule applies to moderate to heavy work activity with warm-up breaks of 10 minutes in a warm location. For light to moderate work (limited physical motion), apply the schedule one step lower. For example, at -30°F with no noticeable wind (step 4, a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4 hour period.

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph, light flag moves; 10 mph, light flag fully extended; 15 mph, raises newspaper sheet; 20 mph, blowing drifting snow.

3. If only the wind-chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind-chill cooling rate of about 17 W/m²; 2) all non-emergency work should have ceased at or before a wind-chill of 2250 W/m². In general the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart over-compensates for the actual temperatures in the colder ranges, since windy conditions prevail at extremely low temperatures.

4. TLVs apply only for workers in dry clothing.

* Adapted from Occupational Health and Safety Division, Saskatchewan Department of Labour.
APPENDIX F

HEAT STRESS PROGRAM
1.0 INTRODUCTION

Heat stress is one of the most common (and potentially serious) illnesses at job sites. Although it is caused by a number of interacting factors, the wearing of personal protective equipment (PPE) puts the worker at a much higher risk during warmer environmental conditions. The results of heat stress range from fatigue to serious illness or death. Through regular fluid replacement and other preventive measures, heat stress can be controlled, leading to increased efficiency and a higher level of safety on the job.

2.0 PURPOSE

To create an awareness among employees concerning the body’s physiologic responses to heat; different types of heat stress that can affect the body; recognition of signs and symptoms; first aid treatment; and, preventive measures.

3.0 SOURCES OF HEAT

There are two sources of heat that are important to anyone working in a hot environment:

- Internally generated metabolic heat;
- Externally imposed environmental heat.

4.0 PHYSIOLOGIC RESPONSES TO HEAT

The human body maintains a fairly constant internal temperature, even though it is exposed to varying environmental temperatures. To keep internal body temperatures within safe limits, the body must get rid of its excess heat, primarily through varying the rate and amount of blood circulation through the skin and the release of fluid onto the skin by the sweat glands. These automatic responses usually occur when the temperature of the blood exceeds 98.6°F and are kept in balance and controlled by the brain. In this process of lowering internal body temperature, the heart begins to pump more blood, blood vessels expand to accommodate the increased flow, and the microscopic blood vessels (capillaries) which thread through the upper layers of the skin begin to fill with blood. The blood circulates closer to the surface of the skin, and the excess heat is lost to the cooler environment.

If the heat loss from increased blood circulation through the skin is not adequate, the brain continues to sense overheating and signals the sweat glands in the skin to release large quantities of sweat onto the skin surface. Evaporation of sweat cools the skin, eliminating large quantities of heat from the body.

As environmental temperatures approach normal skin temperature, cooling of the body becomes more difficult. If air temperature is as warm as or warmer than the skin, blood brought to the body surface cannot lose its heat. Under these conditions, the heart continues to pump blood to the body surface, the sweat gland pour liquids containing electrolytes onto the surface of the skin, and the evaporation of the sweat becomes the principal effective means of maintaining a constant body temperature. Sweating does not cool the body unless the moisture is removed from the skin by evaporation. In high humidity, the evaporation of sweat from the skin is decreased and the body's efforts to maintain an acceptable body temperature may be significantly impaired. These conditions adversely affect an individual's ability to work in the hot environment. With so much blood going...
to the external surface of the body, relatively less goes to the active muscles, the brain, and other internal organs; strength declines; and fatigue occurs sooner than it would otherwise. Alertness and mental capacity also may be affected. Workers who must perform delicate or detailed work may find their accuracy suffering, and others may find their comprehension and retention of information lowered.

When temperature differences exist between two or more bodies, heat can be transferred. Net heat transfer is always from the body (or object) of higher temperature to that of lower temperature and occurs by one or more of the following mechanisms:

- **Conduction.** The transfer of heat from one point to another within the body, or from one body to another when both bodies are in physical contact. Conduction can be a localized source of discomfort from direct physical contact with a hot or cold surface, it is normally not a significant factor to total heat stress.

- **Convection.** The transfer of heat from one place to another by moving gas or liquid. Natural convection results from differences in density caused by temperature differences. Thus warm air is less dense than cool air.

- **Radiation.** The process by which energy, electromagnetic (visible and infrared), is transmitted through space without the presence or movement of matter in or through this space.

### 5.0 PREDISPOSING FACTORS TO HEAT STRESS

Factors that may predispose an individual to heat stress vary according to the individual. These factors include:

- Lack of physical fitness;
- Lack of acclimatization;
- Age;
- Dehydration;
- Obesity;
- Drug/alcohol abuse;
- Infection;
- Sunburn;
- Diarrhea;
- Chronic disease.

Predisposing factors and an increased risk of excessive heat stress are both directly influenced by the type and amount of PPE worn. PPE adds weight and bulk, reduces the body’s access to normal heat exchange mechanisms (evaporation, convection and radiation) and increases energy expenditure.
6.0 FORMS OF HEAT STRESS AND FIRST AID

(The following excerpts were taken from NIOSH Publication No. 86-112, *Working in Hot Environments*):

"Excessive exposure to a hot work environment can bring about a variety of heat-induced disorders. Among the most common are heat stroke, heat exhaustion, heat cramps, fainting and heat rash.

**Heat Stroke**

*Heat Stroke* is the most serious of health problems associated with working in hot environments. It occurs when the body's temperature regulatory system fails and sweating becomes inadequate. The body's only effective means of removing excess heat is compromised with little warning to the victim that a crisis stage has been reached.

A heat stroke victim's skin is hot, usually dry, red or spotted. Body temperature is usually 105°F or higher, and the victim is mentally confused, delirious perhaps in convulsions, or unconscious. Unless the victim receives quick and appropriate treatment, death can occur.

Individuals with signs or symptoms of heat stroke require immediate hospitalization. First aid should be immediately administered. This includes removing the victim to a cool area, thoroughly soaking the clothing with water, and vigorously fanning the body to increase cooling. Further treatment, at a medical facility, should be directed to the continuation of the cooling process and the monitoring of complications which often accompany heat stroke. Early recognition and treatment are the only means of preventing permanent brain damage or death.

**Heat Exhaustion**

*Heat Exhaustion* includes several clinical disorders having symptoms which may resemble the early symptoms of heat stroke. Heat exhaustion is caused by the loss of large amounts of fluid by sweating, sometimes with excessive loss of salt. A worker suffering from heat exhaustion still sweats but experiences weakness or fatigue, giddiness, nausea or headache. In more serious cases, the victim may vomit or lose consciousness. The skin is clammy and moist, the complexion is pale or flushed, and the body temperature is normal or only slightly elevated.

In most cases, treatment involves having the victim rest in a cool place and drink plenty of liquids. Victims with mild cases of heat exhaustion usually recover spontaneously with this treatment. Those with severe cases may require extended care for several days. There are no known permanent effects.

**Heat Cramps**

*Heat cramps* are painful spasms of the muscles that occur among those who sweat profusely in heat, drink large quantities of water, but do not adequately replace the body's salt loss. The drinking of large amounts of water tends to dilute the body's fluids, while the body continues to lose salt. Shortly after, the low salt level in the muscles causes painful cramps. The affected muscles may be part of the arms, legs, or abdomen; but tired muscles
(those used in performing the work) are usually the ones most susceptible to cramps. Cramps may occur during or after work hours and may be relieved by taking salted liquids by mouth.

**Fainting**

**Fainting** occurs in workers not accustomed to hot environments and who stand erect and immobile in the heat.

With enlarged blood vessels in the skin and in the lower part of the body due to the body's attempts to control internal temperature, blood may pool there rather than return to the heart to be pumped to the brain. Upon lying down, the worker should soon recover. By moving around, and thereby preventing blood from pooling, the patient can prevent further fainting.

**Heat Rash (Prickly Heat)**

**Heat rash**, also known as prickly heat, is likely to occur in hot, humid environments where sweat is not as easily removed from the surface of the skin by evaporation and the skin remains wet most of the time. The sweat ducts become plugged, and a skin rash soon appears. When the rash is extensive or when it is complicated by infection, prickly heat can be very uncomfortable and may reduce a worker's performance. The worker can prevent this condition by resting in a cool place part of each day and by regularly bathing and drying the skin.

### 7.0 SELECTION OF PERSONAL PROTECTIVE EQUIPMENT (PPE)

During work periods where the increased risk of heat stress exists, each item's benefit will be carefully evaluated. Once the PPE is chosen, safe work durations/rest periods will be determined based on the following conditions:

- Anticipated work rate;
- Ambient temperature and humidity;
- Level of protection.

### 8.0 PREVENTION OF HEAT STRESS

Prevention of heat stress will be addressed in the following manner:

1. **Adjustment of work schedules.**
   a. Modify work/rest schedules.
   b. Enforce work slowdowns, as needed.
   c. Rotate personnel to minimize overstress or overexertion.
   d. When possible, work will be scheduled and performed during cooler hours.

1. Provide shelter or shaded areas to protect personnel during rest periods.

2. Maintain worker's body fluids at normal levels.
a. Drink approximately 12 to 16 ounces of non-caffeinated liquid (preferably water, Gatorade or equivalent) prior to the start of work. Caffeinated fluids act to dehydrate the worker.

b. Workers will be urged to drink a cup or two every 15 to 20 minutes, or at each break. A total of 1 to 1.5 gallons of water per individual per day are recommended for fluid replacement under heat stress conditions, but more may be required.

3. Encourage physical fitness among the workers.

   Gradually acclimatize workers on site to help build up an "immunity" to the conditions.

   ▪ Heat acclimatization can usually be induced in 5 to 7 days of exposure at a hot job. For workers with previous experience with the job, acclimatization will include exposures of 50% for day 1, 60% for day 2, 80% for day 3, and 100% for the remaining additional days.

4. Provide cooling devices during prolonged work or severe heat exposure.

   a. Supply field showers or hose down areas.

   b. Supply personnel with cooling jackets, vests, and suits.


6. Use of the buddy system that depends on the recognition of signs and symptoms of heat stress.

7. Identification of heat-intolerant individuals through medical screening.
APPENDIX G

PERSONAL PROTECTIVE EQUIPMENT (PPE) PROGRAM:
1.0 PURPOSE

This program has been developed to aide in the proper selection and use of personal protective equipment (PPE) to protect workers from identified potential hazards. Careful selection and use of adequate PPE should protect the respiratory system, skin, eyes, face, hands, feet, head, body and hearing. CONTRACTOR employees may work at a variety of job sites and locations, which may require different types of protective equipment. Client specific requirements will always be adhered to. CONTRACTOR will supply all PPE or reimburse the employee for the costs of PPE if the PPE is required as part of the project.

2.0 SCOPE

This program establishes criteria for the selection, use, donning and doffing, inspection, maintenance, storage, decontamination of PPE, and evaluation. This information is general, and specific PPE use should be included in the site-specific health and safety plan prepared for each project.

3.0 OSHA REQUIREMENTS (29 CFR 1910.120)

A written personal protective equipment program, which is part of the employer's safety and health program and also part of the site-specific health and safety plan shall be established. The PPE program shall address the elements listed below.

- PPE selection based upon site hazards
- PPE use and limitations of the equipment
- Work mission duration
- PPE maintenance and storage
- PPE decontamination and disposal
- PPE training and proper fitting
- PPE donning and doffing procedures
- PPE inspection procedures prior to, during and after use
- Evaluation of the effectiveness of the PPE program
- Limitations during temperature extremes, heat stress, and other appropriate medical considerations

OSHA Standard 29 CFR 1910.132 requires employers to assess the employer's workplace and determine if hazards are present that necessitate the use of PPE. This assessment must be certified in writing and documented.

Due to the variety of job sites and situations that CONTRACTOR personnel may be involved in, it is important that CONTRACTOR maintain a consistent approach in complying with health and safety procedures. The project manager and/or site supervisor are responsible for ensuring that all personnel wear the appropriate PPE. Failure to comply with these requirements may result in disciplinary action. Employee safety is a paramount concern for all CONTRACTOR managers and employees. These procedures will now require the following:

1. Protective footwear must be worn by all field personnel working in the field. Footwear must at a minimum include steel toe and shank protection. Additionally, chemical
protective footwear may also be required if the potential for contaminated materials exists. This type of protection will be required on a site-specific basis.

2. Eye protection must be worn by all field personnel during all sampling activities, drilling and earth removal activities, stack sampling, and inside manufacturing facilities. Eye protection must include side shields. Prescription lenses worn as eye protection and other protective eyewear must meet ANSI Z87.1-1989.

3. Hardhats are to be worn by all field personnel when in the field. New hardhats must meet ANSI Z89-1986.

4. Hand protection is to be worn on a task-specific basis. The hand protection must be selected based on the chemical hazards expected to be encountered. CONTRACTOR maintains a stock of a variety of gloves including:

   Best: Nitrile N-Dey
   PVC
   Latex
   Vinyl
   Solvex, Nitrile
   Leather Work Gloves

   Additionally, nitrile coated Kevlar gloves or other types of puncture resistant gloves are to be worn by all personnel working with or cleaning glass impingers. Manufacturers that supply these gloves include Ansell Edmont, Jomac and Wells Lamont. Insulated electrical gloves with outer leather gloves is required when working around high-voltage systems. CONTRACTOR is responsible for supplying all personal protective equipment required for CONTRACTOR’s projects.

4.0 WORK MISSION DURATION

Before donning any PPE ensembles, workers will estimate their anticipated work duration. There are several limiting factors that affect the length of work time. These factors must be addressed:

- Air supply consumption
- Breakthrough time on respirator cartridges.
- Available cartridge for the chemical for air purifying respirators
- Permeation and penetration of the Chemical Protective Clothing/ensemble;
- Ambient temperature; and
- Coolant supply (ice or chilled area to keep the worker's body temperature at a normal temperature).

No single combination of PPE is capable of protection against all hazards. Thus PPE must be used in conjunction with other protective methods and its effectiveness evaluated periodically.

The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress and impaired vision, mobility and communication. For any given situation,
equipment and clothing should be selected that provide an adequate level of protection. However, over-protection as well as under-protection can be hazardous and should be avoided when possible.

5.0 LEVEL OF PROTECTION

The following section describes the different levels of protection (A through D). Each level is described in the following manner: the protection provided; when this particular level of protection should be used; recommended and optional equipment; and, any limiting criteria. Combinations of PPE other than those described for Levels A, B, C and D protection may be more appropriate and may be used to provide the proper level of protection.

1. Level A

a. Protection provided:

   - Level A provides the highest available level of respiratory, skin and eye protection.

b. Should be used when:

   - The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on any of the following circumstances;
     
     - Measured (or potential for) high concentration of atmospheric vapors, gases or particulates;
     
     - Site operations and work functions involving a high potential for splash, immersion, or exposure to unexpected vapors, gases or particulates of materials that are harmful to skin or capable of being absorbed through intact skin;
     
     - Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible;
     
     - The Operations must be conducted in confined, poorly ventilated areas until absence of conditions requiring Level A protection is determined.

   
c. Recommended equipment:

   - Pressure-demand, full face piece SCBA or pressure-demand supplied-air respirator with escape SCBA;
   
   - Fully-encapsulating, chemical-resistant suit (pressure-tested immediately before use);
   
   - Inner chemical-resistant suit;
- Inner chemical-resistant gloves;
- Chemical-resistant safety boots/shoes; and
- Two-way radio communications.

d. Optional equipment:
- Cooling unit;
- Coveralls;
- Long cotton underwear;
- Hard hat; and
- Disposable gloves and boot covers.

e. Limiting criteria:
- Fully encapsulating suit material must be compatible with the substances involved.

2. Level B

a. Protection provided:
- The same level of respiratory protection, but less skin protection than Level A.

b. Should be used when:
- The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection. This involves atmospheres with IDLH concentrations of specific substances that do not represent a severe skin hazard, or that do not meet the criteria for use of air purifying respirators;
- Atmospheres contain less than 19.5% oxygen; and
- Presence of incompletely identified vapors or gases indicated by direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the intact skin.

c. Recommended equipment:
- Pressure-demand, full face piece SCBA or pressure-demand supplied-air respirator with escape SCBA;
- Chemical-resistant clothing (overalls and long-sleeved jacket; hooded, one- or two-piece chemical splash suit; disposable chemical-resistant one-piece suit);
- Inner and outer chemical-resistant gloves;
- Chemical-resistant safety boots/shoes;
- Hard hat; and
- Two-way radio communications.

d. Optional equipment:
- Coveralls;
- Disposable boot covers;
- Face shield; and
- Long cotton underwear.

e. Limiting criteria:
- Use only when the vapors or gases present are not suspected of containing high concentrations of chemicals that are harmful to skin or capable of being absorbed through the intact skin.
- Use only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases or splashes of material that will affect the exposed skin.

3. Level C

a. Protection provided:
- Level C provides the same level of skin protection as Level B, but a lower level of respiratory protection.

b. Should be used when:
- The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin;
- The types of air contaminants have been identified, concentrations measured, and a canister/cartridge is available that can remove the contaminant; and
- All criteria for the use of air-purifying respirators are met.

c. Recommended equipment:
- Full face piece or half face piece air-purifying negative pressure respirator;
- Chemical-resistant clothing;
- Inner and outer chemical-resistant gloves;
- Chemical-resistant safety boots and shoes;
- Disposable boot covers;
- Hard hat; and
- Two-way radio communications.

d. Optional equipment:

- Coveralls;
- Face shield;
- Escape bottle; and
- Long cotton underwear.

e. Limiting criteria:

- Atmospheric concentration of chemicals must not exceed IDLH levels; and
- The atmosphere must contain at least 19.5% oxygen.

4. Level D

a. Protection provided:

- No respirator protection and minimal skin protection.

b. Should be used when:

- The atmosphere contains no known hazard; and
- Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

c. Recommended equipment:

- Coveralls;
- Safety boots/shoes;
- Safety glasses or chemical splash goggles; and
- Hardhat.

d. Optional equipment:

- Gloves;
- Face shield.

e. Limiting criteria:

- This level should not be worn in the exclusion zone; and
- The atmosphere must contain at least 19.5% oxygen.

6.0 LEVEL OF PROTECTION UTILIZED BY CONTRACTOR PERSONNEL

Due to the nature of our work, personnel will not perform any work that will require the use of Level A protection. Contractor will not directly undertake assignments and Contractor does not train or equip its personnel to handle circumstances involving Level A protection. If Contractor
is working on a site and Level A is deemed necessary, the work will be subcontracted to a qualified firm. Contractor personnel should not directly undertake these tasks.

Sites where Contractor is working often require the use of Level C or D, with Level B equipment available on-site for emergency rescue if necessary. Any questions concerning the level of protection necessary to complete a certain task will be directed to the Corporate Environmental Safety Manager before setting up the job.

7.0 TYPES OF CONTRACTOR PPE

The following list contains all types of PPE that the CONTRACTOR has ready access to if required by site conditions or NGRID bid requirements for site activities.

1. Respiratory Equipment:
   a. SCBAs:
      - Used for emergency rescue and exposures greater than maximum use concentration limits set for canister/cartridge type negative pressure respirators.
   b. Supplied-air respirators:
      - MSA Premaire system.
   c. Negative pressure respirators:
      - Half face and full face, used for exposure to certain types of acid gases, organic vapors and particulates not greater than the canister/cartridge maximum use concentration limit.

2. Chemical protective apparel suits:
   a. Polycoated Tyvek®, Saranex, Chemrel and Tyvek® (porous). Provide protection against certain liquid chemicals.
      - Tyvek® provides protection against particulates only.
   b. Fire/flame retardant coveralls:
      - Provide protection against flash fires.

3. Insulated clothing (Provides protection against exposure to the cold:
   a. Chemical resistant gloves:
      - Provide protection for the hands against skin contact and skin absorption.
   b. Disposable boot covers:
- Protect safety boots from contamination and feet from contact with chemicals.

4. Eye protection:
   a. Safety glasses and chemical splash goggles.
      - Safety glasses protect the eyes against large particles and projectiles.
      - Chemical splash goggles protect the eyes against vaporized chemicals, splashes, large particles, and projectiles.
   b. Vented goggles do not provide protection against vapors and are not adequate for splashes, as material may seep inside the goggles.

5. Hard hat:
   - Provides protection against blows to the head. When worn with a liner, provides protection against the cold.

6. Construction safety boots:
   - Steel-toe and shank construction boots with chemically resistant soles protect the feet from heavy and sharp objects, and contact with chemicals.

7. Safety harnesses and lifelines:
   - Enable the individual to work in elevated areas or enter confined spaces to prevent falls and aid in rescue.

8. Hearing protection:
   - Provides protection against physiological damage.

9. Canvas work gloves:
   - Provide protection for the hands against abrasions and slivers.

8.0 SELECTION OF CHEMICALLY PROTECTIVE CLOTHING

1. Chemically-protective clothing (CPC) will be chosen in the following manner:
   a. Determine what chemicals are present on the site.
   b. CPC chosen must be resistant to permeation, degradation and penetration of the chemical(s).
      - Permeation - Process by which a chemical dissolves in and/or moves through a protective clothing material on a molecular level.
Degradation - The loss of or change in the fabric's chemical resistance or physical properties due to exposure to chemicals, use or ambient conditions (e.g., sunlight).

Penetration - The movement of chemicals through zippers, stitched seams or imperfections (e.g., pinholes) in CPC.

c. Review manufacturer's permeation data to determine the performance characteristics of the material to the specific chemical.

d. Select CPC that protects against the greatest range of chemicals on the site and has the longest breakthrough time.

e. Discuss choice of CPC with the project CESM, PM, and SSO prior commencing work.

9.0 DONNING AND DOFFING PROCEDURES

The following procedures will be used by CONTRACTOR employees for donning and doffing PPE at protection Levels B and C. Donning and doffing will be performed with the assistance of an individual(s) located in the Support Zone and Contamination Reduction Zone, respectively. This individual will help the worker tape up and adjust PPE for proper fit, as well as remove PPE after decontamination.

1. Donning PPE
   - Inspect the clothing and respirator before donning.
   - Unzip the suit.
   - Step into the legs of the suit, slipping the feet through the legs. Push arms through the sleeves.
   - Pull leg cuffs over the feet.
   - Put on chemical-resistant safety boots over the feet. Tape the leg cuff over the tops of the boots.
   - Pull over chemical-resistant boot covers and tape over the leg cuff.
   - If suit contains protective feet, wear chemical-resistant safety boots inside the suit with chemical-resistant boot covers over the suit and taped securely to the leg.
   - If wearing a SCBA, don the face piece and adjust it to be secure, but comfortable. Do not connect the breathing hose. Open valve on the air tank.
   - If wearing a negative pressure respirator, pull hood over the head and perform positive and negative pressure face piece seal test.
- Pull on chemical protective inner gloves.
- Pull on chemical protective outer gloves and tape securely to the sleeve of the suit.
- Securely tape the suit to protect all exposed skin around the neck area, and if wearing a full-face piece, tape around the edge of the hood-to-face piece junction.
- Put on hardhat, if needed, and tape securely on top of head so that the hard hat does not slide off.

2. Doffing PPE

- Doffing of PPE will not take place until the individual has been properly decontaminated by a suitably attired assistant. Both the worker and assistant will make every effort to avoid any direct contact with the outside of the suit.
- If the individual is wearing a SCBA, the hose connection to the diaphragm will be disconnected, leaving the face piece on the wearer. The remainder of the unit will be removed and decontaminated before proceeding further.
- If the individual is wearing a half-face or full-face negative pressure respirator, she/he will be instructed to leave it on until the doffing procedure is complete.

NOTE: Decontamination is to be performed in accordance with the Site-Specific Health and Safety Plan for the site.

10.0 DECONTAMINATION OF PPE

Whenever possible, disposable PPE will be used on-site. Disposable PPE includes the following:

- Chemical protective suits;
- Gloves; and
- Chemical protective boot covers.

After decontaminating the worker, PPE is disposed of on-site in labeled disposal containers.
11.0 INSPECTION OF PPE

PPE will be inspected prior to, during and after each use according to the procedure outlined below.

1. Prior to use (Reusable and Disposable PPE):
   a. Through reviewing available literature, determine that the clothing material is correct for the task.
   b. Visually inspect for:
      - Imperfect seams;
      - Non-uniform coatings;
      - Tears or holes; and
      - Malfunctioning closures.
   c. Hold up to the light and check for pinholes (inflate gloves and check for leaks).
   d. Flex and check for:
      - Cracks; and
      - Shelf deterioration.
   e. If previously used, check for:
      - Discoloration;
      - Swelling;
      - Stiffness and cracking; and
      - Holes and tears.

2. During use (Reusable and Disposable PPE), check for:
   a. Evidence of chemical attack.
   b. Discoloration, swelling, stiffening, softening and/or cracking.
   c. Tears.
   d. Punctures.
   e. Seam discontinuities.

   Note: Report any sense of breakthrough to the Health and Safety Assessment Division. Medical monitoring may be necessary to determine the extent of exposure.

3. After use (Reusable PPE), check for:
   a. Malfunctioning parts.
   b. Evidence of chemical attack.
   c. Punctures.
   d. Tears.
   e. Cracks.
12.0 MAINTENANCE AND STORAGE OF PPE

PPE, other than respiratory equipment, will be maintained and stored in accordance with the manufacturer's recommendations at a minimum to prevent damage due to exposure to dust, moisture, sunlight, chemicals, temperature extremes and sudden impact.

Employees are given Field Operations Equipment bags prior to working on any CONTRACTOR sites. PPE that is given to the individual solely for his/her use will be stored in this bag. Before and after each use, the PPE will be inspected to determine whether or not it is still “field worthy.” Any PPE found to be defective will be reported to the Health and Safety Assessment Division and either discarded or repaired, as appropriate. Under no circumstances will defective PPE be used in the field.

8. The SSO will periodically inspect PPE issued for individual use.

   a. Unless the equipment can be repaired, any PPE found to be defective will be removed from service and discarded immediately.

   b. Repairable PPE will be tagged, returned to the SSO and sent out for repair.

13.0 EVALUATION OF PPE PROGRAM

CONTRACTOR's Personal Protection Equipment Program will be reviewed annually by the CESM. Any program deficiencies that are identified by a CONTRACTOR employee will be reported to the CESM, so that changes will be made immediately. All employees affected by the change(s) will be notified in writing.

Review of the PPE Program will include, but not be limited to, the following:

- Accident and illness experience on various job sites.
- Type and degree of exposure.
- Adequacy of equipment selection process.
- Degree of fulfillment of program objectives.
- Employee acceptance.
- Coordination with overall health and safety program elements.
- Recommendations for program improvements and modifications.
- Adequacy of program records.
APPENDIX H

CONTROL OF HAZARDOUS ENERGY
PROGRAM “LOCK OUT/TAG OUT”
1.0 INTRODUCTION

The Lock Out/Tag Out Standard, 29 CFR 1910.147, is prevents approximately 120 deaths and 60,000 injuries per year. Under this standard, CONTRACTOR is required to establish a program that utilizes procedures for locking out and/or tagging to isolate and disable the equipment to prevent accidental start-up or release of stored energy. CONTRACTOR employees will identify, locate and control these energy sources, as necessary.

DEFINITIONS

Affected Employee: An employee whose job requires operation/use of equipment or machines on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him/her to work in an area in which such servicing or maintenance is being performed. All CONTRACTOR personnel or subcontractors working in these circumstances are “affected employees.”

Authorized Employee: A person who locks out or implements a tagout system procedure on machines or equipment in connection with the servicing or maintenance on that machine or equipment. An authorized person and an affected employee may be the same person when the affected employee's duties also include performing a lock out or tag out on a machine or equipment.

Capable of being Locked Out: An energy isolating device will be considered to be capable of being locked out either if it designed with a hasp or other attachment or integral part to which, or through which, a lock can be affixed, or if it has a locking mechanism built into it. Other energy isolating devices will also be considered to be capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.

Energized: Connected to an energy source or containing residual or stored energy.

Energy Isolating Device: A mechanical device that physically prevents the transmission or release of energy, including but not limited to the following: a manually operated electrical circuit breaker; a disconnect switch; a manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors, and, in addition, no pole can be operated independently; a slide gate; a slip blind; a line valve; a block; and, any similar device used to block or isolate energy. The term does not include a push button, selector switch, and other control circuit type devices.

Energy Source: Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Lockout: The placement of a lockout device on an energy isolating device, in accordance with an established procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout Device: A device that utilizes a positive means such as a lock, either key or combination type, to hold an energy isolating device in the safe position and prevent the energizing of a machine or equipment.
**Tagout:** The placement of a tagout device on an energy isolating device, in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

**Tagout Device:** A prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy isolating device in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

**2.0 PURPOSE**

To establish procedures for locking out and/or tagging to isolate and disable equipment to prevent accidental startup or release of stored energy, and possible injury to employees.

**3.0 SCOPE**

This procedure applies to all field/facility operations that require all operative energy sources, including line breaking, in the work area to be shut down, locked out and tagged, so that CONTRACTOR employees may safely perform their job. Contractors and subcontractors performing work on CONTRACTOR projects will be required to comply with these requirements if their employer does not have a comparable lock out/tag out program already in place.

**4.0 PROCEDURE**

1. The authorized employee will evaluate the scope of work and all equipment, machines or industrial processes in the area that require the use of stored energy. Energized equipment that may cause a safety hazard will be shut down to eliminate the potential for injury.

2. Prior to beginning the work, the authorized employee will be sure that appropriate lock out/tag out equipment is available to isolate the energy source.

3. The authorized employee will ensure that all affected employees have been trained on the following topics:
   a. Scope of Work.
   b. Energy sources.
   c. Energy isolation devices.
   d. Lock out devices.
   e. Tags.
   f. Test procedures.
   g. Authorized personnel. Those individuals charged with the responsibility for deenergizing and reenergizing energy sources).
4. A safety meeting will take place immediately prior to work, and will be documented and placed in the job folder for future reference. All employees will sign the Lockout Worksheet prior to starting the work. See Attachment A for a copy of the Lockout Worksheet.

5. All energized equipment will be shut down before CONTRACTOR personnel or its contractors/subcontractors begin work on site. Shut down will take place in the following manner:

a. The authorized employee will inform the client's representative of the need to shut down the equipment.

b. The authorized employee, with assistance from the client's representative, will locate all power sources on the process or equipment.

c. All power sources will be shut down and verified as such by the authorized employee.

d. A NGRID standardized lockout device must be applied by all parties entering the energized area. Each authorized employee shall affix a personal lockout or tagout device to the group lockout device. Locks and tags shall identify the identity of the employee applying the device.

e. Any necessary testing of equipment will be conducted to ensure that the process or equipment is free of energy.

f. The authorized employee will attempt to operate the machine to be sure that it remains inoperative. All activation controls will be returned to the "off" position after testing.

g. The authorized employee will apply a tag that bears the following warning, “DANGER - EQUIPMENT LOCKOUT” along with the authorized employee’s name, the date, and the time of the lockout.

h. The authorized employee will complete the Lockout Worksheet.

i. Equipment may now be released for work by the authorized employee. No release will be given until all required inspections and testing are performed.

6. Residual energy, i.e., pneumatic/hydraulic power, spring compression, and residual electrical energy in transformers are examples of residual energy that, when unsuspected, may present a greater hazard to the employee. These sources of energy will be identified, located and controlled in the following manner:

a. Residual electrical energy can be controlled through grounding.

b. Pneumatic/hydraulic line pressure can be released, allowing the weight to come to a rest.

c. Spring tensions can be relieved.
d. Product lines will be double blocked (panned) and bled to prevent product from being released.

e. A lockout device and tag will be applied and secured by the authorized employee for the duration of the job to prevent residual energy from reaccumulating and creating a hazard to employees.

f. The lockout/tagout will be documented by the authorized employee on the Lockout Worksheet.

7. After all work is completed, the authorized employee will perform the following:

a. The authorized employee will inform everyone that the job is complete.

b. The Lockout Worksheet will be reviewed by the authorized employee with all employees to make sure that all employees are accounted for before re-energizing the equipment.

c. The authorized employee will be sure that all tools, debris or other material that could be placed into motion are removed before the equipment or process is re-energized. All employees will be instructed to stay clear of movable parts of the equipment or process.

d. All residual energy controls will be removed by the authorized employee, as well as all energy isolation lockouts and tags.

e. In the presence of the client's representative, energy will be restored to the equipment or process.

f. All lockout equipment removal will be documented on the Lockout Worksheet by the authorized employee. The Lockout Sheet will be placed in the job file at the end of the shift.

8. All employees must be accounted for before re-energizing equipment. When employees that have worked on the job are absent from the final inspection before re-energizing the equipment, the authorized employee will initiate the following:

a. The lockout sheet will be checked to account for all employees.

b. The authorized employee will obtain a Lockout/Tagout Absent Employee form (See Attachment B).

c. The authorized employee will appoint employees to look for the individual, paying special attention to high hazard areas where physical harm could result from the start-up of the equipment or process.

d. After a complete search of the equipment or process, and it has been determined by the authorized employee that the employee is not present, all outlying areas surrounding the site will be searched.
e. The area surrounding the site will be guarded to prevent the absent employee from inadvertently entering a hazardous situation.

f. The employer must make all reasonable efforts to contact the authorized employee to inform him/her that his/her lockout or tagout device has been removed.

g. The equipment or process will be cleared for re-energizing only by the authorized employee once all of the above conditions are met.

h. A copy of the completed Absent Employee form will be posted conspicuously in the work area, and not removed until the employee has been located. The client's representative will be notified of the situation so that the absent employee does not endanger himself/herself by entering an energized process or equipment.

9. When appropriate, contractors and subcontractors working under CONTRACTOR's direction will be informed of their responsibilities, under the Lockout/Tagout Standard, to provide protection against hazardous energy.

a. When necessary within the scope of work, contractors and subcontractors without such a program, at the discretion of CONTRACTOR, will be disqualified from bidding on these projects.

b. Contractors and subcontractors with such a program will submit their program to the CESM for review. The contractor or subcontractor program must be comparable or more strict than CONTRACTOR's program.

- Programs found to be insufficient in some areas will be returned, with the requested changes to be made before the program is acceptable for implementation.

- The copy of the program will be returned to the contractor or subcontractor, and will not be duplicated by CONTRACTOR or any of its employees.

10. All affected employees will be given training in these procedures prior to performing any lockout/tagout work. This training will be documented and maintained in the employees' training file with the CESM.

11. This procedure will be reviewed annually by the CESM to ensure that it is relevant to CONTRACTOR operations.
ATTACHMENT A

LOCKOUT WORKSHEET
LOCKOUT WORKSHEET

Job Location: ___________________ Project Manager: ________________________________

Date: _________________ Time: ________________________________ a.m./p.m.

Equipment Description to be locked out: __________________________________________

Equipment No: ______

Energy Source(s): ______________________________________________________________

Pre-Work Safety Meeting Minutes: ______________________________________________

Lockout Hardware Used: _________________________________________________________
No of locks required: ________________________________

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<thead>
<tr>
<th>HAZARDOUS ENERGY</th>
<th>ISOLATING DEVICES</th>
<th>CONTROL DEVICES</th>
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<tr>
<td>Type</td>
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Methods use to verify isolation:
___ Design of machine reviewed
___ Circuitry tested
___ Are valves or hydraulic system attached to electrical sources?
___ Does the electrical cabinet have any live wire circuits?
___ Based on the energy sources listed above, indicate all energy isolating verification procedures required to ensure lockout

_____________________________________________________________________________
_____________________________________________________________________________

Energy Restoration (Check each as you Progress): Time Completed

___ All personnel accounted for and in the clear. ________________________________

___ Point(s) of operation free of tools and debris. _____________________________

___ Points of operation restraints removed. ________________________________

___ Lockout hardware removed. ________________________________

___ Personnel clear of points of operation. ________________________________
Energy Restoration (Check each as you Progress):

___ Energy restored.

___ Equipment operation verified, client's rep on site.

___ Lockout terminated.

Time Completed

Employees’ Signatures: ______________________________________________________

Date: ______________________________
ATTACHMENT B

LOCKOUT/TAGOUT ABSENT EMPLOYEE FORM
LOCKOUT/TAGOUT ABSENT EMPLOYEE FORM

NOTICE

Upon completion of work performed under lockout/tagout conditions, the following employee(s) listed below could not be located or accounted for:

________________________________________

________________________________________

________________________________________

All attempts have been made to locate this employee at the jobsite. It has been verified that this employee is not in the vicinity of the hazardous energy source and will not be affected by the startup of equipment which was under lockout conditions.

________________________________________  __________________________
Signature of Authorized Employee  Date

Signature of Employer  __________________________  Date  __________________________
APPENDIX I

CONFINED SPACE/HOT WORK PERMITTING PROCEDURE
1.0 INTRODUCTION

Any material that is combustible or flammable is susceptible to ignition by heat-producing activity. Common materials such as floors, partitions, roofs, wooden members, paper, textiles, plastics, chemicals, flammable liquids and gases, and grass or brush are very likely to become involved in fire during hot work operations if adequate precautions are not taken.

Hot work is any work that requires the use of tools/equipment that have the potential to produce temperatures which could reasonably be expected to ignite flammable/combustible material or atmospheres in the vicinity of the work area. These tools/equipment have the capability of producing sparks, open flames, heat, or an electrical arc during use. Hot work is not limited to just welding, cutting and brazing, but also grinding, sawing (metal to metal) and chipping operations.

Confined spaces are defined as spaces that which is not designated or intended for normal human occupancy, has limited means of egress and poor natural ventilation. Confined space hazards exist if the potential for hazardous or explosive atmospheres and/or oxygen deficient hazards exist or if there is an engulfment hazard. Other hazards that could exist include mechanical sources and falls. Two types of confined spaces exist: permit required and non-permit required.

DEFINITIONS

Fire Blanket: Blanket made of fire-resistant material, such as NOMEX or KEVLAR (not asbestos), or treated wool, which can be used to cover combustible materials to prevent their ignition from sparks, flames or heat during hot work.

Attendant: Person who observes the confined space activities/hot work to ensure that ignition of the surrounding material does not occur. The Attendant will be equipped with a fully charged, suitable fire extinguisher and/or charged fire hose at the work area at the time of the hot work. The Attendant will not be assigned to any other duties.

Confined Space: Confined spaces are spaces that can be bodily entered but are not meant for human occupancy.

Entrant: Person who is trained and authorized to enter a confined space. Entrants are required to review air-monitoring data prior to entry into a permit required confined space PRCS and understand the hazards.

2.0 PURPOSE

To provide CONTRACTOR employees, who oversee hot work performed and confined space entry on projects, with a standard permitting and safety procedure to prevent injury or loss of life and property.

3.0 SCOPE

This procedure will apply to all CONTRACTOR employees who oversee hot work on projects utilizing welding, cutting, brazing, grinding, chipping, portable heaters, and other potential heat-producing equipment for field/facility activities. This procedure is also to be followed for all
confined space entry situations. This procedure will apply to all contractors or subcontractors working under CONTRACTOR that do not have an adequate Permitting Procedure in place with the company in which they are currently employed. All CONTRACTOR employees involved with confined space entry will be properly trained for the role and duties performed. Training will consist of hands-on training with CONTRACTOR’s confined space entry equipment including harnesses, retrieval equipment, air-line respirators and monitoring equipment. Certification that the training was satisfactorily complete will be provided and documentation maintained.

4.0  PROCEDURE

1.  Hazard Identification

   a.  The Project Manager will identify all work that requires tools, equipment, or operations that may produce sparks or temperatures that are sufficient to ignite flammable/combustible materials or atmospheres.

   b.  The Project Manager, SSO and CESM will determine if a confined space entry is required and determine if the entry requires a permit. Any situation that has the potential to produce hazardous atmospheres or deplete oxygen will require a permit.

   c.  This information will be included in the Site Specific Health and Safety Plan to be reviewed with the CESM prior to starting the project.

   d.  The Project Manager will determine if the work can be performed without the use of hot work, i.e. alternative method to reduce the hazard.

   e.  The CESM should consult the Project Manager if the there are questions on hazard determination. The SSO will act as the Entry Supervisor.

   f.  The CESM will review entry with the Project Manager and review this program at least annually to make sure the Program is effective and enforced. Copies of completed permits will be retained for at least one year.

   g.  The permit program will be reviewed to determine if it is adequate for the projects conducted. Incident reports will be reviewed, employee issues raised and entries reviewed. The permit program will be evaluated to determine if all hazards were adequately identified and evaluated. Additional protective equipment will be purchased, if necessary, for future entries if the review process shows that all hazards were not properly controlled. This review will be part of annual confined space training.

2.  Area Preparation

   a.  The following preparation for the work area will be made once it is determined that hot work is necessary:

      ▪  All flammable/combustible materials will be relocated at least 35 feet away from the work area.
- All combustible materials that cannot be reasonably removed from the area will be covered with a fire blanket.

- An appropriate fully charged fire extinguisher and/or charged fire hose will be available at the work area before, during and 1/2 hour after hot work procedures have ended.

- All safety equipment will be on-site and functional.

The confined space entry area will be identified with a posted sign that reads:

**Caution - Confined Space**, and barricaded to prevent impact from external hazards and vehicles. Ground level entries will be ringed with a toe board to prevent objects from inadvertently being dropped into the space.

### 3. Pre-Work Safety Meeting

a. The Project Manager will assure that a pre-work safety meeting has been provided to the crew prior to any hot work/confined space entry being performed. Individuals involved with confined space entry will be identified as the authorized entrant(s), attendant and the entry supervisor. Additional individuals may be designated to conduct monitoring for multiple entries. This meeting will include, but not be limited to:

- Permitting conditions (environmental conditions, type of work to be performed). This would include reviewing the results of the initial monitoring of the test results, ventilation requirements, potential hazards and continuous testing procedures.

- Personnel authorized to sign-off on the permit. All personnel involved with the confined space entry must sign the permit and acknowledge the hazards expected to be encountered.

- Location of the permit. (Must be conspicuously posted.)

- Type of monitoring required.

- Designation of attendant and discussion of duties.

- Returning completed permit to Project Manager or client when work is complete and project has concluded.

b. During the pre-work safety meeting the authorized entrants will be identified and the entry procedure reviewed. The attendant will be specified and the monitoring and communication procedures reviewed. The entry will be reviewed with the designated entry supervisor before entry. The attendant will be responsible for conducting the air monitoring during the entry and providing results to the entrants and entry supervisor. The designated positions will be posted on the entry permit.
c. The entry supervisor will be responsible for meeting with the client prior to entry to identify if other contractors or client personnel will be working in close proximity to the confined space entry. The entry supervisor will coordinate entry activities in order to make sure the other work does not impact the entry or endanger entry personnel. The entry supervisor will attend scheduled project meetings with the client and other contractor representatives in order to properly coordinate the entry with other projects.

d. Initial air-monitoring results will be conducted immediately prior to entry and will be reviewed with the entry supervisor and the authorized entrants prior to entry. Air-monitoring procedures and alarm levels will also be reviewed. Ventilation of the space will be initiated before entry and periodic monitoring conducted prior to entry to verify the ventilation is adequate. Monitoring will be performed throughout entry by the attendant and entrants will wear meters with alarms to conduct monitoring during the entry.

e. The Project Manager will meet with the client to arrange for adequate rescue services from the client, if available, or from outside rescue operations. The Project Manager will discuss rescue procedures with representatives of the rescue operation and allow the rescue team to examine the area, practice the rescue and decline to act as the rescue team if they feel they are not adequately staffed or equipped. The entry cannot be conducted until adequate rescue services are provided.

f. The Project Manager will meet with the client to discuss other projects or contractors that could interfere with CONTRACTOR’s confined space work. CONTRACTOR will coordinate the entry to have minimal impact on other contractors in the area and to make sure CONTRACTOR personnel are not endangered by other contractors work.

4. Permit Completion

The Confined Space Work Permit (see Attachment A) will be completed by the Project Manager prior to beginning work each day. The permit will not be considered valid until all personnel involved with the entry have reviewed and signed the entry permit. The entry supervisor will review each permit at the completion of the entry to determine if monitoring and safety procedures are adequate for this project. The permit will be modified if appropriate. The permit will be conspicuously posted at the site of the work.

5. Attendant

A designated Attendant will be present to observe the hot work/confined space operation. The Attendant will maintain contact with personnel and conduct air monitoring. The Attendant will oversee safety retrieval systems and initiate the alarm if rescue is necessary. The Attendant will not perform entry rescue or enter the confined space unless relieved of duty by another authorized Attendant and is equipped with maximum respirator protection. The Attendant will monitor only one confined space entry at one time.
6. **Entrant**

Entrants will be identified on the permit and instructed on the purpose for the entry of the confined space. Entrants are responsible for adhering to the permit requirements and communicating with the Attendant. Once work tasks are completed the Entrant is responsible for removing equipment, sampling devices and exiting the confined space safely.

7. **Entry Procedures:**

- A minimum of three workers must be assigned and dedicated to each confined space entry activity: the confined space entrant, the confined space attendant and the entry supervisor.
- Where air-moving equipment is used to ventilate space, chemicals shall be removed from the vicinity to prevent introduction into the confined space.
- If flammable liquids, gases or vapors may be contained within the confined space, explosion-proof equipment will be used. All equipment shall be positively grounded.
- Blank, double block and bleed or otherwise isolate, lockout and tagout all chemical, physical and/or electrical hazards wherever possible. Reduce all forms of energy to zero state energy.
- One person (standby) must remain at the entryway at all times and must keep continuous contact with the person entering the confined space. Contact must be maintained by line-of-sight, the safety line and/or radio. The standby attendant must not enter the confined space unless another trained person is available to act as standby, and he/she is equipped with adequate respiratory protection and dermal protection.
- A ladder is required in all confined spaces deeper than the employee’s shoulders. The ladder should be secured and not removed until all employees have exited the space. Do not rely on permanent ladders because they are often in poor condition. If the must be used, be sure of footing. Inspect permanent ladders for deterioration before entering and while descending. Try each step with one foot, while standing on the step above. When in doubt, use a portable ladder of adequate height to reach 3 feet above opening or a rope ladder or lower the entry person using a tripod. If a portable ladder is used, it should be tied off, if possible; otherwise, it should be held in place by the standby person.
- Vehicles should not be left running near confined space work or near air-moving equipment being used for confined space ventilation.
- Do not work without lighting. Use only “Explosion proof” lights or hand lamps. Lights and other illumination utilized in confined spaces shall be equipped with guards to prevent contact with light bulb.
- Any deviation from these confined space entry procedures requires the prior approval of the Safety Manager.

8. **Atmospheric Monitoring**

a. When cutting, grinding, heating or welding surfaces coated with epoxy finishes or paint, or when cutting certain metals with a welding torch, toxic fumes or vapors can
be emitted in the process. In these instances, monitoring may be required under the OSHA Standard. Therefore, it is the responsibility of the Project Manager to notify the Health and Safety Coordinator of these coatings and have them sampled (if unknown) to determine what type of monitoring will be required.

b. Occasionally, a "liner" will be adhered to the inside of a metal duct or tank. When hot work will be performed on such material, the liner will be removed at least 4 inches to each side of the cut to prevent toxic vapors from being emitted, or fire from occurring.

c. After moving all flammable materials out of the work area, the area will be monitored with a Combustible Gas Meter immediately before hot work takes place. LEL readings at or above 5% will necessitate that the area be ventilated before hot work operations begin. **Hot work should not proceed if readings of five percent or below cannot be achieved.**

d. All area monitoring must be performed continuously in hot work areas.

e. Hot work performed in confined spaces requires that contaminant specific air monitoring be performed. Air monitoring should be conducted in confined spaces whether there is hot work or not. Even non-permit spaces must be monitored initially to confirm the lack of hazardous atmospheres in the confined space. Contact the CESM to determine the type of air monitoring required for the contaminant.

f. Hot work performed on containers that previously contained flammable liquids (i.e. underground storage tanks) will not be performed until the Health and Safety Division has been contacted and has approved the work to be performed. **CONTRACTOR's Site Specific Health and Safety Plan for Flammable and Combustible Underground Storage Tank Removals contains detailed procedures for cleaning, inerting and cutting these types of containers.**

g. Entrants and the attendant will continuously evaluate the permit-required space to determine if additional monitoring or more frequent monitoring is necessary. The permit may be revoked or modified accordingly. All entrants will leave the space if unsafe conditions are observed or measured. The permit will be invalidated and reviewed with the supervisor before re-entry is allowed. Additional monitoring will be performed at the request of employees or attendants. Atmospheric monitoring for confined space entry shall include the following procedures:

- Prior to employee entry and before validation/revalidation of a CSEP, remote atmospheric testing of the confined space shall be conducted at the top, middle, bottom and corners of the space.
- Monitoring shall be conducted with a remote monitor on a wand attached to a toxic gas meter. The monitor shall be able to reach the lowest point of the confined space.
- Air monitoring shall be performed in the following sequence: Oxygen content, flammability, toxicity (organic vapors, hydrogen sulfide, carbon monoxide, etc.)
- If toxic, explosive or oxygen-deficient atmospheres are detected, the area will be purged or ventilated prior to entry. Area must be retested prior to entry. A person can enter the space only if all three test results are within the limits set in the permit.
- If remote testing is not possible, Level B is required for entry.
- Monitors for oxygen content, combustible gases and toxic vapors will be carried into the confined space with the entry team.

9. Prohibitive Circumstances

a. Hot work will be prohibited if any of the following conditions exist:
   - Oxygen levels greater than 21%.
   - LEL greater than 5%.
   - Organic vapor concentration greater than half of the Permissible Exposure Limits depending on contaminant (ventilation may reduce this hazard).

b. Confined space entry will not be permitted if oxygen levels are below 19.5% or if the LEL is >10%. Individual hazardous constituents will be monitored and appropriate levels of respiratory protection will be issued.

10. Conditions of Permit Validity

a. A permit is not valid unless all necessary inspections and air monitoring (if required) have been performed and all required signatures appear on the permit.

b. Work permits will be judged as valid for the following time durations:
   - Work Shift or when until a significant change in personnel occur.
   - Duration of the hot work.
   - When atmospheric changes dictate ceasing the operation, abate the hazard and re-inspect the work area before completing another permit.

c. Permits are valid up to one day and new permits must be completed each day or whenever the permit conditions change.

d. The local Fire Department or client emergency services will be contacted prior to entry into confined spaces. They will be notified of the reason for entry and be requested to be available for rescue and administering first aid. If emergency rescue cannot be provided within three minutes CONTRACTOR will not conduct the entry. The permit program will be reviewed to determine if it is adequate for the projects conducted. Incident reports will be reviewed, employee issues raised and entries reviewed. The permit program will be evaluated to determine if all hazards were adequately identified and evaluated. Additional protective equipment
will be purchased, if necessary, for future entries if the review process shows that all hazards were not properly controlled. This review will be part of annual confined space training.

e. **CONTRACTOR** will coordinate the entry with client and/or other contractors present at the job site. Work will be evaluated to determine the impact by non-**CONTRACTOR** staff on the work being conducted.

f. If conditions change and **CONTRACTOR** employees are at risk the permit will be considered invalid.

g. The permit will be canceled once the project is complete or conditions change that warrant leaving the site. A new permit will be issued for future entries once a permit has been canceled.

11. Training and Program Review

All workers involved with confined space entry will receive training relative to their role on the project. Since **CONTRACTOR** conducts confined space entry infrequently training will be conducted prior to each project in order to refresh **CONTRACTOR** employees on the use of the equipment, monitoring procedures and the confined space entry program. The program will be reviewed annually or when new equipment is acquired. All completed permits will be reviewed and critiqued at the completion of each entry. The entrants and attendants will be interviewed after entry to determine if there were significant problems or concerns.
ATTACHMENT A

CONFINED SPACE PERMIT
CONFIRMATOR

Confined Space Entry Permit

- Location of Confined Space ____________________________ Date/time ____________________________
  Purpose of entry ____________________________ Duration ____________________________

  **Authorized by_____________  Expires on_____________**

Attendant

Authorized Entrants

<table>
<thead>
<tr>
<th>Measures for Isolating Equipment</th>
<th>YES</th>
<th>NO</th>
<th>Measures for Isolating Equipment</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOTO</td>
<td></td>
<td></td>
<td>Protective clothing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lines capped</td>
<td></td>
<td></td>
<td>Communications equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purging</td>
<td></td>
<td></td>
<td>Hot work permit needed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilation</td>
<td></td>
<td></td>
<td>Other PPE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secure area</td>
<td></td>
<td></td>
<td><strong>Special conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harness and retrieval system</td>
<td></td>
<td></td>
<td>Pump out standing water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire extinguishers</td>
<td></td>
<td></td>
<td>Excessive Heat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air line system/5-minute escape</td>
<td></td>
<td></td>
<td>Low overhead</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secure area</td>
<td></td>
<td></td>
<td>Special conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCBAs</td>
<td></td>
<td></td>
<td>Slippery surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Respirators</td>
<td></td>
<td></td>
<td>Unsecured ladder</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Atmospheric Monitoring**

<table>
<thead>
<tr>
<th>Tests to be Taken</th>
<th>yes</th>
<th>no</th>
<th>Acceptable Entry Conditions</th>
<th>Test #</th>
<th>Date: Time:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td></td>
<td></td>
<td>19.5-23.5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEL</td>
<td></td>
<td></td>
<td>&lt;10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td></td>
<td></td>
<td>&lt;25 ppm</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2S</td>
<td></td>
<td></td>
<td>&lt;5 ppm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

  **Individual conducting test:** ____________________________  
  **Supervisor authorizing entry** ____________________________

  **Instruments used:**

<table>
<thead>
<tr>
<th>Instrument(s) name</th>
<th>Type</th>
<th>Serial #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Authorized Entrants within Space**

<table>
<thead>
<tr>
<th>Entrant’s Name</th>
<th>Time In</th>
<th>Time Out</th>
<th>Authorized site Attendants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

  **Emergency and rescue contact:** ____________________________

  **Entry supervisor approval to conduct entry** ____________________________  
  **Date/time** ____________________________
APPENDIX J

INCIDENT REPORTING
1.0 ACCIDENT AND INCIDENT REPORTING

It is important that all accidents and incidents that result in injury, illness, or medical treatment be reported within 24 hours. If an accident occurs, the Contractor will call their Human Resources Director and Corporate Environmental Safety Manager (CESM) to provide information on the injury. The CESM will complete the first report of injury and file it accordingly. Copies will be sent to the Project Manager (PM) and Site Safety Officer (SSO). Supervisors are required to complete the Supervisor’s Report of Accident included in this section. It is CONTRACTOR’S responsibility to investigate each incident, file appropriate paperwork, and conduct a follow-up analysis of each incident to develop information about the cause of the accident.

2.0 REPORTING PHONE NUMBERS

Accident/Incident Contact Information
Corporate Environmental Safety Manager: 
Human Resources Director:

3.0 FIRST AID AND MEDICAL TREATMENT

The CONTRACTOR provides a First Aid Kit on each site and in each Company vehicle. It is there for use in the treatment of minor scratches, burns, headaches, nausea, etc. Each employee should verify the location of the nearest first aid kit and should make use of it whenever needed. Each kit is fully stocked and restocked monthly by an outside vendor. The kit includes bandages, over the counter medications, disinfecting supplies and topical ointments. The user of each kit is responsible for contacting the vendor to replace items used or submitting the kit to CONTRACTOR for replacement. Kits are to be inventoried by the Project Manager before being sent in the field. Only completely stocked kits are to be brought into the field. The kits are maintained in a weatherproof container and in accordance with ANSI Standard Z308.1-1998. The first aid supplies in each kit are included in Attachment A.

Any work related injury or illnesses that requires professional medical assistance should be reported immediately. Failure to promptly notify of a work related injury could make the claim questionable and subject to stricter review. The nearest medical center or hospital will be identified for each project. The phone number and location for this center will be determined before commencing field activities and be included in the Health and Safety Plan. The phone numbers will be posted by Site Safety Officer (SSO) or the Project Manager (PM) and available to all employees in order to provide prompt response to all injuries. The SSO or the PM will contact the nearest medical facility to determine the facility’s capabilities and verify that the facility is willing to provide emergency medical services. The following actions for medical treatment scenarios is presented below:

1. Minor First Aid Treatment

First aid kits are stored in each company vehicle. If an injury is sustained or results in minor first aid treatment:

a. Inform your supervisor.
b. Administer first aid treatment to the injury or wound.
c. If a first aid kit is used, indicate usage on the accident investigation report.
d. Access to a first aid kit is not intended to be a substitute for medical attention.
e. Provide details for the completion of the accident investigation report.

2. Non-Emergency Medical Treatment
For non-emergency work-related injuries requiring professional medical assistance, management must first authorize treatment. If you sustain an injury requiring treatment other than first aid:

a. Inform your supervisor.

b. Proceed to the posted medical facility. Your supervisor will assist with transportation, if necessary.

c. Provide details for the completion of the accident investigation report.

3. Emergency Medical Treatment
If you sustain a severe injury requiring emergency treatment:

a. Call for help and seek assistance from a co-worker.

b. Use the emergency telephone numbers and instructions posted next to the telephone in your work area to request assistance and transportation to the local hospital emergency room.

c. Provide details for the completion of the accident investigation report.

d. The Project Manager will identify an ER provider for each long-term project for emergency medical services. The phone number will be posted at each job site.

4. First Aid Training
Each employee will receive training and instructions from his or her supervisor on our first aid procedures.

5. Wounds

a. Minor - Cuts, lacerations, abrasions, or punctures
   - Wash the wound using soap and water; rinse it well.
   - Cover the wound using clean dressing.

b. Major - Large, deep and bleeding
   - Stop the bleeding by pressing directly on the wound, using a bandage or cloth.
   - Keep pressure on the wound until medical help arrives.
6. Broken Bones
   a. Do not move the victim unless it is absolutely necessary.
   b. If the victim must be moved, “splint” the injured area. Use a board, cardboard, or rolled newspaper as a splint.

7. Burns
   a. Thermal (Heat)
      ▪ Rinse the burned area, without scrubbing it, and immerse it in cold water; do not use ice water.
      ▪ Blot dry the area and cover it using sterile gauze or a clean cloth.
   c. Chemical
      ▪ Flush the exposed area with cool water immediately for 15 to 20 minutes.

8. Eye Injury
   a. Small particles
      ▪ Do not rub your eyes.
      ▪ Use the corner of a soft clean cloth to draw particles out, or hold the eyelids open and flush the eyes continuously with water.
   b. Large or stuck particles
      ▪ If a particle is stuck in the eye, do not attempt to remove it.
      ▪ Cover both eyes with bandage.
   c. Chemical
      ▪ Immediately irrigate the eyes and under the eyelids, with water, for 30 minutes.

9. Neck And Spine Injury
   If the victim appears to have injured his or her neck or spine, or is unable to move his or her arm or leg, do not attempt to move the victim unless it is absolutely necessary.

10. Heat Exhaustion
   a. Loosen the victim’s tight clothing.
   b. Give the victim “sips” of cool water.
Make the victim lie down in a cooler place with the feet raised.

**4.0 FIRST AID/CPR Certification**

Each **CONTRACTOR** project will identify individuals that are certified CPR/first aid. First aid training sponsored by the American Red Cross is acceptable and must be renewed every three years. CPR training must be renewed annually. Other first aid training will be reviewed to see if it is comparable to the Red Cross training.

**5.0 SAFETY RESPONSIBILITIES**

The Contractor and Subcontractor employees also have some important responsibilities concerning safety. They are:

a. The responsibility of reporting all injuries and illnesses to your supervisor, no matter how small.

b. The responsibility of always following the safety rules for every task performed.

c. The responsibility of reporting any hazards seen.

d. The responsibility of helping co-workers recognize unsafe actions or conditions.

e. The responsibility of asking about the safety rules.

It is impossible to list or include all safety rules for all the possible tasks. But the following rules have been prepared to help the employee avoid hazards, which may cause injury while doing some of the more common tasks. Failure to follow safety rules and/or safe practices will result in disciplinary action, up to and including termination.
Supervisor’s Report of Accident

Supervisor's Name: ______________________________________________

Basic Rules for Accident Investigation

- Find the cause to prevent future accidents - Use an unbiased approach during investigation.
- Interview witnesses & injured employees at the scene - conduct a walkthrough of the accident.
- Conduct interviews in private - Interview one witness at a time.
- Get signed statements from all involved.
- Take photos or make a sketch of the accident scene.
- What hazards are present - what unsafe acts contributed to accident
- Ensure hazardous conditions are corrected immediately.

<table>
<thead>
<tr>
<th>Date &amp; Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tasks performed</th>
<th>Witnesses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Resulted in</th>
<th>Injury</th>
<th>Fatality</th>
<th>Property Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>__</td>
<td>__</td>
<td>__</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Injured</th>
<th>Property Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injured</td>
<td>Damage</td>
</tr>
</tbody>
</table>

Describe Accident Facts & Events


Supervisor's Root Cause Analysis

Check ALL that apply to this accident

<table>
<thead>
<tr>
<th>Unsafe Acts</th>
<th>Unsafe Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improper work technique</td>
<td>Poor Workstation design</td>
</tr>
<tr>
<td>Safety rule violation</td>
<td>Unsafe Operation Method</td>
</tr>
<tr>
<td>Improper PPE or PPE not used</td>
<td>Improper Maintenance</td>
</tr>
<tr>
<td>Operating without authority</td>
<td>Lack of direct supervision</td>
</tr>
<tr>
<td>Failure to warn or secure</td>
<td>Insufficient Training</td>
</tr>
<tr>
<td>Operating at improper speeds</td>
<td>Lack of experience</td>
</tr>
<tr>
<td>By-passing safety devices</td>
<td>Insufficient knowledge of job</td>
</tr>
<tr>
<td>Protective equipment not in use</td>
<td>Slippery conditions</td>
</tr>
<tr>
<td>Improper loading or placement</td>
<td>Excessive noise</td>
</tr>
<tr>
<td>Improper lifting</td>
<td>Inadequate guarding of hazards</td>
</tr>
<tr>
<td>Servicing machinery in motion</td>
<td>Defective tools/equipment</td>
</tr>
<tr>
<td>Horseplay</td>
<td>Poor housekeeping</td>
</tr>
<tr>
<td>Drug or alcohol use</td>
<td>Insufficient lighting</td>
</tr>
</tbody>
</table>

Unsafe Acts require a written warning and re-training before the Employee resumes work.
<table>
<thead>
<tr>
<th>Date</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-Training Assigned</td>
<td>Unsafe Condition Guarded</td>
</tr>
<tr>
<td>Re-Training Completed</td>
<td>Unsafe Condition Corrected</td>
</tr>
<tr>
<td>Supervisor Signature</td>
<td>Supervisor Signature</td>
</tr>
</tbody>
</table>

**Accident Report Review**

Supervisor ____________________________________  Date ____________

Department Superintendent _______________________  Date ____________

Safety Manager ________________________________  Date ____________

Plant Manager _________________________________  Date ____________
ATTACHMENT A

First Aid Kits

Each first aid kit is in a weather proof container and contains the following:

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ear Plugs</td>
<td>2 pair</td>
</tr>
<tr>
<td>Band-aids</td>
<td>2 boxes</td>
</tr>
<tr>
<td>Sterile pads</td>
<td>5 2”x2”</td>
</tr>
<tr>
<td>Oval eye pads</td>
<td>2</td>
</tr>
<tr>
<td>Tylenol</td>
<td>10</td>
</tr>
<tr>
<td>Burn cream</td>
<td>1 tube</td>
</tr>
<tr>
<td>Tweezers</td>
<td>1 each</td>
</tr>
<tr>
<td>Scissors</td>
<td>1 each</td>
</tr>
<tr>
<td>Triangular bandage</td>
<td>1</td>
</tr>
<tr>
<td>Antiseptic wipes</td>
<td>1 box</td>
</tr>
<tr>
<td>Ammonia inhalants</td>
<td>1 box</td>
</tr>
<tr>
<td>Flexible gauze</td>
<td>1 roll</td>
</tr>
<tr>
<td>First aid guide</td>
<td></td>
</tr>
<tr>
<td>Latex gloves</td>
<td>2 pair</td>
</tr>
</tbody>
</table>
Directions to the Hospital:
Head southwest on Kent Avenue toward N 11th Street.
Turn left at Broadway.
1.6 miles to Woodhull Medical-Mental Health Center at 760 Broadway, Brooklyn, NY.

SOURCE: MAP CREATED WITH TOPO\textsuperscript{TM} ©2000 WILDFLOWER PRODUCTIONS (www.topo.com)
APPENDIX K

ADDENDUM
MATERIAL SAFETY DATA SHEETS
# Material Safety Data Sheets Collection

## Sheet No. 316

### Benzene

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

### Section 1. Material Identification

**Benzene (C₆H₆)**
- **Description:** Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical intermediate; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenezene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and recrystallization; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.
- **Other Designations:** CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phenyl, phenyl hydride, pyrobenzol.
- **Manufacturer:** Contact your supplier or distributor. Consult the latest Chemicalweek Buyers' Guide(f) for a suppliers list.

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

### Section 2. Ingredients and Occupational Exposure Limits

<table>
<thead>
<tr>
<th>Benzene, ca 100%*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989 OSHA PELs</td>
</tr>
<tr>
<td>(29 CFR 1910.1000, Table Z-1-A)</td>
</tr>
<tr>
<td>8-hr TWA: 1 ppm, 3 mg/m³</td>
</tr>
<tr>
<td>15-min STEL: 5 ppm, 15 mg/m³</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>1985-86 Toxicity Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man, oral, LD₅₀: 50 mg/kg; no toxic effect noted</td>
</tr>
<tr>
<td>Man, inhalation, LC₅₀: 150 ppm inhaled intermittently over 1 yr in a number of different studies; the exposure occurs for the blood (other changes) and neurological and gross metabolism (body temperature increase)</td>
</tr>
<tr>
<td>Rabbit, eye: 2 mg administered over 24 hr produces severe irritation</td>
</tr>
</tbody>
</table>

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

### Section 3. Physical Data

| Boiling Point: 176 °F (80 °C) |
| Melting Point: 42 °F (-5.5 °C) |
| Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C) |
| Vapor Density (Air = 1): 2.7 |
| Evaporation Rate (Ether = 1): 2.8 |

| Molecular Weight: 78.11 |
| Specific Gravity (15 °C/4 °C): 0.8787 |
| Water Solubility: Slightly (0.180 g/100 g of H₂O at 25 °C) |
| % Volatile by Volume: 100 |
| Viscosity: 0.0468 mPa·s at 20 °C |

### Section 4. Fire and Explosion Data

| Flash Point: 12 °F (-1.1 °C), CC |
| Autoignition Temperature: 928 °F (498 °C) |
| LEL: 1.3% v/v |
| UEL: 7.1% v/v |

- **Extinguishing Media:** Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can spread and scatter the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an uninitiated benzene leak.
- **Unusual Fire or Explosion Hazards:** Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.

### Section 5. Reactivity Data

- **Stability/Reactivity:** Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
- **Chemical Incompatibilities:** Benzene explodes on contact with dioxane, permanganic acid, bromine pentfluoride, peroxodisulfuric acid, and peroxomonsulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxy + water. Benzene forms sensitive, explosive mixtures with iodine pentfluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentfluoride + potassium methoxide (explosives above 50 °C). A vigorous or incandescent reaction occurs on heating trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.

### Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.
Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a suspected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).

Summary of Risk: Prolonged or repeated contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher levels exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.

Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.

Target Organ(s): Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.

Primary Entry Routes: Inhalation, skin contact.

Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).

Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flowing amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Immediately rinse with flowing amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, do not induce vomiting since aspiration may be fatal. Call a physician immediately.

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

Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure.

Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Design and practice a benzene spill control and countermeasure plan (SCCP). Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, piket far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into suitable containers for disposal. Keep waste out of confined spaces such as sewers, waterheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).

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

EPA Designations

Listed as an RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
Listed as SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

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

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. Warning: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 1910.1000) and HCS PELs.* Use ventilation to keep the concentration of benzene away from water and clothing. Provide adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation.

Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation.

Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD, FLAMMABLE." Use ventilation or other controls as necessary to prevent breathing of benzene vapors. If possible, substitute less toxic solvents.

Other Precautions: Provide preplacement and periodic medical examinations with emphasis on history of blood disease or previous exposure.

Transportation Data (49 CFR 172,161,102)

DOT Shipping Name: Benzene (benzol)
DOT Hazard Class: Flammable liquid
ID No.: UN1114
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Label: Flammable liquid
IMDG Packaging Group: II

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

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

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Section 1. Material Identification

Cresol, mixed isomers (CH₃.C₆H₄.OH) Description: Derived from coal tar or petroleum. Cresol is marketed by individual isomer and as pure or crude cresol. Pure cresol is a mixture of ortho, meta, and para isomers. Crude cresol (commercial cresol) is prepared by distilling "grey phenolic acid" at 356 to 401 °F (180 to 205 °C) and is comprised of 20% ortho, 40% meta, and 30% para isomers, plus small amounts of phenol and xenophenols. Each isomer may be prepared synthetically by diazotization of the specific corresponding toluidine. Used in manufacturing synthetic resins, explosives, photographic developers, petrochemicals, paint, disinfectants, and insecticides as an antifreeze agent; and in the agriculture industry for herbicides and insecticides.

Uses Designations: CAS 133-77-3, Barcillot, cresylic acid, Tekersol, tricresol.

Manufacturers: Consult your supplier or distributor. Consult latest Chemical Week Buyers’ Guide for a suppliers list.

Cautions: Cresol is severely irritating to mucous membranes, eyes, and skin. Depending on the cresol concentration, extent of exposure, and amounts of skin exposed, toxicity may be slight (irritation) or severe (permanent injury or death).

Section 2. Ingredients and Occupational Exposure Limits

- Cresol (mixed isomers) National Formulary (NF) grade contains ≤ 5% phenol
- 1990 OSHA PEL (Skin) 8-hr TWA: 5 ppm (22 mg/m³)
- 1991-92 ACGIH TLV (Skin) TWA: 5 ppm (22 mg/m³)
- 1994 Antoine MAK TWA: 5 ppm (22 mg/m³)
- 1998-97 Exposure Limit: 10 ppm, 5 min.

* Danger of cutaneous absorption. 
† See NIOSH, RTECS (GO9590000), for additional toxicity data. For data on specific isomers, see RTECS (GO6125000, meta; GO6300000, ortho; and GO6475000, para).

Section 3. Physical Data

- Boiling Point Range: 375.8 to 397.4 °F (191 to 203 °C)
- Melting Point Range: 51.8 to 95 °F (11 to 35 °C)
- Vapor Pressure: 0.25 (ortho), 0.15 (meta), 0.11 (para) mm Hg at 68 °F (20 °C)
- Vapor Density (air = 1): 3.72
- pH: Saturated solutions are neutral or slightly acidic to litmus
- Viscosity: 4.49 to 7.00 cP at 104 °F (40 °C)
- Molecular Weight: 108.13
- Specific Gravity: 1.030 to 1.038 at 77 °F (25 °C)
- Water Solubility: Soluble, 1%
- Other Solubilities: Soluble in alcohol, ether, dibutyl amyl, glycol and vegetable oils
- Refraction Index: 1.5353 at 75.2 °F (24 °C)
- Odor Threshold: Low, 0.012 mg/m³, high, 22 mg/m³

Appearance and Odor: Colorless, yellow, or pinkish liquid turning brown on exposure to air or light with a phenolic odor and pungent taste.

Section 4. Fire and Explosion Data

- Flash Point: 178 °F (81.1 °C, ortho), 187 °F (86.1 °C, meta, and para), CC
- Autoignition Temperature: 1110 °F (559 °C, ortho), 1038 °F (568 °C, meta, and para)
- LEL: 1.4% (ortho), 1.1% (meta and para) at 302 °F (150 °C)
- UEL: None reported

Extinguishing Media: While cresol does not ignite easily, it burns. For small fires, use dry chemical, carbon dioxide (CO₂), water spray, or regular foam.

For large fires, use water spray, fog, or regular foam. Do not scatter material with more water than is necessary to put out fire.

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

Special Fire-fighting Procedures: Since fires may produce toxic thermal decomposition products, use 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 cresol.

Use clothing the manufacturer recommends specifically for use with cresol. If possible without risk, remove container from fire area. Fight fire from maximum distance. Stay away from ends of tanks. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

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

Chemical Incompatibilities: Cresol reacts with oxidizing materials and causes a temperature and pressure increase with chloramphenicol, nitric acid, and ozone.

Conditions to Avoid: Ignition sources and contact with incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of cresol can produce carbon dioxide (CO₂) and toxic cresol fumes.

Section 6. Health Hazard Data

Cardiovascular: The IARC(146) NTP(147) and NIOSH(148) do not list cresol as a carcinogen. Summary of Risks: Cresol is corrosive to eyes, skin, and mucous membranes. Degree of toxicity depends on the cresol concentration involved, amount of surface area exposed, and duration of exposure. Ingestion is corrosive to the digestive tract's mucous membranes and can pose serious problems if not treated promptly. Because cresol has a low vapor pressure, it is not volatile enough under normal conditions to present an inhalation hazard. If heated, vapor inhalation is likely. Severe chemical burns and dermatitis are the main hazards in industry. Note that cresol's ortho and para isomers (if used individually) are in crystal form and thus are a dust inhalation hazard. By all routes of exposure, cresol produces toxic symptoms similar to phenols. Medical Conditions Aggravated by Long-Term Exposure: Skin diseases.

Target Organ: Eyes, skin, central nervous system (CNS), liver and kidney. Primary Entry Routes: Skin and eye contact/sorption. Acute Effects: Cresol is absorbed through skin, open wounds, and the mucous membranes of the respiratory and digestive tracts. The rate at which skin absorbs cresol depends more on the size of exposure area than on the concentration of material applied. Cresol is corrosive to the skin causing smarting; tingling; redness; swelling; burns that may be very painful and become white and wrinkled with softening that may become gangrenous; blisters; possible shock as a result.

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Section 6. Health Hazard Data, continued

of pain; and, in severe cases of absorption, coma and death. Contact with eyes may cause stinging, and burning, watering of eyes, redness and swelling of lids, corneal opaqueness causing blurred vision and possible loss of sight. In rare cases, a pigment disorder called ochronosis occurs characterized by darkening of skin, conjunctiva, and cartilage of the nose and ears. Ingestion leads to burning of lips, mouth, and throat, pain in swallowing, ulceration of the mucous membranes of the mouth, color change of the tongue (white), thirst, throat swelling, cramps, nausea and vomiting (sometimes of coffee grounds like digested blood in emesis). In severe cases symptoms might progress to shock, convulsions, coma, and death. If vapor inhalation occurs, symptoms include irritation of mucous membranes of nose, eyes, and mouth, watering of eyes, sneezing, coughing, difficulty breathing, headache, nausea, muscle weakness, and possible pulmonary edema. In most cases of exposure, if death occurs, it is usually caused by respiratory failure. Chronic Effects: Repeated exposure to cresol may cause digestive disturbances, liver, kidney, spleen and pancreatic damage, and skin eruptions or dermatitis. Some people can become allergic or hypersensitive to cresol.

First Aid for Ingestion: If you use a full face mask should protect against contamination.

Eyes: Gently lift eyelids and flush immediately and continuously with flowing 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 to prevent burns. Rinse with flowing amounts of water for at least 15 min. If clothing is stuck to skin after flushing with water, do not remove! Thoroughly 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; then induce vomiting with 2 tablespoons of ipecac (adult dose). After patient vomits, give activated charcoal in 8 oz. of water to drink. After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Since effects may be delayed, keep victim under observation. Irrigate eyes and wash skin with a mixture of polyethylene glycol 300 and industrial methylated spirits (PEG 300/IMS, 2:1 by volume). Recommended treatment for ingestion is repeated gastric lavage with large quantities of olive oil.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Liquid: Immediately notify safety personnel, isolate and ventilate area (with fixed or portable fan systems for cross-ventilation), deny entry, and stay upwind. Shut off all ignition sources. Spilled liquid can be neutralized with crushed limestone or soda ash. Take up small spills with earth, sand, vermiculite or other absorbent, noncombustible material and place into neutralization tanks. For large spills, dike far ahead of liquid for later disposal or reclamation. For water spills, you may need to trap cresol at the bottom with sandbag barriers, apply activated charcoal, and then remove trapped material with dredges or lifts. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Degradation: When released into the atmosphere, cresol degrades by reacting with photochemically produced hydroxyl radicals during the day (half-life = 8 to 10 hr), and with nitrate radicals at night (half-life = 2 to 5 min). Crescent biodegrades in estuarine (nutrient-rich) waters.

Ecotoxicity Values: Blue Gill, TL50 = 24 mg/L/96 hr (fresh water); shrimp, TL50 = 10 to 100 ppm/48 hr (saltwater).

Soil Absorption/Mobility: Cresol is mobile in soil but biodegradation is probable. Cresol probably leads due to water solubility.

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

EPA Designations

Listed as a CERCLA Hazardous Substance (40 CFR 302.4): Reportable

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 or face shields to protect against droplets or spray, 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. At 50 to 100 ppm use a full face gas mask. For emergency or nonroutine operations (cleaning spills, washing vehicle or storage tank) 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: 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. Rubber is suggested as a material suitable for protection against cresol.

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.(20)

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 properly labelled (with trade name) iron or steel containers in cool, dry, well-ventilated location. Protect from light and keep away from incompatibles (Sec. 5). Outside or detached storage is preferred. To prevent static sparks, electrically ground and bond all equipment used in cresol manufacture, use, and 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.

Administrative Controls: Consider preplacement and periodic examinations of exposed workers that emphasize skin, kidney, liver, and respiratory system.

Transportation Data (49 CFR 172.101, 102)

DOT Shipping Name: Cresol
DOT Hazard Class: Corrosive material
DOT No.: UN2076
DOT Label: Corrosive
DOT Packaging Exceptions: 173.244
DOT Packaging Requirements: 173.245

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

Prepared by: M. Gannon, BA, Industrial Hygiene Review: PA Roy, MPH, CII, Medical Review: AC Darlington, MPH, MD; Edited by: JR Smart, MS

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Material Safety Data Sheets Collection:
Sheet No. 385
Ethylbenzene
Issued: 8/78
Revision: B, 9/92

Section 1. Material Identification
Ethylbenzene (C₆H₅CH₃) Description: Derived by heating benzene and ethylene in presence of aluminum chloride with subsequent distillation, by fractionation directly from the mixed xylene stream in petroleum refining, or by dehydrogenation of naphthenes. Used as a solvent, an antiknock agent in gasoline; and as an intermediate in production of synthetic rubber, styrene, cellulose acetate, diethylbenzene, acetoephone, edyl anethraquinone, propyl oxide, and α-methylbenzol alcohol.
Other Designations: CAS No. 100-41-4, ethylbenzol, EB, phenylethane, NCI-CS6393.
Manufacturer: Contact your supplier or distributor. Consult latest Chemical Week Buyers’ Guide for a suppliers list.

Cautions: Ethylbenzene is a skin and mucous membrane irritant considered the most irritating of the benzene series. Inhalation causes acute and chronic central nervous system (CNS) effects. It is highly flammable and forms explosive mixtures with air.

Section 2. Ingredients and Occupational Exposure Limits
Ethylbenzene, ca >99.0%. Impurities include ~0.1% meta & para xylene, ~0.1% cumene, and ~0.1% toluene.
1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m³)
15-min STEL: 125 ppm (545 mg/m³)
Action Level: 50 ppm (217 mg/m³)
1990 IDLH Level
2000 ppm
1990 NIOSH REL
TWA: 100 ppm (435 mg/m³)
STEL: 125 ppm (545 mg/m³)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m³)
STEL: 125 ppm (545 mg/m³)
1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m³)
Category 1: local irritants
Peak Exposure Limit: 200 ppm, 5 min
momenanl value, max of 8/shift
Danger of cutaneous absorption

1985-86 Toxicity Data
Human, inhalation, TLV: 100 ppm/8 hr caused eye effects, sleep, and respiratory changes.
Human, lymphocytosis: 1 mmol/L induced sister chromatid exchange.
Rat, oral, LD₅₀: 3500 mg/kg; toxic effects not yet reviewed
Rat (female), inhalation, TLV: 1000 ppm/7 hr/day, 5 days/week, for 3 wk prior to mating and daily for 19 days of gestation produced pups with high incidence of extra ribs.

* See NIOSH, RTECS (DA0700000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data
Boiling Point: 277 °F (136 °C)
Melting Point: -139 °F (-59 °C)
Surface Tension: 31.5 dyn/cm
Vaporization Potential: 8.76 eV
Viscosity: 0.64 cP at 77 °F (25 °C)
Refraction Index: 1.4959 at 68 °F (20 °C)
Relative Evaporation Rate (ether = 1): 0.0106
Bulk Density: 7.21 lb/Gal at 77 °F (25 °C)
Critical Temperature: 651 °F (343.9 °C)
Critical Pressure: 35.6 atm
Molecular Weight: 106.16
Density: 0.863 at 77 °F (25 °C)
Water Solubility: Slightly, 14 mg/100 mL at 59 °F (15 °C)
Other Solubilities: Miscible in alcohol, ether, soluble in carbon tetrachloride, benzene, sulfur dioxide, and many organic solvents; insoluble in ammonia
Odor Threshold: 2.3 ppm
Vapor Pressure: 7.1 mm Hg at 68 °F (20 °C); 10 mmHg at 78.62 °F (25.9 °C); 100 mm Hg at 165.38 °F (74.1 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.0768 lb/ft³ or 1.2298 kg/m³
Appearance and Odor: Colorless, flammable liquid with a pungent odor.

Section 4. Fire and Explosion Data
Flash Point: 64 °F (18 °C) CC
Autoignition Temperature: 810 °F (432 °C)
LEL: 1.0% v/v
UEL: 6.7% v/v
Extinguishing Media: Class 1B Flammable liquid. For small fires, use dry chemical, carbon dioxide, or ‘alcohol-resistant’ foam. For large fires, use fog or ‘alcohol-resistant’ foam. Use water only if other agents are unavailable; EB floats on water and may travel to an ignition source and spread fire. Unusual Fire or Explosion Hazards: Burning rate is 5.8 mm/min. Vapors may travel to an ignition source and flash back. Container may explode in heat of fire. EB poses a vapor explosion hazard indoors, outdoors, and in sewers. Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, use a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Cool container sides with water 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. Withdraw immediately if you hear rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data
Stability/Polymerization: Ethylbenzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Reacts vigorously with oxidizers.
Conditions to Avoid: Exposure to heat and oxidizers.
Hazardous Products of Decomposition: Thermal oxidative decomposition of EB can produce acid smoke and irritating fumes.

Section 6. Health Hazard Data
Carcinogenicity: The IARC(165) NTP, (166) and OSHA(166) do not list EB as a carcinogen. Summary of Risks: Occupational exposure to EB alone is rare since it is usually present together with other solvents. EB is irritating to the eyes, skin, and respiratory tract. Vapor inhalation produces varying degrees of CNS effects depending on concentration. The liquid is absorbed through the skin but vapors are not. 5 to 64% of inhaled ethylbenzene is retained and metabolized. Urinary metabolites following exposure to 23 to 85 ppm for 8 hr are mandelic acid (64%), phenylglyoxylic acid (25%), and methylphenylcarbinol/1-phenyl ethanol (5%). Concurrent exposure to xylene and ethylbenzene causes slower excretion of EB metabolites. Based on the rat LD₅₀, one manufacturer gives 3 to 4 oz as the lethal dose for a 100 lb person.

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Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Skin and CNS diseases and impaired pulmonary function (especially obstructive airway disease). Target Organ: Skin. Sites: Respiratory system, skin, CNS, blood. Primary Entry Routes: Inhalation, skin and eye contact. Acute Effects: Vapor inhalation of 200 ppm caused transient eye irritation; 1000 ppm caused eye irritation with profuse watering (tolerance developed rapidly; 2000 ppm caused severe and immediate eye irritation and watering, nasal irritation, chest constriction, and vertigo; 5000 ppm was intolerable and caused eye and nose irritation. Inhalation of high concentrations may cause narcosis, cramps, and death due to respiratory paralysis. Skin exposed to pure ethylbenzene for 10 to 15 min absorbed 22 to 33 mg/cm²/hr. Immersion of hand in solutions of 112 & 156 mg/l for 1 hr absorbed 118 & 215.7 µg/cm²/hr, respectively. Chronic Effects: Repeated skin contact may cause dryness, scaling, and fissuring. Workers chronically exposed to > 100 ppm complained of fatigue, sleepiness, headache, and mild irritation of the eyes and respiratory tract. Repeated vapor inhalation may result in blood disorders, particularly leukopenia (abnormally low level of white blood cells) and lymphocytosis.

FIRST AID
Eyes: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flowing amounts of water until transported to an emergency medical facility. Consult a physician immediately. Skin: Quickly remove contaminated clothing. Rinse with flowing amounts of water for at least 15 min. 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 and unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water to dilute. Do not induce vomiting! Aspiration of even a small amount of EB in vomitus can cause severe damage since its low viscosity and surface tension will cause it to penetrate a large area of the lung tissue.

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

Note to Physicians: B/EI = mandelic acid in urine (1.5 µg/g of creatinine), sample at end of shift at weekends end. Since this test is not specific, test for EB in expired air for confirmation.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate and ventilate area, deny entry and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against vapor inhalation and skin/eye contact. Take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container. Dike far ahead of large spill for later reclamation or disposal. Report any release >1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Transport: If released to soil, EB partially evaporates into the atmosphere, with a half-life of hours to weeks, and some leaches into groundwater, especially in soil with low organic carbon content. Biodegradation occurs with a half-life of 2 days. Some EB may absorb to sediment or biocculate in fish. Evidence points to slow biodegradation in groundwater. In air, it reacts with photochemically produced hydroxyl radicals with a half-life of days to weeks. Additional amounts may be removed by rain. Ecotoxicity Values: Shrimp (Mysisidops bahia) LC50 = 87.6 mg/L/96 hr; sheephead minnow (Cyprinodon variegatus) LC50 = 275 mg/L/96 hr; fish (Pimephales promelas) LC50 = 423.3 mg/L/96 hr in hard water & 48.5 mg/L/96 hr in soft water. Disposal: A candidate for rotary kiln incineration at 1500 to 2912°F (820 to 1600°C), liquid injection incineration at 200 to 2912°F (650 to 1600°C), and fluidized bed incineration at 842 to 1796°F (450 to 980°C). Contact your state, federal, or local contractor for detailed recommendations. Follow applicable federal, state, and local regulations.

OSHA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.21): No. D001
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a CERCLA Hazardous Substance (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311 (b)(4) & CWA, Sec. 307 (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. Respirators: Seek professional advice prior to selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use a powered air-purifying respirator equipped with an appropriate organic vapor cartridge, a supplied-air respirator (SAR), SCBA, or chemical cartridge respirator with appropriate organic vapor cartridge. For < 2000 ppm, use a SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear a 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: 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 made of Viton or polyvinylchloride to prevent skin contact. Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion to the work area by controlling it at its source. 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 contamination 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 cool, dry, well-ventilated area away from ignition sources and oxidizers. Outside or detached storage is preferred. If inside, store in a standard flammable liquids cabinet. Containers should have flame-arrester or pressure/vacuum venting. To prevent static sparks, electrically ground and bond all equipment used with ethylbenzene. Install Class I, Group D electric equipment. Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain levels as low as possible. Purge and ventilate reaction vessels before workers are allowed to enter for maintenance or cleaning. Administrative Controls: Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, skin, blood, and respiratory system.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Ethylbenzene
DOT Hazard Class: 3
ID No.: UN1175
DOT Packing Group: II
DOT Label: Flammable liquid
Special Provisions (172.102): T1

MSDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 153, 159, 162, 163, 164, 167, 168, 171, 176, 179

Prepared by: M Gannon, BA; Industrial Hygiene Review: D Wilson, CIH; Medical Review: W Silverman, MD

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**Section 1 - Chemical Product and Company Identification**

**Product/Chemical Name:** Methanol  
**Chemical Formula:** CH₃OH or CH₂O  
**CAS Number:** 67-56-1  
**Synonyms:** carbinol; Coat-B140; Colonial Spirits; Columbian Spirit; EPA pesticide chemical code 053801; methyl alcohol; methyl hydrate; methyl hydroxide; monohydroxymethane; pyrolignous spirit; pyroxylic spirit; pyroxylic spirits; Surflo-B17; wood alcohol; wood naphtha; wood spirit  
**Derivation:** Prepared by wood pyrolysis; non-catalytic oxidation of hydrocarbons; as a by-product in the fisher-tropsch synthesis; or by reduction of carbon monoxide.  
**General Use:** Used as an industrial solvent; starting material for organic synthesis; antifreeze for windshield washer fluid; in fuel antifreeze; gasoline octane booster; fuel for stoves; extractant for oils; denaturing ethanol; softening agent; food additive; in paint, varnish removers, and embalming fluids; in manufacture of photographic film, celluloid, textile soap, wood stains, coated fabrics, shatterproof glass, paper coating, waterproofing formulations, artificial leather, dyes.  
**Vendors:** Consult the latest Chemical Week Buyers’ Guide. (73)

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**Section 2 - Composition / Information on Ingredients**

Methanol, ca 100% vol  
Trace Impurities (Grade A): Acetone and aldehydes < 30 ppm, acetic acid < 30 ppm  

<table>
<thead>
<tr>
<th>OSHA PELs</th>
<th>NIOSH REL</th>
<th>DFG (Germany) MAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>8- hr TWA: 200 ppm (260 mg/m³)</td>
<td>10- hr TWA: 200 ppm (260 mg/m³), Skin</td>
<td>TWA: 200 ppm (260 mg/m³), Skin</td>
</tr>
<tr>
<td>Vacated 1989 Final Rule Limits:</td>
<td>STEL: 250 ppm (325 mg/m³)</td>
<td>Category II, 1: Substances with systemic effects:</td>
</tr>
<tr>
<td>TWA: 200 ppm (260 mg/m³)</td>
<td>IDLH Level</td>
<td>onset of effect ≤ 2 hr, half life &lt; 2 hr</td>
</tr>
<tr>
<td>STEL: 250 ppm (325 mg/m³)</td>
<td>6000 ppm</td>
<td>Embryo/Fetus Risk of Damage Classification C†</td>
</tr>
</tbody>
</table>

ACGIH TLVs*  
TWA: 200 ppm (262 mg/m³), Skin  
STEL: 250 ppm (328 mg/m³)  
*There are also ACGIH Biological Exposure Indices (BEIs™).  
†There is no reason to fear risk of damage to developing embryo or fetus when MAK or BAT values are observed.

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**Section 3 - Hazards Identification**

**ANSI Signal Word:** Warning!  

<table>
<thead>
<tr>
<th>Wilson Risk Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>R 1</td>
</tr>
<tr>
<td>I 3</td>
</tr>
<tr>
<td>S 2*</td>
</tr>
<tr>
<td>K 3</td>
</tr>
<tr>
<td>*Skin absorption</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HMIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>H 2*</td>
</tr>
<tr>
<td>F 3</td>
</tr>
<tr>
<td>R 0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PPE†</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Chronic effects</td>
</tr>
<tr>
<td>+Sec. 8</td>
</tr>
</tbody>
</table>

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**Emergency Overview**

Methanol is a colorless liquid with a slight alcohol odor when pure, or disagreeably pungent odor when crude. It is irritating to the eyes, skin, and respiratory tract. Exposure may result in headache, visual disturbance, blindness, and respiratory failure. Reproductive effects have been reported in animal testing. This flammable liquid is a moderate explosion hazard. When heated to decomposition, methanol emits carbon oxides (COₓ).

Formaldehyde, acrid smoke, and irritating fumes.

---

**Potential Health Effects**

**Primary Entry Routes:** Inhalation, ingestion, skin and/or eye contact/absorption  
**Target Organs:** Eyes, skin, central nervous system (CNS), gastrointestinal (GI) tract, respiratory system  
**Acute Effects**

**Inhalation:** Irritation, breathing difficulty, headache, drowsiness, vertigo, light-headedness, nausea, vomiting, acidosis (decreased blood alkalinity), visual disturbance, and at high concentrations, CNS damage, convulsions, circulatory collapse, respiratory failure, coma and blindness can result from inhalation of methanol vapor. Concentration ≥ 200 ppm may cause headache; 50,000 ppm can cause death within 1-2 hrs.  
**Eye:** Contact with liquid may result in irritation, inflamed lids, light sensitization, and superficial lesions.  
**Skin:** Contact may cause irritation, dermatitis, swelling, scaling, and systemic effects listed under inhalation.  

**Ingestion:** GI irritation and systemic effects (see Inhalation). Symptoms may be delayed 18-48 hours. Fatal dose: 2-8 ounces.

**Carcinogenicity:** IARC, NTP, and OSHA do not list methanol as a carcinogen. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Chronic Effects:** Exposure to methanol vapors has caused conjunctivitis, headache, giddiness, insomnia, GI disturbance, impaired vision. CNS damage is also likely. Methanol is slowly eliminated from the body; exposure is considered cumulative over the short term.
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 develops. Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. 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. After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Follow emesis with rehydration, correction of acidosis, and folate to enhance formate oxidation. Consider IV administration of ethanol (if blood methanol >20 mg/dL) to show metabolic oxidation of methanol. Assay formic acid in urine, blood pH and plasma bicarbonate.

Section 5 - Fire-Fighting Measures

Flash Point: 54 °F (12 °C) Flash Point Method: CC Burning Rate: 1.7 mm/min NFPA
Autoignition Temperature: 867 °F (464 °C) LEL: 6.0% v/v UEL: 36% v/v
Flammability Classification: OSHA Class IB Flammable Liquid.
Extinguishing Media: Use dry chemical, carbon dioxide, water spray, fog or alcohol-resistant foam. A water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources.

Unusual Fire or Explosion Hazards: Can form explosive mixtures in the air. The heavier-than-air vapors of methanol may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Containers may explode in heat of fire. Hazardous Combustion Products: Heating methanol to decomposition can produce carbon oxides (CO₂), formaldehyde, acrid smoke, and irritating fumes. Fire-Fighting Instructions: Do not scatter material with any more water than needed to extinguish fire. 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: Isolate spill area for at least 330-660 feet (100-200 m) in all directions. Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Ground all equipment used when handling this product. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A vapor suppressing foam may be used to reduce vapors. Small Spills: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Use clean non-sparking tools to collect absorbed material. Large Spills, Containment: Dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways. Cleanup: Ground all equipment. Use non-sparking tools. Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations to non-hazardous levels (see Sec. 2). Wear protective gloves, goggles, and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers. Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors. Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.106) for Class 1B Flammable Liquids.

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. 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. Administrative Controls: Enclose operations and/or provide local explosion-proof exhaust ventilation at the site of chemical release. Where possible, transfer methanol from drums or other storage containers to process containers. Minimize sources of ignition in surrounding areas. 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 concentrations ≤ 2000 ppm, use a supplied air respirator. ≤ 5000 ppm, supplied air (SA) respirator in continuous flow mode; ≤ 6000 ppm, SA respirator with tight-fitting face mask operated in continuous flow mode, or SCBA with full facepiece, or SA respirator with full facepiece; > IDLH/unknown/emergency, SCBA with full facepiece operated in pressure-demand or other positive-pressure mode, or SA respirator with full facepiece operated in pressure-demand...
or other positive-pressure mode in combination with auxiliary SCBA operated in pressure-demand or other positive-pressure mode. For escape, use an appropriate escape-type 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 of butyl rubber, Teflon™, Viton™, Saranex™, 4H™, Responder™, Trelchex HPS™, or Tychem 10000™ (Breakthrough Time (BT) >8 hr) to prevent skin contact. Natural rubber, neoprene, nitrile rubber, polyethylene, polyvinyl alcohol and CPF 3™ may degrade after contact and are not recommended. Wear splash-proof chemical safety goggles, and face shield, 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, washing facilities available in work area. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. 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 - Physical and Chemical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical State:</strong></td>
<td>Liquid</td>
</tr>
<tr>
<td><strong>Appearance and Odor:</strong></td>
<td>Colorless; slight alcohol odor when pure, disagreeably pungent odor when crude</td>
</tr>
<tr>
<td><strong>Odor Threshold Range:</strong></td>
<td>13.1150 to 26840 mg/m³</td>
</tr>
<tr>
<td><strong>Vapor Pressure:</strong></td>
<td>127 mm Hg at 77 °F (25 °C)</td>
</tr>
<tr>
<td><strong>Vapor Density (Air=1.0):</strong></td>
<td>1.11</td>
</tr>
<tr>
<td><strong>Saturated Vapor Density:</strong></td>
<td>1.221 kg/m³</td>
</tr>
<tr>
<td><strong>Formula Weight:</strong></td>
<td>32.04</td>
</tr>
<tr>
<td><strong>Density:</strong></td>
<td>0.796 g/mL at 59 °F (15 °C)</td>
</tr>
<tr>
<td><strong>Specific Gravity:</strong></td>
<td>0.81 at 0 °C/°C</td>
</tr>
<tr>
<td><strong>Bulk Density:</strong></td>
<td>6.59 lbs/gal at 68 °F (20 °C)</td>
</tr>
<tr>
<td><strong>pH:</strong></td>
<td>Slightly acidic</td>
</tr>
<tr>
<td><strong>Water Solubility:</strong></td>
<td>Miscible</td>
</tr>
<tr>
<td><strong>Other Solubilities:</strong></td>
<td>Ethanol, acetone, benzene, chloroform, DMSO, ether, ketones, most organic solvents.</td>
</tr>
<tr>
<td><strong>Boiling Point:</strong></td>
<td>148 °F (64.7 °C) at 760 mm Hg</td>
</tr>
<tr>
<td><strong>Freezing Point:</strong></td>
<td>-144.04 °F (-97.8 °C)</td>
</tr>
<tr>
<td><strong>Viscosity:</strong></td>
<td>0.614 mPa sec</td>
</tr>
<tr>
<td><strong>Refractive Index:</strong></td>
<td>1.3292 at 68 °F (20 °C)/D</td>
</tr>
<tr>
<td><strong>Surface Tension:</strong></td>
<td>22.61 dynes/cm</td>
</tr>
<tr>
<td><strong>Ionization Potential (eV):</strong></td>
<td>10.84</td>
</tr>
<tr>
<td><strong>Henry’s Law Constant (H):</strong></td>
<td>4.55 x 10⁻⁶ atm-m³/mole at 77 °F (25 °C)</td>
</tr>
<tr>
<td><strong>Octanol/Water Partition Coefficient:</strong></td>
<td>log K&lt;sub&gt;ow&lt;/sub&gt; = -0.77</td>
</tr>
<tr>
<td><strong>Soil Sorption Coefficient (log K&lt;sub&gt;ow&lt;/sub&gt;):</strong></td>
<td>0.44</td>
</tr>
</tbody>
</table>

### Section 10 - Stability and Reactivity

**Stability:** Methanol is stable at room temperature in closed containers under normal storage and handling conditions. **Polymerization:** Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include beryllium dihydride, metals (potassium, magnesium), oxidants (barium perchlorate, bromine, chlorine, hydrogen peroxide, sodium hypochlorite, phosphorus trioxide), potassium tertbutoxide, carbon tetrachloride and metals, chloroform and heat, diethyl zinc, alkyl aluminum salts, acetyl bromide, chloroform and sodium hydroxide, cyanuric chloride, nitric acid, chronic anhydride, lead perchlorate. **Conditions to Avoid:** Vapor inhalation, oxidizers. **Hazardous Decomposition Products:** Thermal oxidative decomposition of methanol can produce carbon oxides (CO<sub>2</sub>), formaldehyde, acrid smoke, and irritating fumes.

### Section 11 - Toxicological Information

**Toxicity Data:**

**Reproductive Effects:**
- Rat (female), oral: 7500 mg/kg, administered during gestational days 17-19 produced effects on newborn - behavioral.
- Rat (female), oral: 35295 mg/kg administered during gestational days 1-15 produced effects on the fertility index; preimplantation mortality; and post-implantation mortality.
- Rat (female), inhalation: 20000 ppm/7 hr, administered during gestational days 1-22 produced specific developmental abnormalities - musculoskeletal system; cardiovascular (circulatory) system; urogenital system.
- Rat (male), oral: 200 ppm/20 hr, 78 weeks prior to mating produced paternal effects - testes, epididymis, sperm duct.

**Multiple Dose Toxicity Data:**
- Rat, oral: 12 g/kg/8 weeks intermittently produced toxic effects: behavioral - ataxia; behavioral - alteration of operant conditioning.
- Rat, inhalation: 50 mg/m³/12 hr/13 weeks intermittently produced degenerative changes to brain and coverings; muscle contraction or spasticity.
- Rat, inhalation: 2610 ppm/6 hr/4 weeks intermittently produced toxic effects: endocrine - changes in spleen weight.

**Eye Effects:**
- Rabbit, standard Draize test: 100 mg/24 hr resulted in moderate irritation.
Section 11 - Toxicological Information, continued

**Toxicity Data:**

**Acute Dermal Effects:**
- Monkey, skin, LD<sub>50</sub>: 393 mg/kg
- Rabbit, skin, LD<sub>50</sub>: 15800 mg/kg

**Acute Inhalation Effects:**
- Human, inhalation, TL<sub>50</sub>: 300 ppm produced visual field changes, headache; lungs, thorax, or respiration - other changes.
- Rat, inhalation, LC<sub>50</sub>: 64000 ppm/4 hr

**Mutagenicity:**
- Human, lymphocyte: 300 mmol/L resulted in DNA inhibition.
- Rat, oral: 10 μmol/kg resulted in DNA damage.

* See NIOSH, RTECS (PC1400000), for additional toxicity data.

Section 12 - Ecological Information

**Ecotoxicity:** Trout, LC<sub>50</sub>: 8,000 mg/L/48 hr; *Pimephales promelas* (fathead minnow) LC<sub>50</sub>: 29.4 g/L/96 hr.

**Environmental Fate:** Bioconcentration (BCF, estimated at 0.2) is not expected to be significant. Physical removal from air can occur via rainfall. Related rapid evaporation from dry surfaces is likely to occur.

**Environmental Degradation:** If released to the atmosphere, it degrades via reaction with photochemically produced hydroxyl radicals with an approximate half-life of 17.8 days. If released to water or soil, biodegradation is expected to occur.

**Soil Adsorption/Mobility:** A low K<sub>oc</sub> indicates little sorption and high mobility in the soil column.

Section 13 - Disposal Considerations

**Disposal:** 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:** Methanol
- **Shipping Symbols:** D
- **Hazard Class:** 3
- **ID No.:** UN1230
- **Packing Group:** II
- **Label:** FLAMMABLE LIQUID
- **Special Provisions (172.102):** T*

**Packaging Authorizations**
- a) Exceptions: 173.150
- b) Non-bulk Packaging: 173.202
- c) Bulk Packaging: 173.242

**Quantity Limitations**
- a) Passenger, Aircraft, or Railcar: 1 L
- b) Cargo Aircraft Only: 60 L

**Vessel Stowage Requirements**
- a) Vessel Stowage: B
- b) Other: 40

Section 15 - Regulatory Information

**EPA Regulations:**
- Listed and Classified as a RCRA Hazardous Waste (40 CFR 261.33): Characteristic of Ignitability
- RCRA Hazardous Waste Number: U154
- Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per (3) CAA, Sec. 112; (4) RCRA, Sec. 3001
- CERCLA Final Reportable Quantity (RQ), 5000 lb (2268 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:** 1, 73, 99, 103, 124, 136, 149, 176, 190, 209, 216, 217, 218, 222, 223, 224, 227, 228, 230

**Prepared By:** HM Spiehoff, MS

**Industrial Hygiene Review:** PA Roy, MPH, CIH

**Medical Review:** T Thoburn, MD, MPH

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Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Naphthalene
Chemical Formula: C10H8
CAS Number: 91-20-3
Synonyms: Albocarbon; camphor tar; Dezodorator; Mighty 150; moth balls; moth flakes; naftalen (Polish); naphthalin; naphthylene; naphthalinum; napthene; NTM; tar camphor; white tar
Derivation: From coal tar; from petroleum fractions after various catalytic processing operations.
General Use: Used as a moth repellent, an antiseptic, toilet bowl deodorant, heat transfer agent, fungicide, smokeless powder, cutting fluid, lubricant, wood preservative; an intermediate for naphthol, phthalic anhydride, chlorinated naphthalenes, Tertralin, Decalin, naphthyl and naphthol derivatives, and dyes; in synthetic resins, synthetic tanning, textile chemicals, scintillation counters, and emulsion breakers.
Vendors: Consult the latest Chemical Week Buyers’ Guide. (73)

Section 2 - Composition / Information on Ingredients

Naphthalene, ca 100% wt. Grade: By melting point, 165 °F (74 °C) min (crude) to greater than 174 °F (79 °C) (refined); scintillation 176-177 °F (80-81 °C)

OSHA PELs
8-hr TWA: 10 ppm (50 mg/m³);
Vacated 1989 Final Rule Limit:
15-min. STEL: 15 ppm
(79 mg/m³)

ACGIH TLVs
TWA: 10 ppm (52 mg/m³)
STEL: 15 ppm (79 mg/m³)

NIOSH RELs
10-hr TWA: 10 ppm
(50 mg/m³);
15-min. STEL: 15 ppm
(75 mg/m³)

IDLH Level
500 ppm

DFG (Germany) MAK
10 ppm (50 mg/m³)

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆
Naphthalene is a white crystalline solid with a ‘moth ball’ or coal-tar odor. It is toxic by ingestion. Irritating to skin, eyes, and respiratory system. Naphthalene is a combustible solid. Dust may form explosive mixtures in air if subjected to an ignition source.

Potential Health Effects

Primary Entry Routes: Inhalation, skin absorption, skin and/or eye contact
Target Organs: Blood (red blood cell effects), eyes, skin, central nervous system (CNS), liver and kidneys

Acute Effects

Inhalation: Vapor inhalation causes headache, confusion, nausea, sometimes vomiting, loss of appetite, extensive sweating, dysuria (painful urination), hematuria (blood in the urine), and hemolysis (destruction of red blood cells).

Eyes: Irritation, conjunctivitis, and corneal injury upon prolonged contact.

Skin: Irritation and hypersensitivity dermatitis.

Ingestion: Unlike. However, ingestion causes irritation of the mouth and stomach, hemolytic anemia with hepatic and renal lesions and vesical congestion, kidney failure, hematuria, jaundice, depression of CNS, nausea, vomiting, abdominal pain, blue face, lips, or hands, rapid and difficult breathing, headache, confusion, excitement, malaise, fever, perspiration, urinary tract pain, dizziness, convulsions, coma, and death. Symptoms may appear 2 to 4 hours after exposure.

Carcinogenicity: IARC, NTP, and OSHA do not list naphthalene as a carcinogen. EPA-D, Not Classifiable as to Human Carcinogenicity; MAK-B, Justifiably suspected of having carcinogenic potential; TLV-A4, Not Classifiable as a Human Carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: Diseases of the blood, liver and kidneys; individuals with a hereditary deficiency of the enzyme glucose-6-phosphate dehydrogenase in red blood cells are particularly susceptible to the hemolytic properties of naphthalene metabolites.

Chronic Effects: May cause optical neuritis, corneal injuries, cataracts, kidney damage.

Other: There are two reports of naphthalene crossing the placenta in humans.
Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed. Contact a physician immediately if symptoms of systemic poisoning are present.

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 min. Consult a physician or ophthalmologist if pain, irritation, swelling, or photophobia persist.

Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area thoroughly with soap and water. For reddened or blistered skin, consult a physician. Contact a physician immediately if symptoms of systemic poisoning are present.

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. Contact a physician immediately.

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

Note to Physicians: Obtain baseline CBC, electrolytes, liver and renal function tests, glucose-6-phosphatase dehydrogenase level, urinalysis, and benzidine dipstick to check for hemoglobinuria. Urinary metabolite, 1-naphthol or mercapturic acid, may help confirm the diagnosis.

Section 5 - Fire-Fighting Measures

Flash Point: 174 °F (79 °C); 190 °F (88 °C)
Flash Point Method: OC; CC
Burning Rate: Data not found.
Autoignition Temperature: 979 °F (526 °C)
LEL: 0.9% v/v
UEL: 5.9% v/v
Flammability Classification: Combustible solid
Extinquishing Media: Use dry chemical, foam, carbon dioxide (CO₂), or water spray. Water or foam may cause frothing. Use water spray to keep fire-exposed containers cool.
Unusual Fire or Explosion Hazards: Volatile solid that gives off flammable vapors when heated. Dust may explode in air if an ignition source is provided.

Hazardous Combustion Products: Toxic vapors including carbon monoxide.

Fire-Fighting Instructions: Move containers from the fire area if it can be done without risk. Otherwise cool fire-exposed containers until well after the 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. Wear full protective clothing (see Sec. 8). Structural clothing is permeable, remain clear of smoke, water fall out, and water run off.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources. Isolate and ventilate area, deny entry, stay upwind. Stop leak if you can do it without risk. Use spark-proof tools and explosion proof equipment. Cleanup personnel should wear personal protective equipment to protect against exposure (see Sec. 8).

Small Spills: Do not sweep! Carefully scoop up or vacuum (with a HEPA filter). Absorb liquid spill with an inert, noncombustible absorbent such as sand or vermiculite.

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: To avoid vapor inhalation use only with ventilation sufficient to reduce airborne concentrations to nonhazardous levels. Avoid skin and eye contact. Wear personal protective clothing and equipment to prevent any contact with skin and eyes (see Sec. 8). Practice good personal hygiene procedures to prevent inadvertently ingesting this material.

Storage Requirements: Store in tightly closed, explosion-proof containers in a cool, well-ventilated area away from heat, ignition sources, and incompatibles (see Sec. 10). May be stored under nitrogen gas. Protect containers against physical damage. Use monitoring equipment to measure the extent of vapor present in any storage facility containing naphthalene because of potential fire and explosion hazards.
Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose operations to avoid vapor and dust dispersion into the work area. Ventilate at the site of chemical release. During the fractional distillation of naphthalene and in any operation entailing the heating or volatilization of naphthalene, enclosed apparatus should be employed.

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.

Administrative Controls: Educate workers about the health and safety hazards associated with naphthalene. Train in work practices which minimize exposure. Consider preplacement and periodic medical exams with emphasis on the eyes, skin, liver, kidneys, CBC (RBC count, WBC count, differential count of a stained smear, hemoglobin, and hematocrit), and urinalysis including at a minimum specific gravity, albumin, glucose, and a microscopic examination on centrifuged sediment.

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 skin contact. Teflon® is recommended. Do not use butyl rubber, natural rubber, neoprene or polyvinyl chloride. Wear chemical dust-proof safety goggles and face shield, 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 naphthalene 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 - Physical and Chemical Properties

Physical State: Crystalline solid
Appearance and Odor: White, volatile flakes, cakes, cubes, spheres, or powder; strong coal-tar or moth ball odor
Odor Threshold: 0.084 ppm to 0.3 ppm
Vapor Pressure: 0.05 mm Hg at 68 °F (20 °C); 1.0 mm Hg at 127 °F (53 °C)
Formula Weight: 128.2
Density: 1.145 g/cm³ at 68 °F (20 °C)
Saturated Vapor Concentration: 100 ppm at 77 °F (25 °C)

Water Solubility: Insoluble [31.7 mg/L at 68 °F (20 °C)]
Other Solubilities: Benzene, absolute alcohol; very soluble in ether, chloroform, carbon disulfide, hydronaphthalenes, fixed and volatile oils
Boiling Point: 424 °F (218 °C)
Melting Point: 176 °F (80.2 °C)
Volatility: Volatilizes appreciably at room temperature; volatile with steam
Octanol/Water Partition Coefficient: log Kow = 3.30

Section 10 - Stability and Reactivity

Stability: Naphthalene is stable at room temperature in closed containers under normal storage and handling conditions. It volatilizes at room temperature.
Polymerization: Hazardous polymerization cannot occur.
Chemical Incompatibilities: Include aluminum chloride, benzoyl chloride, chronic acid, chromium trioxide, oxidizers.
Explosive reaction with dinitrogen pentoxide. Melted naphthalene will attack some forms of plastics.
Conditions to Avoid: Exposure to heat and ignition sources, incompatibles.
Hazardous Decomposition Products: Thermal oxidative decomposition of naphthalene can produce toxic fumes including carbon monoxide.

Section 11 - Toxicological Information

Toxicity Data:

Acute Effects:
Human (child), oral, LD₅₀: 100 mg/kg
Man, unreported, LD₅₀: 74 mg/kg
Rat, oral, LD₅₀: 490 mg/kg

Reproductive Effects:
Rat, oral: 4500 mg/kg administered on gestational days 6-15 produced fetotoxicity and other developmental abnormalities.
Section 12 - Ecological Information


Environmental Fate: If released to the atmosphere, naphthalene rapidly photodegrades with a half-life of 3-8 hr. Volatilization, photolysis, adsorption, and biodegradation are important loss mechanisms for naphthalene discharged into water. Depending on local conditions, the half-lives range from a couple of days to a few months. If released on land, it is adsorbed moderately to soil, undergoes biodegradation; but in some cases biodegradation may still occur if conditions are aerobic. Bioconcentration occurs to a moderate extent, but is a temporary problem since depuration and metabolism readily proceed in aquatic organisms.

Section 13 - Disposal Considerations

Disposal: Consider rotary kiln or fluidized bed incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Handle empty containers carefully as hazardous residues may still remain.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Naphthalene, crude or Naphthalene, refined
Shipping Symbols: Not listed
Hazard Class: 4.1
ID No.: UN1334
Packing Group: III
Label: FLAMMABLE SOLID
Special Provisions (172.102): A1

Packaging Authorizations
a) Exceptions: 173.151
b) Non-bulk Packaging: 173.213
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 25 kg
b) Cargo Aircraft Only: 100 kg

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: Not listed

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33). Hazardous Waste Number: U165
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307(a); CAA, Sec. 112
CERCLA Final 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, 99, 103, 124, 139, 140, 167, 168, 179, 190, 196, 197, 200, 220

Prepared By: S Fleming, BS/MJ Wurth, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: G Kelafant, MD

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

Material Safety Data Sheets Collection:
Sheet No. 355
Phenol

Issued: 9/80
Revision: C, 11/90

Section 1. Material Identification

Phenol (C₆H₅·OH) Description: One of many aromatic compounds in coal tar. Made by alkylation benzene with propylene then oxidizing the resulting cumene to produce phenol and acetone. Used as a feedstock in manufacturing various phenol formaldehyde, bisphenol-A, and other chemicals and drugs; a disinfectant; a fuel-oil sludge inhibitor; a reagent in chemical analysis; in producing or manufacturing a large variety of aromatic compounds including fertilizers, illuminating gas, coke, explosives, lampblack, paints, paint removers, asbestos goods, wood preservatives, textiles, perfumes, bakelite, rubber, and other plastics; in medical and industrial organic compounds and dyes; and in germicidal paints and slimicides. Phenol has been identified in cigarette smoke and automobile exhaust.

Other Designations: CAS No. 108-95-2, carboxylic acid, hydroxybenzoic, monohydroxy benzene, oxybenzene, phenic acid, phenolic alcohol, phenyl hydroxide.

Manufacturer: Contact your supplier or distributor. Consult the latest Chemical Week Buyers’ Guide(1) for a suppliers list.

Cautions: Phenol has a marked corrosive effect on any tissue. Eye contact may cause severe damage and blindness. Its primary entry route is through skin absorption. Systemic absorption may cause liver and kidney damage, convulsions (seizures), or death.

Section 2. Ingredients and Occupational Exposure Limits

Phenol, ca 100%

1989 OSHA PEL (Skin): 8-hr TWA: 5 ppm, 19 mg/m³
1990-91 ACGIH TLV (Skin): TWA: 5 ppm, 19 mg/m³
1988 NIOSH REL: TWA: 5 ppm, 19 mg/m³
1987 TLV Level: 5 ppm, 60 mg/m³

* See NIOSH, RTCS (ST325000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 135.15 °F (181.75 °C) at 760 mm Hg
Melting Point: 105.4 °F (43 °C)
Vapor Pressure: 0.3513 mm Hg at 77 °F (25 °C)
Appearance and Odor: White crystalline solid with a characteristic sharp medicinal sweet, tangy odor detectable above 0.05 ppm. Phenol turns pink or red if it contains impurities or is exposed to heat or light.

Section 4. Fire and Explosion Data

Extinguishing Media: Use water spray, carbon dioxide, dry chemical, or alcohol-type foam to extinguish fires involving phenol. Do not use a solid stream of water since the stream scatters and spreads fire. Use water spray to cool fire-exposed tanks/containers.

Unusual Fire or Explosion Hazards: Phenol presents a moderate fire hazard when exposed to heat, flame, or oxidizers. When heated, it emits toxic fumes and vapors that form explosive mixtures with air. Air mixtures containing 3 to 10% phenol are explosive. Solid phenol burns with difficulty, giving off heavy smoke.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. Be aware of runoff from fire control methods. Water containing phenol can cause severe chemical burns. Do not release to sewers or waterways.

Section 5. Reactivity Data

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

Chemical Incompatibilities: In general, phenol is incompatible with strong oxidizing agents and halogen. It coagulates colloid and proteins. A potentially explosive reaction occurs with formaldehyde, peroxysulfuric acid, peroxymonosulfuric acid, sodium nitrite + heat, and aluminum chloride + nitromethane (at 110°C/100 bar). A violent reaction occurs with butadiene, sodium nitrite + trifluoroacetic acid, and aluminum chloride + nitrobenzene at 248 °F (120 °C). Combining phenol with mineral oxidizing acids results in fire; with acetaldehyde results in violent condensation; with isocyanates results in heat generation and violent polymerization, with calcium hypochlorite results in an exothermic reaction producing toxic fumes which may ignite; and with nitriles results in heat and flammable gas generation. Hot phenol is corrosive to many metals, including aluminum, lead, magnesium, and zinc. Reaction with these materials causes phenol to discolor.

Conditions to Avoid: Avoid heating phenol above 122 °F (50 °C).

Hazardous Products of Decomposition: Thermal oxidative decomposition of phenol can produce oxides of carbon and water.

Section 6. Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list phenol as a carcinogen. Although no specific evidence of human cancer exists, this carcinogeneity in mice emphasizes the need for precaution when handling this material. Phenol also causes human mutations (genetic changes).

Summary of Risks: Phenol is a general protoplasmic poison that is corrosive to any living tissue it contacts. Toxicity most likely results from dermal (skin) contact or ingestion. Skin absorption occurs readily with a rapid onset of symptoms or death (within 30 min to several hours). Contact with eyes may cause severe damage and blindness. Ingestion of 1 g may be fatal. Although phenol is irritating to the respiratory tract, due to its low volatility and good warning properties, inhalation is typically less of a concern. Chronic toxic effects are uncommon, but may include digestive disturbances, neurological disorders, skin rash (dermatitis), and liver and kidney damage.

Medical Conditions Aggravated by Long-Term Exposure: Individuals with chronic respiratory disorders, pre-existing skin disorders, convulsions, diabetes, or kidney or liver abnormalities may be at increased risk of phenol exposure.

Target Organs: Liver, kidneys, nervous system, and skin.

Primary Entry Routes: Skin contact, eye contact, ingestion, and inhalation.

Acute Effects: Skin contact results in white, wrinkled discoloration, followed by a severe burn or systemic poisoning if removed improperly.

Continue on next page
Section 6. Health Hazard Data, continued

Phenol ingestion can cause gangrene and corrosion of lips, mouth, throat, esophagus, and stomach if not properly decontaminated (see First Aid). Although not immediately painful, skin contact can cause serious burns and systemic toxicity. In addition to skin burns and respiratory tract irritation, systemic absorption may cause pallor, anorexia (appetite loss), nausea, vomiting, diarrhea, weakness, muscle aches, darkened urine, headache, fainting, dizziness, darkened urine, and mental disturbance. Chronic exposure can cause death from liver and kidney damage. Ingestion can cause severe tissue corrosion or gangrene affecting lips, mouth, throat, esophagus, and stomach. Eye contact can cause severe corrosive damage to the eye (conjunctival edema, corneal opacification, and hypopyon) and possible blindness.

Chronic Effects: Chronic phenol poisoning is rarely reported. Symptoms include vomiting, difficulty swallowing, diarrhea, appetite loss, headache, fainting, dizziness, darkened urine, and mental disturbance. Chronic exposure can cause death from liver and kidney damage. Repeated skin contact with phenol or phenol-bearing products can result in dermatitis with dark pigmentation (ochronosis) of skin and whites of eyes (sclera).

FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flowing amounts of water for at least 15 min. Consult a physician immediately.
Skin: Speedy action is critical. Flood exposed area with water and quickly remove contaminated clothing. As soon as possible, repeatedly spray or swab with the decontaminating agent polyethyleneglycol-300 (PEG). Immense extremities in PEG. Rescue personnel should protect themselves from skin contact with phenol. Do not use grease, powders, or ointments to treat phenol burns. Never delay phenol removal if PEG is not readily available. Use soap and water instead.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Speed is essential in the treatment of oral poisoning. Immediately consult a physician and poison center. Never give anything by mouth to an unconscious or convulsing person. Administer to that conscious person 15 to 30 cc castor oil or another vegetable oil, and be prepared to induce vomiting upon a physician's advice. Vegetable oils slow phenol absorption and reduce local damage. After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: If phenol ingestion is known to be 40% or greater Bacto-Peptone, milk, or water until phenolic odor is eliminated. Then give 15 to 30 cc castor or vegetable oil. Debride necrotic skin. Monitor vital signs, fluid status, electrolytes, BUN, renal and hepatic function, and electrocardiogram. Manage sedation, seizures, renal failure, and fluid electrolyte imbalances symptomatically as indicated.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and skin and eye contact with a self-contained breathing apparatus and full personal protective clothing and equipment. Absorb small spills with some uncontaminated inert material and place in a closed metal container for disposal. Discharge large spills and allow material to cool and solidify. Using nonsparking tools, shovel solid into steel containers for disposal. Thoroughly flush spill area with water, use caustic soda solution for neutralization, and collect flashings and sludge and wash water for disposal. Do not allow phenol to enter sewers, waste, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120). Notify proper authorities including the National Response Center (800-424-8802).
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)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4), Sec. 307(a), and per RCRA, Sec. 3001]
Listed as a SARA Extremely Hazardous Substance (40 CFR 335): RQ, 1000 lb; Threshold Planning Quantity (TPQ), 500/10,000 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-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 an N95, N100, or P100 or higher respirator. If exposure exceeds a Permissible Exposure Limit of 19 mg/m³, use a MSHA/NIOSH-approved full facepiece respirator with an organic vapor cartridge/canister and dust/mist prefilter. Increased protection is obtained from full facepiece powered-air purifying respirators. For emergency or nonroutine operations (cleaning spills, reactor vessel, or storage tanks), wear a 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. ACGIH recommends neoprene or butyl rubber as good-to-excellent protective materials.
Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source. Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a cool, dry, well-ventilated area away from heated surfaces, open flame, and ignition sources. Outside or detached storage is preferred. Protect containers from physical damage.
Engineering Controls: Enclose all operations, eliminating all possible phenol exposure routes. Educate workers about phenol's hazards and potential dangers. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Provide local exhaust ventilation at the site of chemical release. Practice good personal hygiene and local containment procedures.
Medical Examinations: Provide preplacement or periodic medical examinations that emphasize central nervous system (CNS), hepatic, renal, and skin tests. Tests should include BUN, creatinine, LFTs, and urinalysis. Phenol can be detected in urine in free or conjugated forms. The ACGIH biological exposure index (BEI) is 250 mg total phenol/g creatinine or 15 mg/hr.

Transportation Data (49 CFR 172.101, 102)
DOT Shipping Name: Phenol
DOT Hazard Class: Poison B
ID No.: UN 1671
DOT Label: Poison
DOT Packing Exceptions: 173.364
DOT Packaging Requirements: 173.369

MSDS Collection References: 1, 2-12, 15, 19, 23, 24, 26, 31, 34, 37, 38, 59, 73, 79, 84, 85, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138-140, 143, 146, 148, 149
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MU Upfal, MD, MPH; Edited by: JR Stuart, MS

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

Material Safety Data Sheets Collection:
Sheet No. 351
Styrene monomer
Issued: 8/79
Revision: D, 6/92

Section 1. Material Identification

Styrene monomer (C₆H₅CH=CH₂) Description: Produced by catalytic dehydrogenation of ethylbenzene at 932 to 1292°F (500 to 700 °C) at 30 mm Hg; catalyst is a mixture of zinc oxide (86%), aluminum, calcium, and magnesium. Available in technical (99.2% pure) and polymer (99.6% pure) grades. Occurs naturally in the sap of styraxaceous plants, in pyrolysis and cracking products of petroleum derivatives, in bluenose-coal and shale-oil tars, in rubber latexes, and as a product of organic substance pyrolysis. Used in the manufacture of a wide range of polymers including polystyrene and copolymer elastomers such as butadiene-styrene rubber or acrylonitrile-butadiene-styrene (ABS); in production of plastics and insulations, as a resin-modifying additive, dental filling component, chemical reaction intermediate, and in agricultural products.

Other Designations: CAS No. 100-42-5, cinnamene, Diarex HP 77, ethylbenzene, NCI-C02200, phenylethylene, styrol, styrorop, vinylbenzene.

Manufacturer: Contact your supplier or distributor. Consult latest Chemical Week Buyers’ Guide™ for a supplier's list.

Cautions: Styrene is extremely flammable and polymerizes easily. The vapor is irritating to eyes, skin, and respiratory system and may cause burns. Inhalation of high concentrations can lead to central nervous system (CNS) depression. Rating is for inhibited monomer.

Section 2. Ingredients and Occupational Exposure Limits

Styrene monomer, ca 99.6%, containing inhibitors butylcelatoce or hydroquinone

1991 OSHA PELs
8-hr TWA: 50 ppm (215 mg/m³)
15-min STEL: 100 ppm (425 mg/m³)

1991-92 ACGIH TLVs (Skin)
TWA: 50 ppm (213 mg/m³)
STEL: 100 ppm (426 mg/m³)

1990 IDLH Level
5000 ppm

1990 NIOSH RELs
TWA: 50 ppm (215 mg/m³)
STEL: 100 ppm (425 mg/m³)

1985-86 Toxicity Data

Human, inhalation, Tₐ 0: 20 μg/m³ caused eye effects.
Human, skin: 500 mg (non-standard test, accidental) caused irritation.
Human, HeLa cell: 28 mmol/L caused unscheduled DNA synthesis.
Rat, oral, LD₅₀: 5000 mg/kg; toxic effects not yet reviewed
Rat, inhalation, LC₅₀: 24 g/m³/4 hr produced an antipyschotic effect.

* See NIOSH, RTCS (WL367500), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 293 °F (145 °C)
Freezing Point: -23 °F (-31 °C)
Vapor Pressure: 5 mm Hg at 68 °F (20 °C)
Viscosity: 0.751 mPa
Refraction Index: 1.5463 at 68 °F (20 °C)
Odor Threshold Range: 0.15 to 25 ppm
Density: 0.9045 at 25/25 °C

Appearance and Odor: Colorless to slightly yellow oily liquid with a sweet, pleasant odor at low levels becoming pungent as levels increase.

Section 4. Fire and Explosion Data

Flash Point: 88 °F (51 °C), CC
Autoignition Temperature: 914 °F (490 °C)
LEL: 1.1% v/v
UEL: 7% v/v

Extinguishing Media: A Class 1C flammable liquid. For small fires, use dry chemical, carbon dioxide (CO₂), or regular foam. For large fires, use fog, or regular foam. Water may be ineffective since styrene tends to float on water; use only when other agents are unavailable.

Unusual Fire or Explosion Hazards: Styrene may accumulate static electricity. Hazardous polymerization can occur causing container to rupture due to heat of fire. Vapors may travel to ignition sources and flash back. Styrene poses a vapor explosion hazard indoors, especially in sewers or confined spaces.

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. Include structural firefighters’ protective clothing provides only limited protection. Use protective clothing specifically recommended for CSBA. Apply cooling water to container sides until well after fire is out. If possible without risk, remove container from fire area. Stay away from ends of tanks. For massive fire in cargo area use monitor nozzles or unmanned hose holders; if this is impossible, withdraw from area and let fire burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymorization: Uninitiated styrene monomer is very unstable and even when initiated (butylcelatoce or hydroquinone) polymerization occurs slowly at room temperature and fastest at elevated temperatures or in contact with certain initiators. Chemical Incompatibilities: Styrene vapor is explosive when exposed to heat or flame; reacts with oxygen above 104 °F (40 °C) to form a heat-sensitive explosive peroxide. Violent polymerization may be initiated by alkali metal-graphite compositions, butyllithium, dibenzoyl peroxide, azoisobutyronitrile or di-tert-butyl peroxide. Styrene reacts violently with chlorosulfonic acid, oleum, sulfuric acid, chlorine + iron (II) chloride (above 50 °C) and can react vigorously with oxidizing materials. Conditions to Avoid: Exposure to heat and ignition sources, light, and contact with incompatible materials.

Hazardous Decomposition Products: Thermal oxidative decomposition of styrene can produce carbon dioxide, acid smoke and irritating fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC[141] lists styrene monomer as a carcinogen: Class 2B (possibly carcinogenic, limited human evidence in the absence of sufficient animal data). Summary of Risks: Styrene is irritating to the eyes, skin, and respiratory system. It is absorbed through the skin at 9 to 15 mg/m³/h (0.001% and forens). Inhalation of high concentrations can cause CNS depression but styrene's pungent, irritating odor is usually enough to prevent acute toxic exposures. If heavy exposure occurs, styrene can saturate the body in 30-40 minutes, is distributed throughout the organs and is rapidly eliminated (~85% in 24 hr) either in urine (71%) or expired air (10%). Unexposed styrene accumulates in adipose tissue (subcutaneous connective tissue containing fat cells). Ovulation and menstrual disorders were observed in women exposed to styrene. In one case, CNS effects were observed in infants whose mother was exposed to chemicals such as styrene during pregnancy. In general, pregnant women may be at elevated risk because styrene crosses the placental barrier. Target Organs: CNS, eyes, respiratory system, and skin. Primary Entry Routes: Inhalation, skin contact/absorption. Medical Conditions Aggravated by Long-term Exposure: Possibly, liver, kidney, blood, skin, and CNS disorders.

Acute Effects: Inhalation of concentrations as low as 50 ppm causes irritation of the eyes, and respiratory tract.
Section 6. Health Hazard Data, continued

Symptoms include watering of eyes and nose, chest heaviness or pain, difficulty breathing, coughing, bluish face and lips, wheezing, headache, nausea, vomiting, dizziness, fatigue, diarrhea and risk of pulmonary edema (fluid in lungs). Skin contact is irritating, with itching, inflammation and possible blisters. Splashes to the eyes cause irritation, watering, lid inflammation, chemical corned burns, and possibly, serious lesions. Cases of ingestion have not been reported but by analogy to animal studies it could cause irritation of the lips, mouth, and throat and painful swallowing, abdominal pain, nausea, vomiting, diarrhea, shock, convulsions, and risk of pulmonary edema. Chronic Effects: Repeated exposure has caused "styrene sickness" described by nausea, vomiting, appetite loss, and general weakness. Occupational asthma may occur rarely. Functional disorders of the nervous system, irritation of the upper airways, and blood changes particularly leukopenia (abnormally low number of circulating, nucleated white or colorless blood cells) and lymphocytosis (increased number of lymphocytes which are involved in the immune system) have also been observed. Medical exams revealed toxic hepatitis in workers exposed to ~50 mg/m³ styrene for over 5 yr. Prolonged exposure to <50 mg/m³ caused certain liver function disorders (protein, pigment, glycogen). Peripherial neuropathies were observed in chronically exposed workers. Repeated or prolonged skin exposure may cause dermatitis in rough, dry, fissured skin due to degreasing. FIRST AID: Eyes: Gently lift eyelids and flush immediately and continually with flushing amounts of water until transported to an emergency medical facility. Do not allow victim to rub or keep eyes tightly shut. Immediately consult a physician. Skin: Quickly remove contaminated clothing. Rinse with flushing amounts of water for at least 15 min. 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 and unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water to dilute. Do not induce vomiting. Gastric lavage may be indicated if victim is at risk of convulsing but the decision should be carefully weighed since severe esophageal irritation may occur. Note to Physicians: For acute exposure, give baseline liver and kidney function tests and liver function tests. CBC, urine and urinalysis. Monitor arterial blood gases and perform chest X-ray if significant respiratory irritation occurs. Phenylglyoxylic and mandelic acid may be determined in urine.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should protect against inhalation and eye and skin contact. Shut off all ignition sources. Use water spray to cool and disperse vapors (this may not prevent ignition in closed spaces). For small spill, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers. For large spills, drive far ahead of liquid spill for later disposal or reclamation. For spills in water, apply activated carbon at 10 X the spilled amount (at least 10,000 ppm) or use barriers or oil booms to limit movement. "Universal" gelling agent injected into spill may aid in solidification. Remove material from suction boxes or mechanical dredges. Follow applicable OSHA regulations (29 CFR 1910.120). Report spills in emergency and release. Ecotoxicity Values: TLm: Empedocles nemoralis (frohead minnow), 33.6 mg/L (48 hr); TLm: Artemia salina (brine shrimp), 68 mg/L (24 hr) and 52 mg/L (48 hr). Environmental Degradation: In water, styrene monomer volatilizes rapidly and may be subjected to biodegradation. It is not expected to hydrolyze. In air, styrene will react rapidly with hydroxyl radicals and ozone with a combined calculated half-life of 2.5 to 9 hr. In soil, styrene will biodegrade and leach to groundwater with low to moderate mobility (depending on soil conditions). 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 & 261.23): D001 and D003. Characteristic of ignitability and reactivity Listed as a CERCLA Hazardous Substance. (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, 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 & Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH/MSHA-approved respirator. For < 5000 ppm, use any SAR with a full facepiece in 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, and cleaning, sanitary storage areas. Other: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polyvinyl alcohol is recommended as suitable material for FG. 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. (See) Safety Statement: 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. Thoroughly decontaminate PPC. Comments: Never eat, drink, or smoke in work area. 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. Styrene is corrosive to copper or copper alloy containers. Store in cool (hazardous above 32 °C), dry, well-ventilated area away from incompatible materials (Sec. 5). Store small refrigerated amounts in glass containers and large amounts in ventilated metal boxes or detached storage under inert blanket (i.e., nitrogen). Install electrical equipment Class 1, Group D. Inhibit styrene during storage to prevent polymerization. Uninhibited vapor may polymerize in vents and cause blockage. To prevent static sparks, electrically ground and bond all equipment used in styrene manufacture, use, storage, transfer, and shipping. 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. Continuously monitor workplace air levels of styrene. Make sure ducting, piping, and pipe joints are leak tight. Give prestart maintenance, periodic reviews and periodic medical exams of exposed workers that emphasize the CNS, blood, liver, kidney, and skin. Consider precluding pregnant women from styrene exposure.

Transportation Data (49 CFR 172.101, 102)

DOT Shipping Name: Styrene monomer, inhibited
DOT Hazard Class: Flammable liquid
ID No.: UN2055
DOT Label: Flammable liquid
DOT Packaging Exclusions: 173.118
DOT Packaging Exceptions: 173.119

MSDS Collection References: 73, 89, 100, 101, 103, 124, 125, 127, 130, 131, 132, 133, 136, 139, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168
Prepared by: M. Egan, BA; Industrial Hygiene Review: DJ Wilson, CICH; Medical Review: AC Darlington, MPH, MD

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Genium Publishing Corporation  
One Genium Plaza  
Schenectady, NY 12304-4690 USA  
(518) 377-8854  

Material Safety Data Sheets Collection:  
Sheet No. 318  
Xylene (Mixed Isomers)  

Section 1. Material Identification

Xylene (Mixed Isomers) (C₈H₁₀) Description: The commercial product is a blend of the three isomers (ortho-α, meta-α, and para-α) with the largest proportion being m-xylene. Xylene is obtained from coal tar, toluene by transalkylation, and pseudocumene. Used in the manufacture of dyes, resins, paints, varnishes, and other organics, as a general solvent for adhesives, a cleaning agent in microscopy, as a fuel component in aviation gasoline, protective coatings, sterilizing agents, and perfumes, insect repellents, pharmaceutials, and the leather industry; in the production of phthalic anhydride, isophthalic and terephthalic acids, and their dimethyl esters, which are used in the manufacture of polyester fibers, and as an indirect food additive as a component of adhesives. Around the home, xylene is found as vehicles in paints, paint removers, degreasing cleaners, lacquers, glues and cements and as solvent/vehicles for pesticides.


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

Cautions: Xylene is an eye, skin, and mucous membrane irritant and may be narcotic in high concentrations. It is a dangerous fire hazard.

Section 2. Ingredients and Occupational Exposure Limits

Xylene (mixed isomers): the commercial product generally contains ~ 40% m-xylene, 20% each of α-xylene, p-xylene, and ethylbenzene; and small quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs  
8-hr TWA: 100 ppm (435 mg/m³)  
15-min STEL: 150 ppm (655 mg/m³)

1990 IDLH Level  
1000 ppm

1990 NIOSH RELs  
TWA: 100 ppm (435 mg/m³)  
STEL: 150 ppm (655 mg/m³)

1992-93 ACGIH TLVs  
TWA: 100 ppm (434 mg/m³)  
STEL: 150 ppm (651 mg/m³)

1985-86 Toxicity Data*  
Human, inhalation: TGL = 200 ppm produced olfactory effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.  
Man, inhalation, LGL = 1000 ppm/h; toxic effects not yet reviewed.

Rat, oral, LD₅₀: 50 mg/kg; no toxic effect noted.  
Rat, inhalation, LC₅₀ = 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH, RTECS (Z21000000), for additional toxicity data.

Section 3. Physical Data

Boiling Point Range: 279 to 284 °F (137 to 140 °C)*  
Boiling Point: ortho: 291 °F (144 °C), meta: 281.8 °F (138.8 °C); para: 281.3 °F (135.5 °C)

Freezing Point/Melting Point: ortho: -13 °F (-25 °C); meta: -53.3 °F (-47.4 °C); para: 55 to 57 °F (13 to 14 °C)

Vapor Pressure: 6.72 mm Hg at 70 °F (21 °C)

Vapor Density (Air = 1.2 kg/m³): 1.23 kg/m³, 0.077 lbs/ft³

Appearance and Odor: Clear, sweet-smelling liquid.

* Materials with wider and narrower boiling ranges are commercially available.

Section 4. Fire and Explosion Data

Flash Point: 63 to 77 °F (17 to 25 °C) CC  
Autoignition Temperature: 982 °F (527 °C) CC  
LEL: 1.1 (m-p-); 0.9 (α)  
UEL: 7.0 (m-p-), 6.7 (α)

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO₂), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective on acute fires; cool fire-exposed containers. Unusual Fire or Explosion Hazards: Xylene vapors or liquid (which is flammable) may travel to an ignition source and flash back. The heat of fire may cause containers to explode and/or produce irritating or poisonous decomposition products. Xylene may produce a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may cause xylene to vaporize from liquid to vapor flow sufficient to cause ignition. 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 will provide limited protection. If feasible and without risk, move containers from fire area. Otherwise, cool fire-exposed containers until well after fire is extinguished. Stay clear of tank ends. Use unmanned hose holder or monitor nozzles for massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Xylene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Xylene is easily chlorinated, sulfonated, or nitrated. Chemical Incompatibilities: Incompatibilities include strong acids and oxidizers and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidinedione (dichlorhydrin). Xylene attacks some forms of plastics, rubber, and coatings. Conditions to Avoid: Avoid heat and ignition sources and incompatibles. Hazardous Products of Decomposition: Thermal oxidative decomposition of xylene can produce carbon dioxide, carbon monoxide, and various hydrocarbon products.

Section 6. Health Hazard Data

Carcinogenicity: The IARC (110) NTP (119), and OSHA (109) do not list xylene as a carcinogen. Summary of Risks: Xylene is an eye, mucous membrane, and respiratory tract irritant. Irritation starts at 200 ppm; severe breathing difficulties which may be delayed in onset can occur at high concentrations. It is a central nervous system (CNS) depressant and at high concentrations can cause coma. The kidney and liver damage can occur with xylene exposure. With prolonged or repeated cutaneous exposure, xylene produces a defatting dermatitis. Chronic toxicity is not well defined, but it is less toxic than benzene. Prior to the 1950s, benzene was often found as a contaminant of xylene and the effects attributed to xylene such as blood dyscrasias are questionable. Since the late 1950s, xylene has been virtually benzene-free and blood dyscrasias have not been associated with xylene exposure. Chronic exposure to high concentrations of xylene in animal studies has demonstrated mild reversible decrease in red and white cell counts as well as increases in platelet counts.

Continue on next page
No. 318 Xylene (Mixed Isomers) 9/92

Section 6. Health Hazard Data, continued

Maternal irregularity was reported in association with workplace exposure to xylene perhaps due to effects on liver metabolism. Xylene crosses the human placenta, but does not appear to be teratogenic under conditions tested to date. Medical Conditions Aggravated by Long-Term Exposure: CNS, respiratory, eye, skin, gastrointestinal (GI), liver and kidney disorders. Target Organs: CNS, eyes, GI tract, liver, kidneys, and skin.

Primary Entry Routes: Inhalation, ingestion. Ingestion is the chief route of entry and is the predominant cause of acute toxicity. Acute Effects: Inhalation of high xylene concentrations may cause central nervous system depression, respiratory depression, vomiting, and abdominal pain; eye, nose, and throat irritation; respiratory tract irritation leading to pulmonary edema (fluid in lungs); drowsiness; and unconsciousness. Direct eye contact can result in conjunctivitis and corneal burns. Ingestion may cause a burning sensation in the oropharynx and stomach and transient CNS depression. Chronic Effects: Repeated or prolonged skin contact may cause drying and defatting of the skin leading to dermatitis. Repeated eye contact with high vapor concentrations may cause reversible eye damage, peripheral and central neuropathy, and liver damage. Other symptoms of chronic exposure include headache, fatigue, irritability, chronic bronchitis, and GI disturbances such as nausea, loss of appetite, and gas.

First Aid Measures: Eye Contact: Immediately flush eyes with large amounts of water. First Aid Treatment: Skin Contact: Wash with soap and water. Use of tissues to wipe off exposed skin is not recommended. Ingestion: Do not induce vomiting. Followed person’s head below the hips to prevent aspiration (breathing liquid xylene into the lungs). Aspiration of a few milliliters of xylene can cause chemical pneumonitis, pulmonary edema, and hemorrhage. Note to Physicians: If a patient is vomiting, they should be placed in a supine position and aspiration precautions taken. Most cases of xylene poisoning are self-limited and uncomplicated. One report described a 34-year-old woman who ingested 300 mL (6 cups) of xylene. She developed moderate respiratory distress, emesis, and hyperventilation but was otherwise asymptomatic. The patient required no hospitalization and had a complete recovery. Extreme precautions should be taken to protect the physician or other emergency personnel who must care for an xylene-poisoned patient. The physician’s or other emergency personnel’s head should be below the hips to prevent aspiration (breathing liquid xylene into the lungs).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and ventilate spill area. Clean-up personnel should protect against vapor inhalation and skin or eye contact. If feasible and without undue risk, stop leak. Use appropriate foam to blanket release and suppress vapors. Water spray may reduce vapor, but does not prevent ignition in closed spaces. For small spills, absorb on paper and evaporate in appropriate exhaust hood or absorb with sand or some non-combustible absorbent and place in containers for later disposal. For large spills dike far ahead of liquid release. Do not allow xylene to enter a confined space such as sewers or drains. On land, dikes should be constructed to contain spills and vacuum or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material at a safe distance with pumps or vacuum equipment. On water, contain material with natural barriers, booms, or weirs; apply universal cleaning agent; and use suction hoses to remove spilled material. Report any occurrence of this material to the nearest appropriate OSHA regulations (29 CFR 1910.120). Environmental Transport: Little biocconcentration is expected. Biological oxygen demand 5 (after 5 days at 20°C): 0.64 (not stated isomer). Ecotoxicity values: LD₅₀ Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer. Environmental Degradation: In the atmosphere, xylene degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1.17 hr. in the summer to 10-18 hr. in winter or a typical loss of 0.76-86% per day. Xylenes are resistant to hydrolysis. Soil Absorption/Mobility: Xylenes have low to moderate adsorption to soil and when spilled on land, will volatilize and leach into ground water. Disposal: As a hydrocarbon, xylene is a good candidate for controlled incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, State, and local regulations.

EPA Designations
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)
Listed as an Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a Toxic Chemical (40 CFR 372.65)
Listed as a Hazardous Waste (40 CFR 261.33): No. U239, F003 (spent solvent)
Listed as a Contaminated Hazardous Substance (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4); per RCRA, Sec. 3001]

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 >1000 ppm, use any chemical cartridge respirator with organic vapor cartridges. For high-powered, air-purifying respirator with organic vapor cartridges; any supplied-air respirator, or any self-contained breathing apparatus. For emergencies 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 chemically protective gloves, boots, aprons, and gauntlets to prevent all skin contact. With breakthrough times >8 hr, consider polyvinyl alcohol and fluorocarbon rubber (Viton) as materials for PPE. Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents containment dispersion into the work area by controlling it at its source.100 Safety Stations: Make available in the works 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 PPE. Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene by 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 labeled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources. Do not store toxic chemicals, or operating, electrically ground and bond metal containers. Engineering Controls: To reduce potential toxic exposure, use sufficient air dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Use hermetically sealed equipment. Transfer xylene in enclosed systems, avoid processes associated with open evacuating surfaces, and provide sources of gas release with enclosures and local exhaust ventilation. Use Class I Group D electrical equipment. Administrative Controls: Establish air and biological monitoring programs and evaluate regularly. Consider preplacement and periodic medical examinations including a complete blood count, a routine urinalysis, and liver function tests. Consider hematologic studies if there is any significant contamination of the solvent with benzene. If feasible, consider the replacement of xylene by less toxic solvents such as petrol (motor fuel) or white spirit. Before carrying out maintenance and repair work, steam and flush all equipment to remove any xylene residues.

DOT Shipping Name: Xylene
DOT Hazard Class: 3
ID No.: UN1307
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Previsions (172.102); T1

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Xylene
Packaging Authorizations
a) Exceptions: 173.150
b) Nonbulk Packaging: 173.202
b) Bulk Packaging: 173.242

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


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Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

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}Cl_{x}, (x=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 hydrocarbon 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 biphenyl (12), triphenyl (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 wax, paper, insecticides, fuel, insecticides, 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.

Other Designations: CAS No. 1336-36-3, Aroclor, Clophen, Chlorobenzol, chlorinated diphenyl, chlorinated dibenz-p-dioxin, chlorinated diphenylene, chloro-biphenyl, chloro-1,1-biphenyl, Dyxanol, Fenoclor, Ineret, Kaneclos, Montar, Noflamol, Phenoclor, Pyralene, Pyraclor, Santoserm, Sopi, Thermolin 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 carcinogenic. 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 dibenzo-p-dioxins and chlorinated naphthalenes as contaminants.

1991 OSHA PELs, Skin
8-hr TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m³
8-hr TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m³
1990 DFG (Germany) MAK, Danger of Cutaneous Absorption
TWA (Chlorodiphenyl, 42% chlorine): 0.1 ppm (1 mg/m³)
Category III: Substances with systemic effects, onset of effect > 2 h., 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/m³)
Category III: (see above)
Short-term Level: 0.5 ppm, 30 min., average value, 1 per shift

1985-86 Toxicity Data*
Rat, oral, TD: 1520 mg/kg administered intermittently for 25 weeks produced liver tumors.
Mammal, oral, TD: 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/m³
TWA (Chlorodiphenyl, 54% chlorine): 0.001 mg/m³
1992-93 ACGIH TLVs, Skin
TWA (Chlorodiphenyl, 42% chlorine): 1 mg/m³
TWA (Chlorodiphenyl, 54% chlorine): 0.5 mg/m³

* These guidelines offer reasonably good protection against systemic intoxication, but may not guarantee that chloroform won't occur.
† See NIOSH, RTECS (TQ1555000), for additional reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data*

Boiling Point: 644-707 °F (340-375 °C)
Melting Points: 42%-47 °C (109-117 °F); 14 °F (-10 °C)
Vapor Pressure: 1 mm Hg at 100 °F (38 °C); 10-6 to 10-5 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) O*C
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 (CO₂), 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 dibenzo-p-dioxins, 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 firefights protective clothing will provide limited protection. Do not release runoff from fire control methods to sewers or waterways. Bake 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 photochlorination 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 dibeno-p-dioxins (PCDDs), polychlorinated dibenzo-p-dioxins (PCDFs), hydrogen chloride, phosgene and other irritants.

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Section 6. Health Hazard Data

Carcinogenicity: The IARC (1990) and NTP (1989) 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, with longer exposure times causing toxic effects, but can accumulate in fatty tissues and severe health effects may develop later. Generally, toxicity increases with 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 pigmentation, 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, Skin. Inhalation: 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, neurobehavioral and psychomotor impairment and memory loss have also been seen after acute exposure. Chronic Effects: Repeated exposure to PCBs can cause chloracne; 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, ataxia, tremor, and muscle irritability; changes in 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. Rinse 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 enough amounts of water until transported to an emergency medical facility. Consult a physician immediately. Skin: Quickly remove contaminated clothing. Rinse with flowing 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, chloracne, 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: Bacteria, TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16; TLM: -2.278, 0.087; MAC: -0.67; DCM: -0.269; T: 0.16; MTC: 0.16; DCM: -0.269; T: 0.16; MTC: 0.16;

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 NIOSH-approved respirator. Select respirator based on its suitability for vapor and adequate worker protection for given 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 short term 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. 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 process. Remove this material from your shoes and on PPE. Comments: Never eat, drink, or smoke in work area. 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)

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<thead>
<tr>
<th>DOT Shipping Name: Polychlorinated biphenyls</th>
<th>Packaging Authorizations</th>
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</thead>
<tbody>
<tr>
<td>DOT Hazard Class: 9</td>
<td>a) Exceptions: 173.155</td>
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<tr>
<td>UN No.: UN3215</td>
<td>b) Non-bulk Package:</td>
</tr>
<tr>
<td>DOT Packing Group: II</td>
<td>c) Bulk Packaging: 173.241</td>
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<td>DOT Label: CLASS 9</td>
<td>Vessel Stowage Requirements</td>
</tr>
<tr>
<td>Special Provisions (172.102): 9, N81</td>
<td>a) Vessel Stowage: A</td>
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<td>MSMDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 164, 168, 169, 174, 175, 180</td>
<td></td>
</tr>
</tbody>
</table>

Prepared by: MJ Wurd, BS; Industrial Hygiene Review: PA Roy MPH, CH; Medical Review: AC Darlington, MD

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Section 1 - Chemical Product and Company Identification

Product/Chemical Name: 2, 3, 7, 8-Tetrachlorodibenzop-dioxin (TCDD)
Chemical Formula: C_{12}H_{4}Cl_{4}O_{2}
CAS No.: 1746-01-6
Synonyms: dioxin; dioxine; NCI-C03714; tetrachlorodibenzodioxin; 2, 3, 7, 8-tetrachlorodibenz(h, e)(1, 4)dioxin; 2, 3, 7, 8-tetrachlorodibenzo-1, 4-dioxin; TCDD; TCDD: 2, 3, 7, 8-TCDD: tetrachlorodibenzo-p-dioxin
Derivation: TCDD is not manufactured, but is formed as a by-product of chlorobenzenes, chlorophenols, and the herbicides 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T) and 2,2'- (4, 5-trichlorophenoxy)propionic acid (Silvex) which are produced from 2, 4, 5-trichlorophenol (TCP). 2, 4, 5-T, commonly known as Agent Orange, was the defoliant used during the Vietnam War. TCP, 2, 4, 5-T and Silvex are no longer commercially produced in the U.S. As a chemical and toxicological standard, TCDD can be prepared by catalytic condensation of potassium 2, 4, 5-trichlorophenate. TCDD has been released to the environment during the incineration of chemical wastes including chlorinated benzenes, chlorophenols, and biphenyl ethers, from the improper disposal of certain chlorinated chemical wastes, in emissions from wood burning in the presence of chlorine, in accidental fires involving transformers containing PCBs, and from the use of the herbicides 2, 4, 5-T and Silvex.
General Use: TCDD is an extremely toxic, unwanted by-product and essentially has no beneficial uses. It may be used as a research chemical. Vendors: Consult the latest Chemical Week Buyers' Guide. (75)

Section 2 - Composition / Information on Ingredients

2, 3, 7, 8-Tetrachlorodibenzop-dioxin, ca 100 %wt. TCDD normally persists as a contaminant in TCP in variable amounts (0.07-6.2 mg/kg). Consequently, the concentrations of TCDD in different batches of Agent Orange varied greatly with an average concentration of about 2 ppm.

OSHA PEL*  
None established

NIOSH REL  
Carcinogen, lowest feasible concentration.

ACGIH TLV  
None established

* A preliminary occupational exposure limit of 0.2 mg/m^3 (200 pg/m^3) is recommended. It provides an ample margin of safety to prevent chloracne and takes into consideration the chronic effects of animal studies and accidental human exposure. [Leung HW et al; American Industrial Hygiene Association Journal, 49 (9): 466-74 (1988)]

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆
TCDD is a colorless, crystalline solid at room temperature. It is highly toxic and a potential human carcinogen. Exposure to TCDD-contaminated materials may cause a severe and disabling acne-like rash that may persist for years (chloracne), metabolic disorders, and nervous system and liver damage. In animals, TCDD causes teratogenesis, tumorigenesis, and immunological dysfunction. Findings in humans are inconclusive, but human toxicology is under continuing investigation. Workers may be exposed to TCDD from residues prior production or use of 2, 4, 5-T or Silvex, waste materials contaminated by TCDD, or contamination resulting from transformer fires. Take every precaution to avoid any exposure to TCDD.

Potential Health Effects

Primary Entry Routes: Inhalation (dust),* skin contact, ingestion.
Target Organs: Skin, liver, and nervous system.

Acute Effects
Inhalation: Shortness of breath, headaches, fatigue, severe muscle pains, weakness, and digestive disturbance. Most symptoms develop slowly, over many days.
Eye: Conjunctivitis and chemical burns.
Skin: Chemical burns. In most cases, chloracne appears within 2 to 4 weeks after initial exposure. It consists of blackheads with small, pale-yellow cysts. In severe cases, there may be papules (red spots) or even pustules (pus-filled spots). This acne-like rash appears on the cheeks under the eyes and behind the ears in very mild cases. With increasing severity, the rest of the face and neck are affected and the outer upper arms, chest, back, abdomen, outer thighs and genitalia may be involved in varying degrees in the worst cases. In the worst cases, lesions may be active 15 or more years after the contact has ceased. Chloracne may also appear after ingestion or inhalation. Skin fragility, hirsutism (excessive growth of hair of normal or abnormal distribution), and photosensitivity may also occur.
Ingestion: Nausea, vomiting, and possible pancreatitis.

Wilson Risk Scale
R 4+ S 4+ K 1
*Skin absorption

HMIS
H 4+ F 1 R 0
+Chronic Effects
PPE +
+Sec. 8
Carcinogenicity: The IARC, NTP, MAK, and NIOSH list TCDD as an IARC-2B (possibly carcinogenic to humans: inadequate evidence of carcinogenicity in humans but there is sufficient evidence of carcinogenicity in experimental animals), an NTP-2 (reasonably anticipated to be a carcinogen: limited evidence from studies in humans or sufficient evidence from studies in experimental animals), an MAK-A2 (unmistakably carcinogenic in animal experimentation only), and a NIOSH-X (carcinogen defined with no further categorization). OSHA does not list TCDD as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: Skin, liver, nervous and endocrine system disorders.

Chronic Effects: Lack of energy, loss of sex drive, personality and mood changes, numbness, weakness and pain in the legs, liver damage, chloracne, and elevated blood lipids. TCDD increased the incidence of a variety of tumors in animals, but human data is inconclusive. Little is known of the human health effects (if any) as a result of long-term exposures to low concentrations.

Comments: The observed health effects from clinical or epidemiological studies of populations who were occupationally and non-occupationally exposed cannot be solely attributed to TCDD because of the concurrent exposure to 2, 4, 5-T and TCP and to other herbicides as well. There is no report of human exposure to TCDD alone.

\* Vapor inhalation is unlikely because TCDD has a low vapor pressure.

**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 flowing amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: Quickly remove contaminated clothing. Flush with water to remove solid particles; follow with a soap and water wash of exposed areas. 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: For an acute exposure, obtain liver function tests, CBC, prothrombin time, serum lipids, and uroporphyrins. EMG may be useful in detecting subclinical neuropathy. Current analytical techniques to detect dioxins in human tissue specimens involve gas chromatography and mass spectrometry. Chloracne may respond to topical retinoic acid, and oral tetracyclines may help secondary postural follicles. Resistant cases may require dermabrasion or acne surgery. Isotretinoin may be tried.

Special Precautions/Procedures: Emergency personnel should protect against contamination.

**Section 5 - Fire-Fighting Measures**

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 extinguisher.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: Toxic fumes of chlorine.

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 of spill, evacuate all unnecessary personnel, remove heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against skin and eye contact and dust inhalation.

Small Spills: Carefully collect and place in sealed containers 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: Avoid generating dust. Do not sweep. Provide an organized procedure of containment, collection, and disposal of contaminated solutions and residues generated during cleanup. Provide separate facilities for decontamination of large equipment. Conduct repetitive wash/rinse cycles separately, either by using different locations or by spacing in time.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120). For specific recommendations, contact your Department of Environmental Protection or your regional EPA office.

**Section 7 - Handling and Storage**

Handling Precautions: Handle with extreme caution. Take all the necessary precautions to avoid any exposure.

Storage Requirements: Store in tightly closed and properly labeled containers in a cool, well-ventilated area.

**Section 8 - Exposure Controls / Personal Protection**

Engineering Controls: Isolate work areas involving TCDD or TCDD-contaminated materials.
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 workplace and periodic medical examinations with emphasis on the skin, liver, nervous and endocrine systems. Regularly monitor glassware, bench tops, instruments, and tools with wipe tests (wipe with filter paper and measure amount of TCDD). 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 situations where TCDD contamination is low (e.g., exposure to dust contaminated with low levels of TCDD), wear an air-purifying respirator until the extent and characterization of the exposure can be determined. For materials highly contaminated with TCDD, wear respirators that consist of self-contained breathing apparatus with a full facepiece operated in a pressure-demand or other positive pressure mode. An alternate method utilizes a combination Type C supplied-air respirator, with full facepiece, operated in a pressure-demand mode and equipped with auxiliary positive pressure self-contained air supply. 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/Apparel: Consider disposable clothing due to the uncertainty of adequate decontamination. Wear protective clothing consisting of both outer (zippered coverall with attached hood and draw string or elastic sleeves, gloves and closure boots) and inner (cotton overalls, undershirts, undershorts, gloves, and socks) garments. For dust or particulate exposure, wear coveralls of a non-woven fabric such as Tyvek or spun bonded polyethylene. For exposure to liquids, wear coveralls, gloves, and boots made of chemically resistant materials such as Saranex coated Tyvek or butyl, nitrile, or neoprene rubber. 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: Shower and change clothes after potential exposures or at the end of the work day. Separate contaminated work clothes from street clothes. Launder before reuse. Place disposable clothing in marked and approved containers for disposal. Remove this material from your shoes and clean personal protective equipment. To prevent cross-contact, provide segregated decontamination locations with separate, controlled, and well-marked entry/exit routes and locations. 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 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: Colorless needles
Water Solubility: 19.3 ng/L
Other Solubilities: o-dichlorobenzene (1.4 g/L); chlorobenzene (0.72 g/L); benzene (0.57 g/L); chloroform (0.37 g/L); acetone (0.11 g/L); n-octanol (0.05 g/L); methanol (0.01 g/L); lard oil (0.04 g/L)
Vapor Pressure: 7.4 x 10^-15 mm Hg at 77 °F (25 °C)
Formula Weight: 322
Melting Point: 581-583 °F (305-306 °C)
Octanol/Water Partition Coefficient: log Kow = 7.02
Henry's Law Constant: 1.62 x 10^-5 atm m^3/mole at 25 °C (estimated)

Section 10 - Stability and Reactivity

Stability: TCDD is relatively stable toward heat, acids, and alkalis. It is changed chemically when exposed in isooctane or n-octanol to UV light. Polymerization: Hazardous polymerization cannot occur. Chemical Incompatibilities: None reported.
Conditions to Avoid: Avoid heat and ignition sources. Hazardous Decomposition Products: Thermal oxidative decomposition of TCDD can produce toxic fumes of chlorine. Decomposition begins at 932 °F (500 °C) and complete decomposition occurs within 21 sec at 1472 °F (800 °C).

Section 11- Toxicological Information

Toxicity Data:

Eye Effects:
Rabbit, eye: 2 mg caused moderate irritation.
Acute Effects:
Human, skin, TDLo: 107 µg/kg produced dermatitis and allergic reaction.
Mammal, oral, LD50: 4200 ng/kg produced changes of the liver, kidney, ureter, bladder, and spleen.
Rat, oral, LD50: 20 µg/kg
Reproductive Effects:
Monkey, oral, TDLo: 92 ng/kg (46 weeks prior to mating, on each day during gestation, and for 17 weeks following birth) caused effects on the newborn (behavioral; delayed effects).
Genetic Effects:
Human cell: 100 pmol/L caused unscheduled DNA synthesis.
Genetic Effects (continued):
Human cell: 10 nmol/L caused DNA inhibition.

Tumorigenic Effects:
Rat, oral: 52 μg/kg/2 yr (intermittent) caused liver and thyroid tumors.
Rat, oral: 27 μg/kg/65 weeks (continuous) caused liver and kidney tumors.

Multiple Dose:
Rat, oral: 6500 ng/kg/13 weeks (intermittent) caused changes in liver and thymus weight and pigmented or nucleated red blood cells.
Mouse, skin: 97 μg/kg/13 weeks (intermittent) caused diffuse hepatitis (hepatocellular necrosis); changes in spleen; and death.

* See NIOSH, RTECS (HP3500000), for additional toxicity data.

Section 12 - Ecological Information

Environmental Transport: Bioconcentration will occur in aquatic organisms. Due to TCDD's low solubility in water and lipids as well as its low partition coefficient in lipids, TCDD is not likely to accumulate in as many biological systems as DDT.

Environmental Degradation: When released to the atmosphere, gas-phase TCDD is degraded by reaction with hydroxyl radicals and direct photolysis (half-life = 8.3 days). Particulate-phase TCDD may be physically removed from air by wet and dry deposition. TCDD may be transported long distances through the atmosphere with surface water sediments being an ultimate environmental sink of airborne particulates. TCDD will absorb to sediments and limit the overall rate by which TCDD is removed from water. TCDD near the water's surface may experience significant photodegradation. 1.5 yr is the persistence half-life of TCDD in lakes. TCDD is generally resistant to biodegradation. Photodegradation on terrestrial surfaces may be an important transformation process. During warm conditions, volatilization from soil surfaces may be a major removal mechanism. Volatilization of TCDD from dry soil surfaces is likely to be faster than from wet soil surfaces. TCDD that has been mixed into soil depths beneath the upper surface boundary will volatilize extremely slowly. On soil surfaces, persistence half-life of TCDD on soil surfaces varies from less than 1 yr to 3 yr. Half-lives in soil interiors may be as long as 12 yr.

Soil Absorption/Mobility: TCDD is immobile in soil and is not expected to leach. Lateral movement due to surface erosion may occur.

Section 13 - Disposal Considerations

Disposal: 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, 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: —

* If it is in a quantity, in one package which equals or exceeds the RQ of 1 lb (0.454 kg).

Section 15 - Regulatory Information

Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA, Sec. 307(a)
CERCLA Reportable Quantity (RQ). 1 lb (0.454 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, 132, 136, 139, 148, 187, 189, 190, 193
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Section 1. Material Identification

Toluene (C₈H₈CH₃) Description: Derived from petroleum i.e., dehydrogenation of cyclopentane fractions followed by the aromatization of saturated aromatic hydrocarbons or by fractional distillation of coal-tar light oil and purified by rectification. Used widely as a solvent (replacing benzene in many cases) for oils, resins, adhesives, natural rubber, coal tar, asphalt, pitch, acetyi celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharin, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solvent for navigational instruments.

Other Designations: CAS No. 108-88-3, Methadice, methylbenzene, methylbenzol, phenylethylmethane, tolol, Tolu-sol.

Manufacturer: Contact your supplier or distributor. Consult latest Chemical Week Buyer's Guide(70) for a suppliers list.

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high concentrations. Liver and kidney damage has occurred. Pregnant women chronically exposed to toluene have shown teratogenic effects. Toluene is highly flammable.

Section 2. Ingredients and Occupational Exposure Limits

<table>
<thead>
<tr>
<th>Toluene</th>
<th>&lt; 100%; may contain a small amount of benzene (~1%), xylene, and non aromatric hydrocarbons.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 OSHA PeLS</td>
<td>8-hr TWA: 100 ppm (375 mg/m³)</td>
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<tr>
<td>15-min STEL: 150 ppm (560 mg/m³)</td>
<td>TWA: 50 ppm (188 mg/m³)</td>
</tr>
<tr>
<td>1990 IDLH Level</td>
<td>1990 DFG (Germany) MAK*</td>
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<tr>
<td>2000 ppm</td>
<td>TWA: 100 ppm (380 mg/m³)</td>
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<td>1990 NIOSH RELs</td>
<td>Half-life: 2 hr to end of shift</td>
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<tr>
<td>TWA: 100 ppm (375 mg/m³)</td>
<td>Category II: Substances with systemic effects</td>
</tr>
<tr>
<td>STEL: 150 ppm (560 mg/m³)</td>
<td>Peak Exposure Limit: 500 ppm, 30 min</td>
</tr>
<tr>
<td>Average Value</td>
<td>2/v/2</td>
</tr>
<tr>
<td>* Available information suggests damage to the developing fetus is probable.</td>
<td></td>
</tr>
<tr>
<td>†See NIOSH, RTECS (KSS250000), for additional irritation, mutation, reproductive, and toxic effects data.</td>
<td></td>
</tr>
</tbody>
</table>

Section 3. Physical Data

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Point</td>
<td>223 °F (106.6 °C)</td>
</tr>
<tr>
<td>Melting Point</td>
<td>-139 °F (-95 °C)</td>
</tr>
<tr>
<td>Molecular Weight</td>
<td>92.15</td>
</tr>
<tr>
<td>Density</td>
<td>0.866 at 68 °F (20/4 °C)</td>
</tr>
<tr>
<td>Surface Tension</td>
<td>25 dyn/cm at 68 °F (20 °C)</td>
</tr>
<tr>
<td>Viscosity</td>
<td>0.59 cP at 68 °F (20 °C)</td>
</tr>
<tr>
<td>Refraction Index</td>
<td>1.4967 at 20 °C/D</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Solubility</td>
<td>Very slightly soluble, 0.6 mg/L at 68 °F (20 °C)</td>
</tr>
<tr>
<td>Other Solubilities</td>
<td>Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.</td>
</tr>
<tr>
<td>Vapour Pressure</td>
<td>22 mm Hg at 68 °F (20/4 °C); 36.7 mm Hg at 86 °F (30 °C)</td>
</tr>
<tr>
<td>Saturated Vapor Density</td>
<td>(Air = 0.075 lb/m³ or 1.2 kg/m³) 0.0797 lb/m³ or 1.2755 kg/m³</td>
</tr>
<tr>
<td>Odor Threshold</td>
<td>Range of all referenced values; 0.021 to 69 ppm</td>
</tr>
</tbody>
</table>

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Points</td>
<td>40 °F (4.4 °C) CC</td>
</tr>
<tr>
<td>Autoignition Temperature</td>
<td>896 °F (480 °C)</td>
</tr>
<tr>
<td>LEL</td>
<td>1.27% v/v</td>
</tr>
<tr>
<td>UEL</td>
<td>7.0% v/v</td>
</tr>
</tbody>
</table>

| Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Water spray may be ineffective as toluene floats on water and may actually spread fire. Wool Fire or Explosion Hazards: Concentrated vapors are heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toulene's burning rate = 5.7 mm/minute and its flame speed = 37 cm/sec. Vapor poses an explosion hazard indoors, outdoors, and in sewers. May accumulate static electricity. 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 provides only limited protection. Apply cooling water to sides of tanks until well after fire is out. Stay away from ends of tanks. For massive fire in cargo areas, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and set bomb. Withdraw immediately if you have a rising smell from venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Do not release runoff from fire control means to sewers or waterways. |

Section 5. Reactivity Data

Stability/Polymerization: Toluene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can occur. Chemical Incompatibilities: Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetroxide, silver chloride, bromine trifluoride, tetranirotene, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolidinedione. Conditions to Avoid: Contact with heat, ignition sources, or incompatibles. Hazardous Products of Decomposition: Thermal oxidative decomposition of toluene can produce carbon dioxide, and acrid irritant smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC (146), NTP (149), and OSHA (150) do not list toluene as a carcinogen. Summary of Risks: Toluene is irritating to the eyes, nose, and respiratory tract. Inhalation of high concentrations produces a narcotic effect sometimes leading to coma as well as liver and kidney damage. 93% of inhaled toluene is retained in the body of which 80% is metabolized to benzoic acid, then to hippuric acid and excreted in urine. The remaining benzene is metabolized to o-toluic acid or excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is synergistic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 mg/cm²/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due to its lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leukopenia with biopsy showing bone marrow hyalypia. These reports are few and some authorities argue that the effects may have been due to benzene contaminants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction, attentional deficits, developmental delay and language impairment, growth retardation, and physical defects including a small midface, short palpebral fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that toluene causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on next page
## Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. Target Organ: CNS, liver, kidney, skin. Primary Entry Routes: Inhalation, skin contact/absorption. Acute Effects: Vapor inhalation causes respiratory tract irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, paralysis, and vertigo progressing to narcotic coma. Death may result from cardiac arrest due to ventricular fibrillation with catecholamines loss. Liquid splashed in the eye causes conjunctival irritation, transient corneal damage and possible burns. Prolonged skin contact leads to drying and fissured dermatitis. Ingestion causes GI tract irritation and symptoms associated with inhalation. Chronic Effects: Symptoms include mucous membrane irritation, headache, vertigo, nausea, appetite loss and alcohol intolerance. Repeated heavy exposure may result in encephalopathies (cerebral ataxia and cognitive dysfunction), liver enlargement, and kidney dysfunction (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend.

FIRST AID: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flowing amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. Skin: Quickly remove contaminated clothing. Rinse with flowing amounts of water for at least 15 min. Wash exposed area with soap and water. Inhalations: 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 and unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water to dilute. Do not induce vomiting because of danger of aspiration into the lungs. Gastric lavage may be indicated if large amounts are swallowed; potential toxicity needs to be weighed against aspiration risk when deciding for or against gastric lavage. Note to Physicians: Monitor cardiac function. If indicated, use epinephrine and other catecholamines carefully, because of the possibility of a lowered myocardial threshold to the arrhythmogenic effects of such substances. Obtain CBC, electrolytes, and urinalysis. Monitor arterial blood gases. If toluene has > 0.02% (200 ppm) benzene, evaluate for potential benzene toxicity. BEI: hippuric acid in urine, sample at shift end (2.5 g/l creatinine). Toluene in venous blood, sample at shift end (1.0 mg/L).

## Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry privilege. Cleanup personnel protect against inhalation and skin contact. Use water spray to cool and disperse vapors but may not prevent ignition in closed spaces. Cellosolve, hydac absorbent materials, and fluorocarbon water can also be used for vapor suppression/containment. Take up small spill with earth, sand, vermiculite, or other absorbent, noncombustible material. Dip far ahead of large spills for later reclamation or disposal. For water spills, (10 ppm or greater) apply activated carbon at 10X the spilled amount and remove trapped material with suction hoses or mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo thermal decomposition at about 1756 °F (958 °C, rotary kiln incineration at 1958 °F to 2912 °F (1069 to 1600 °C), or liquid injection incineration at 1202 to 2912 °F (650 to 1600 °C). Follow applicable OSHA regulations 29 CFR 1910.120. Ecotoxicity Values: Blue gill, LC50 = 17 mg/L/24 hr; shrimp (Crangon crangon), LC50 = 4.3 ppm/96 hr; fathead minnow (Pimephales promelas), LC50 = 36.2 mg/L/96 hr. Environmental Degradation: If released to land, toluene evaporates and undergoes microbial degradation. In water, toluene volatilizes and biodegrades with a half-life of days to several weeks. In air, toluene degrades by reaction with photodecomposition producing hydroxyl radicals. Disposal: Treat contaminated water by gravity separation of solids, followed by skimming of surface. Pass through dual media filtration and carbon absorption units (carbon ratio 1 kg to 10 kg soluble material). Return waste water from backwash to gravity separator. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

### EPA Designations
- SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
- Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)
- * per RCRA, Sec. 3001; CWA, Sec. 311(b)(4); CWA, Sec. 307(a)
- Listed as a SARA Toxic Chemical (40 CFR 372.65): Not listed

## Section 8. Special Protection Data

Goggles: Wear protective eyeglasses with shatter-resistant glass and side-shields 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. Respirators: 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 < 1000 ppm, use any chemical cartridge respirator with appropriate organic vapor cartridges, any supplied-air respirator (SAR), or SCBA. For < 2000 ppm, use any SAR operated in continuous-flow mode, any SAR or SCBA with a full facemask, or any air-purifying respirator with a full facemask having a chin-style, front or back mounted organic vapor canister. 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. Polyvinyl alcohol with a breakthrough time of > 8 hr, Teflon and Viton are recommended as suitable materials for PPE. Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source. 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 toluene 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: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles. Outside or detached storage is preferred. If stored inside, use a standard flammable liquid warehouse, room, or cabinet. To prevent static sparks, electrically ground and bond all equipment used with toluene. Do not use open lights in toluene areas. Install Class 1, Group D electrical equipment. Check that toluene is free of or contains < 1% benzene before use. Engineer controls: To reduce potential health hazards, use efficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Administrative controls: Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (hulls, wells, storage tanks). "Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, liver, kidney, and skin. Include hemocytometric and thrombocyte count in cases where benzene is a contaminant of toluene. Monitor air at regular intervals to ensure effective ventilation.

### Transportation Data (49 CFR 172.101)

<table>
<thead>
<tr>
<th>DOT Shipping Name: Toluene</th>
<th>Packaging Authorizations</th>
<th>Quantity Limitations</th>
<th>Vessel Stowage Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOT Hazard Class: 3</td>
<td>a) Exceptions: 150</td>
<td>a) Passenger Aircraft or Railcar: 5L</td>
<td>Vessel Stowage: B</td>
</tr>
<tr>
<td>No.: UN1294</td>
<td>b) Non-bulk Packaging: 202</td>
<td>b) Cargo Aircraft Only: 60L</td>
<td></td>
</tr>
<tr>
<td>DOT Packing Group: II</td>
<td>c) Bulk Packaging: 242</td>
<td>Other: --</td>
<td></td>
</tr>
<tr>
<td>DOT Label: Flammable Liquid</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


reprinted by: M Cannon, BA; Industrial Hygiene Review: PA Roy, CH, MPH; Medical Review: AC Darling, MD, MPH

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Section 1. Material Identification

Nitric Acid (HNO₃) 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). HNO₃ is usually found in conjunction with nitrogen dioxide, which is considered more dangerous. 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 reagent, in metallurgy (mainly as a pickling agent) and the printing industry.

Other Designations: CAS No. 7697-31-2, aqua foris, aqua regia, acetic 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 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 HNO₃.

Section 2. Ingredients and Occupational Exposure Limits

Nitric acid, various %. Commerically 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/m³)
15-min STEL: 4 ppm (10 mg/m³)
1990 IDLH Level
100 ppm (2 mg/m³)
1990 NIOSH REL
8-hr TWA: 2 ppm (5 mg/m³)
15-min STEL: 4 ppm (10 mg/m³)

* 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% HNO₃ = 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/m³): 1.212 kg/m³ or 0.0757 lb/ft³ (67 % HNO₃)
pH: 1

Appearance and Odor: Transparent, clear to yellow, fuming liquid with an acid, 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% HNO₃), use dry chemical, carbon dioxide (CO₂), water spray, or regular foam. For large fires, use water spray, fog, or regular foam. For small fires (40% > HNO₃), use water spray, dry chemical, or soda ash. For large fires, flood area with water (do not get inside HNO₃ containers). Apply water from as far as a distance as possible.

Unusual Fire or Explosion Hazards: HNO₃ 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. Applying 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 devices to sewers or waterways.

Section 5. Reactivity Data

Stability/Reactivity: 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, paper, fiber, and hydrogen sulfide, carbides, cyanides, and alkalis; causes spattering with strong bases; is corrosive to paper, cloth, and metal surfaces (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. HNO₃ reacts with water to produce heat and toxic corrosive fumes.

Hazardous Decomposition Products: Thermal oxidative decomposition of HNO₃ produces nitrogen peroxide and toxic, irritating nitrogen oxides.

Section 6. Health Hazards Data

Carcinogenicity: The IARC[116] NTP[119] 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. More than 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. HNO₃ 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.
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, muscle 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. HNO₃ liquid 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 irritation, 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 NOₓ such as produced by thermal decomposition of HNO₃ 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 flowing 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 large amounts of water for at least 15 min. Apply a 3% triethylamine 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-proof-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), TQP: 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)]

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 operated in an air-purifying respirator mode with a fall facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. Warning! Air-purifying respirators do not protect you when you are exposed to rapidly changing 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 contaminant levels 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. Safety Stations: Make available in the work area emergency eyewash stations, safety/sprinkler showers, and washing facilities. Contaminated Equipment: Separate contaminated work clothes from clean work clothes. Launder contaminated work clothing before wearing it. Do not 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 contact withcompatible materials. Store in aluminum, stainless steel, or glass containers on a cement floor in a cool, dry, well-ventilated area away from incompatibles (Sec. 5). Place around storage tanks with large kibbs or stalls 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 replacement and periodic medical examination of exposed workers that emphasize due eyes, skin, respiratory tract and teeth. Pulmonary function tests (FEV₁, FVC) are helpful. Educate workers about the hazardous properties of nitric acid.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: * N, T, §, V, ¥, φ
DOT Hazard Class: 8
ID No.: UN1826 (**) UN1796 ($) UN2031 (¥), UN2032 (¥)
DOT Packing Group: I (†§¥), II (*¥)
DOT Packaging Label: Corrosive (†¥), Corrosive, Oxidizer (†¥), Corrosive, Oxidizer, Poison (‡¥)
Special Provisions (172.102): B2, T12, T27 (*); B2, T12, T27 (¥); B2, B12, R35, T27 (¥); B2, B12, B33, T79 (¥); B9, B32, B74, T38, T43, T45 (¥)
• Nitrating acid mixtures, <50% HNO₃
† Nitrating acid mixtures, >50% HNO₃
‡ Nitrating acid mixtures, >50% HNO₃
§ Nitrating acid mixtures, <50% HNO₃
¥ Nitrating acid mixtures, >50% HNO₃
$ Nitrating acid other than red fuming, >70% HNO₃
φ Nitric acid, red fuming

Packaging Authorizations

a) Exceptions: None
b) Non-bulk Packaging: 173.158 (*†¥¥¥), 173.227 (¥)
Bulk Packaging: 173.242 (¥¥¥), 173.243 (¥¥¥), 173.244 (¥¥¥)

Quantity limitations

a) Passenger Aircraft or Railcar: Forbidden
b) Cargo Aircraft Only: 30L (‡¥¥), 2.5L (†¥¥), Forbidden (¥)

Vessel Stowage Requirements

a) Vessel stowage: D
b) Other: 40(*), 40, 66, 89 (¥), 40 (¥), 40, 66, 89 (§), 110, 110 (¥), 110, 111 (¥), 40, 66, 74, 89, 90, 95 (¥)

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 125, 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 Row, MHP, CH; Medical Review: W Silverman, MD

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**Section 1 - Chemical Product and Company Identification**

**Product/Chemical Name:** Coal tar creosote  
**Chemical Formula:** Not found; consists of many compounds and the composition depends on the coal used to make the tar and the design and operating conditions of the coke oven and still.  
**CAS Number:** 8001-58-9  
**Synonyms:** AWPA #1; brick oil; Caswell No. 225; coal tar oil; creosote; creosote oil; creosote P1; creosotum; cresylic creosote; heavy oil; liquid pitch oil; naphthalene oil; Preserv-o-sote; Sakresote; tar oil; wash oil  
**Derivation:** By distillation of coal tar produced by high-temperature carbonization of bituminous coal; by mixing strained naphthalene oil, wash oil, and strained or light anthracene oil; as a by-product of conventional coal coking.  
**General Use:** Used mainly as a wood preservative for railroad ties, poles, fence posts, marine pilings, and other lumber for outdoor use; as a water-proofing agent; fuel oil constituent; frothing agent for mineral separation, tap hole refractory cement, and lubricant for die molds. Used only in limited quantities as an animal and bird repellent, animal dip, and insecticide (ovicide).  
**Vendors:** Consult the latest Chemical Week Buyers’ Guide.  

**Section 2 - Composition / Information on Ingredients**

Coal tar creosote consists of aromatic hydrocarbons, anthracene, naphthalene, and phenanthrene derivatives; some tar acids; and tar bases. Polycyclic aromatic hydrocarbons make up at least 75%,*.† (198)  

<table>
<thead>
<tr>
<th>OSHA PEL†</th>
<th>NIOSH REL†</th>
<th>DFG (Germany) MAK</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-hr TWA: 0.2 mg/m³</td>
<td>0.1 mg/m³ (cyclohexane-extractable fraction)</td>
<td>None established</td>
</tr>
<tr>
<td>Carcinogen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACGIH TLV†</td>
<td>DLH Level†</td>
<td></td>
</tr>
<tr>
<td>TWA: 0.2 mg/m³</td>
<td>80 mg/m³</td>
<td></td>
</tr>
</tbody>
</table>

* Creosote contains several carcinogenic polycyclic aromatic hydrocarbons including benz[a]anthracene, benzo[a]pyrene, and dibenz[a,h]anthracene.  
† Coal tar pitch volatiles, as benzene solubles (CAS No. 65996-93-20)

**Section 3 - Hazards Identification**

⭐⭐⭐⭐⭐ Emergency Overview ⭐⭐⭐⭐⭐  
Coal tar creosote is a colorless (pure) or yellow to black (industrial) liquid with an aromatic smoky smell. It is irritating to the eyes, skin and respiratory tract and can be corrosive, causing severe burns. Coal tar creosote is a probable human carcinogen. It is a combustible liquid that is a moderate fire hazard when exposed to an ignition source.

**Potential Health Effects**

**Primary Entry Routes:** Inhalation, skin absorption, and skin and/or eye contact  
**Target Organs:** Eyes, skin, bladder, kidneys, and respiratory system  
**Acute Effects:** Note! Phenol and phenolic derivatives of various aromatic hydrocarbons (tar acids), present in low concentrations, are the constituents most likely to be responsible for acute toxicity.  
**Inhalation:** Inhalation of vapors causes moderate irritation to the nose, throat, and upper respiratory tract.  
**Eye:** Contact with liquid causes conjunctivitis (inflammation of the eye's lining), keratitis (corneal inflammation), or corneal burns with scarring. May cause loss of vision.  
**Skin:** Contact causes irritation, burning, itching, redness, pigment changes, dermatitis (a rash of redness and bumps), or burns. Photosensitization (worsening of rash with exposure to sunlight) may occur.  
**Ingestion:** Causes salivation, nausea; vomiting; gastrointestinal tract irritation or bleeding; abdominal pain; rapid, thready pulse; vertigo; headaches; loss of papillary reflexes; hypothermia; cyanosis; respiratory distress; shock and mild convulsions. Large doses may be fatal.  
**Carcinogenicity:** IARC classifies coal tar creosote as Group 2A: probably carcinogenic to humans; limited human evidence, sufficient animal evidence. NTP classifies coal tar creosote as Group 2B: sufficient evidence of carcinogenicity from studies in experimental animals. OSHA does not specifically classify coal tar creosote as a carcinogen. NIOSH classifies coal tar pitch volatiles, as benzene solubles, as a carcinogen defined with no further categorization.  
**Medical Conditions Aggravated by Long-Term Exposure:** Skin disorders.  
**Chronic Effects:** Include dermatitis and, possibly, skin cancer or other forms of cancer. An increased risk of scrotal cancer for creosote-exposed brick makers was indicated in a worker mortality analysis. Epidemiological studies of coke oven workers revealed increased incidences of lung, bladder, prostate, pancreas, and intestinal cancer.
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 water until transported to an emergency medical facility. Consult a physician or ophthalmologist immediately.

Skin Contact: Quickly remove contaminated clothing. Prior to washing and if readily available, use undiluted polyethylene glycol 300 to 400. Wash affected area with soap and flooding amounts of water for at least 15 min. Do not rub or apply pressure to the affected skin, apply any oily substance or use hot water to rinse. 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. Rinse the mouth several times with cold water. Unless the poison control center advises otherwise, have the conscious and alert person drink 1 to 2 glasses of water. Do not induce vomiting! Keep victim warm and at rest.

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

Note to Physicians: Creosote may be detected in urine.

Special Precautions/Procedures: An exposed person should examine their skin periodically for growths, changes in warts or moles, and sores that do not heal.

Section 5 - Fire-Fighting Measures

Flash Point: 165.2 °F (74 °C)
Flash Point Method: CC
Autoignition Temperature: 637 °F (336 °C)
LEL: None reported.
UEL: None reported.

Flammability Classification: OSHA IIIA 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: Coal tar creosote may present a vapor explosion hazard indoors, outdoors, and in sewers. Vapors may travel to an ignition source and flash back.

Hazardous Combustion Products: Include carbon oxides.

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

Fire-Fighting Equipment: Because fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear full protective clothing. 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. Immediately leave area if you hear a rising sound from venting safety device or notice any fire-caused tank discoloration as a BLEVE (boiling liquid expanding vapor explosion) may be imminent. Isolate area for 1/2 mile in all directions if fire involves tank, rail car or tank truck. Fully decontaminate or properly dispose of personal protective clothing.

Section 6 - Accidental Release Measures

Spill/Leak Procedures: Notify safety personnel. Isolate hazard area, deny entry, and stay upwind of spills. Shut off all ignition sources. Cleanup personnel should protect against vapor inhalation and skin and eye contact.

Small Spills: Take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal.

Large Spills

Containment: Consider initial downwind evacuation for at least 300 meters (1000 feet). For large spills, dike far ahead of liquid spill for later disposal. Water spray may reduce vapor. Do not release into sewers or waterways.

Cleanup: Use nonsparking tools.

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

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor inhalation and skin and eye contact. Use ventilation sufficient to reduce airborne exposures to nonhazardous levels (Sec. 2). Wear protective gloves, goggles, and clothing to avoid contact. Wear respiratory protection when necessary (Sec. 8). Consult your industrial hygienist. Practice good personal hygiene procedures to avoid inadvertently ingesting this material. Keep away from ignition sources.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and ignition sources. Store coal tar creosote as close to area of use as possible to minimize transporting distance. Avoid physical damage to containers.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all operations and/or ventilate at the site of release to avoid vapor dispersion into the work area. To prevent static sparks, electrically ground and bond all containers and equipment.
Ventilation: Provide general or local exhaust ventilation systems equipped with high-efficiency particulate filters to maintain airborne concentrations below 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)

Administrative Controls: Preplacement and periodic medical examinations of exposed workers emphasizing respiratory, skin, liver, and kidney disorders, including comprehensive work and medical history, physical examination, CXR, PFTs, urinalysis, LFT; and sputum cytology as the attending physician considers appropriate. Educate workers about the health and safety hazards associated with coal tar creosote.

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. (The following respirator recommendations are for coal tar pitch volatiles.) For concentrations above the NIOSH REL or at any detectable concentrations, wear a SCBA 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. 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 any skin contact. With breakthrough times of >8 hr, butyl rubber, Teflon™, and Viton™ are recommended materials. Frequent change of protective garments is an additional protective measure. Wear protective eyeglasses or chemical safety goggles and face shield, 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 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 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 - Physical and Chemical Properties

Physical State: Oily liquid
Appearance and Odor: Colorless (pure) or yellow to black (industrial); aromatic smoky smell
Specific Gravity (H₂O=1, at 4 °C): 1.07 to 1.08 at 68 °F (20 °C)
Water Solubility: Slightly soluble
Other Solubilities: Soluble in alcohol; ether; glycerin; dimethyl sulfate; fixed or volatile oils; in solution of fixed alkali hydroxides.
Boiling Point Range: 381 to 752 °F (194 to 400 °C)
Octanol/Water Partition Coefficient: log Kow = 1.0
Heat of Combustion: -12,500 Btu/lb; -6,900 cal/g

Section 10 - Stability and Reactivity

Stability: Coal tar creosote is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization cannot occur.
Chemical Incompatibilities: Creosote oil mixed with chlorosulfonic acid in a closed container causes an increase in temperature and pressure.
Conditions to Avoid: Avoid excessive heat and contact with chlorosulfonic acid.
Hazardous Decomposition Products: Thermal oxidative decomposition of coal tar creosote can produce carbon oxides and thick, black, acrid smoke.

Section 11 - Toxicological Information

Toxicity Data:

Acute Oral Effects:
- Rat, oral, LD₅₀: 725 mg/kg
- Mouse, oral, LD₅₀: 433 mg/kg
Tumorigenicity: Mouse, skin, 99 g/kg/33 weeks administered intermittently produced tumors on skin and appendages (carcinogenic by RTECS criteria).

Genetic Effects:
- S. typhimurium: 20 μg/plate (-S9) produced mutations.
- Hamster, ovary cell: 10 mg/L induced sister chromatid exchange.

Reproductive Effects:
- Mouse, oral: 2 g/kg administered on gestational days 5-9 produced maternal effects and fetotoxicity.

* See NIOSH, RTECS (GF7615000), for additional toxicity data.
Section 12 - Ecological Information

Ecotoxicity: TL$_{50}$, goldfish (Carassius auratus), 3.51 ppm/24 hr (60:40) mixture of creosote and coal tar; TL$_{50}$, rainbow trout (Salmo gairdneri), 3.72 ppm/24 hr (60:40) mixture of creosote and coal tar; LD$_{50}$, bob white quail (Colinus virginianus), 1.260 ppm/8 days (60:40) mixture of creosote and coal tar.

Environmental Fate: Data not found.

Section 13 - Disposal Considerations

Disposal: Coal tar creosote is a good candidate for rotary kiln and fluidized bed incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Handle empty containers carefully as hazardous residues may still remain.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

<table>
<thead>
<tr>
<th>Shipping Name: Corrosive liquids, n.o.s.</th>
<th>Packaging Authorizations</th>
<th>Quantity Limitations</th>
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<tr>
<td>Shipping Symbols: Not listed.</td>
<td>a) Exceptions: None †; 173.154 ‡ §</td>
<td>a) Passenger, Aircraft, or Railcar: 0.5 L †;</td>
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<tr>
<td>Hazard Class: 8</td>
<td>b) Non-bulk Packaging: 173.201 †; 173.203§</td>
<td>1 L †; 5 L §</td>
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<tr>
<td>ID No.: UN1760</td>
<td>c) Bulk Packaging: 173.243 †; 173.242 ‡; 173.241§</td>
<td>b) Cargo Aircraft Only: 2.5 L †; 30 L †; 60 L §</td>
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<tr>
<td>Packing Group: I, II, or III*</td>
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<td>Vessel Stowage Requirements</td>
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<td>Label: CORROSIVE</td>
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<td>a) Vessel Stowage: B †; B ‡; A §</td>
</tr>
<tr>
<td>Special Provisions: A7, B10, T42 †; B2, T14 ‡; T7 §</td>
<td></td>
<td>b) Other: 40 †; ‡; §</td>
</tr>
</tbody>
</table>

* See 49 CFR 172.137 to assign Packing Group. Data was not available for Genium to make this determination.
† Packing Group I
‡ Packing Group II
§ Packing Group III

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Material No. U051
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) listed specific per RCRA, Sec. 3001
CERCLA Final Reportable Quantity (RQ): 1 lb (0.454 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 coal tar pitch volatiles) as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
Listed as an OSHA Specifically Regulated Substance (29 CFR 1910.1002; interpretation of term)

Section 16 - Other Information

References: 73, 103, 124, 136, 139, 184, 196, 197, 198, 200, 209

Prepared By: J Sawyer, MS/MJ Wurth, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: G Kelafant, MD

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Material Safety Data Sheets Collection:
Sheet No. 789
Cyanide

Issued: 11/91

Section 1. Material Identification

Cyanide (CN) Description: Derived by combining a carbon ion with a nitride ion. Used in rat and pest poisons, silver and metal polishes, photographic solutions, fumigating products, and electroplating solutions. Cyanide may also be liberated in burning of plastics, natural fibers (wool or silk), polyurethane bedding or furniture, acrylic baits, nylon carpets, and melamine resin insulation.

Other Designations: CAS No. 57-12-5, carbon nitride ion, cyanide anion, isocyanide.

Manufacturers: Contact your supplier or distributor. Consult latest Chemical Week Buyers’ Guide® for a suppliers list.

Caution: Cyanide is severely toxic by all routes of entry and its lethal dose is an estimated 1 µg/ml. Take necessary precautions to avoid all possible exposure to this material.

Section 2. Ingredients and Occupational Exposure Limits

Cyanide, ca 100%

<table>
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<tr>
<th>Year</th>
<th>OSHA PEL (Skin)</th>
<th>ACGIH TLV (Skin)</th>
<th>MAK (Danger of cutaneous absorption)</th>
<th>Toxicity Data*</th>
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<tr>
<td>1990</td>
<td>STEL: 4.7 ppm, 5 mg/m³, as hydrogen cyanide (gas)</td>
<td>Ceiling: 10 ppm, 11 mg/m³, as hydrogen cyanide (gas)</td>
<td>1990 DFG (Germany) MAK</td>
<td>Mouse, intraperitoneal, LD₅₀: 3 mg/kg; toxic effects not yet reviewed</td>
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<td></td>
<td></td>
<td>TWA: 10 ppm, 11 mg/m³ as hydrogen cyanide (gas)</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>IDLH Level</td>
<td>1990 NIOSH REL (Skin)</td>
<td>STEL: 4.7 ppm, 5 mg/m³ as hydrogen cyanide (gas)</td>
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<tr>
<td></td>
<td>50 mg/m³</td>
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</tr>
</tbody>
</table>

* See NIOSH, RTECS (Q57175000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: Varies with specific CN compound
Melting Point: Varies with specific CN compound
Molecular Weight: 26.02

Density: Varies with specific CN compound
Water Solubility: Varies with specific CN compound

Appearance and Odor: Varies with specific CN compound, but usually has an almond odor.

Section 4. Fire and Explosion Data

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

Extinguishing Media: Cyanide is combustible. For small fires, use dry chemical, water spray or foam. Do not use carbon dioxide (CO₂)!

Unusual Fire or Explosion Hazards: Combustible by chemical reaction with heat, moisture, or acid. Many cyanides readily evolve hydrogen cyanide (HCN), a toxic flammable gas.

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 firefiteger's protective clothing is ineffective for fires involving cyanide. Wear chemical protective clothing that the shepper or manufacturer specifically recommends. If possible without risk, remove container from fire area. Fight fire from maximum distance. Stay away from ends of tanks. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Remove and isolate contaminated clothing at the site.

Section 5. Reactivity Data

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

Chemical Incompatibilities: Cyanide may react violently with hypochlorite solutions at pH 10 to 10.3, is explosive with nitrates if heated above 450 °C, and is incompatible with chlorates, fluorine, magnesium, nitrates, and all inorganic acids.

Conditions to Avoid: Avoid exposure to heat and contact with incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of cyanide can produce carbon dioxide and toxic, flammable vapors of CN.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA do not list cyanide as a carcinogen.

Summary of Risks: Cyanide is a potent, fast-acting, chemical asphyxiant (material which causes pulse and breathing obstruction) that prevents tissue utilization of oxygen by inhibiting the enzyme involved (cytochrome oxidase). Death can occur within seconds to minutes after inhalation of some cyanide gases, and may take as long as an hour after ingestion of a large amount of a cyanide salt due to a slower absorption.

Toxicity is dependent on the form of cyanide the victim is exposed to. Mortality from acute exposures is high, but recovery is generally complete in nonfatal cases.

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

Continue next page
Section 6. Health Hazard Data, continued

Target Organs: Brain, heart, lungs, skin, blood.

Primary Entry Routes: Inhalation, ingestion, skin absorption.

Acute Effects: Inhalation of cyanide gases may cause rapid toxicity where the victim may only have time to utter a warning cry before succumbing to unconsciousness caused by asphyxiation. If exposure is small there may be a weak, rapid, irregular heartbeat with bright-pink coloration of the skin due to high oxyhemoglobin content in the veins before person loses consciousness. A telltale sign of inhalation or ingestion is the odor of bitter almonds on the breath, however up to half the population is genetically unable to detect this smell. Dialyzed patients are common in severe poisonings. Contact with broken skin can cause cyanide absorption into the bloodstream. Cyanide ingestion can cause a bitter, burning taste, salivation, nausea, vomiting, fluttering, confusion, vertigo (dizziness), giddiness, sensation of stiffness in the lower jaw, and dyspnea (difficult respiration). In severe cases symptoms could progress to convulsions, paralysis, coma, cardiac arrhythmias, followed by death due to respiratory failure.

Chronic Effects: Chronic skin contact may cause cyanide rash, characterized by itching, and mucous (blotches), popular (small, solid, conical, elevation of the skin), and vesicular (blistery-like) eruptions. Chronic cyanide inhalation may cause appetite loss, headache, weakness, nausea, dizziness, and symptoms of irritation of the upper respiratory tract and eyes. Other symptoms of chronic exposure include goiter, B12 and folic acid abnormalities, chest discomfort, epistaxis (nose bleed), poor appetite and sleeping, and functional changes in hearing.

FIRST AID: Emergency personnel should protect against contamination!

Eye: Gently wash the eyes and flush immediately and continuously with flowing amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Speed is extremely important. Rinse with flowing amounts of water for at least 15 min. Wash exposed area extremely thoroughly with soap and water. If irritation and pain persist, consult a physician.

Inhalation: Remove exposed person to fresh air and immediately begin administering 100% oxygen. Avoid mouth-to-mouth resuscitation during CPR to prevent self-poisoning.

Ingestion: Obtain and prepare the Lilly cyanide antidote kit [Eli Lilly Co. (Stock No. M76)] for use in symptomatic patients. Never give anything by mouth to an unconscious or convulsing person. Do not induce vomiting with Ipecac syrup. Consider gastric lavage. Activated charcoal is said to be ineffective.

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

Note to Physicians: If the victim is unconscious, bradycardia and absence of cyanosis may be key diagnostic signs. Consider administration of amyl nitrite followed by sodium nitrite and sodium thiosulfate (antidote kit). Consider use of 100% oxygen.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate 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 or leaks without fire. For small dry spills, carefully scoop into clean, dry, suitable container and cover loosely. For small solution spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers. For large spills, dike far ahead of solution spills for later disposal.

Follow applicable OSHA regulations (29 CFR 1910.120).

EPA Designations:
Listed as a CERCLA Hazardous Substance (40 CFR 302.4), Reportable Quantity: An RQ is not being assigned to the general class [* 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). 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 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 with full facepiece operated in pressure-demand or other positive-pressure mode. Warning: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. Others Wear appropriate goggles, boots, aprons, and gloves to prevent repeated or prolonged skin contact.

Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by containing it at its source.

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. Cyanide detoxifying kits and instructions should be available in use areas. Instruct employees working in these areas on how and when to use these kits.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in tightly closed and properly labeled containers in cool, dry, well-ventilated area away from heat and incompatibles.

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

Other Precautions: If respirators are used, implement a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Consider preplaciation and periodic medical examinations of exposed workers that emphasize the heart, blood, and respiratory system.

Transportation Data (49 CFR 172.101, 102)
DOT Shipping Name: Cyanide or cyanide mixture, dry
DOT Hazard Class: Poison B
ID No.: UN1888
DOT Labels: Poison
DOT Packaging Exceptions: 173.354
DOT Package Requirements: 173.370

MSDS Collection References: 73, 101, 103, 126, 127, 130, 143, 146, 148, 153, 159, 161, 163
Prepared by: M Gannon, BA; Industrial Hygiene Reference: DJ Wilson, CID; Medical Review: AC Darlington, MPH, MD; Edited by: JR Stuart, MS

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I. PRODUCT & COMPANY INFORMATION

PRODUCT NAME: CRYSTAL SIMPLE GREEN®
OTHER NAMES: CRYSTAL SIMPLE GREEN® - SPECIALIZED CLEANER / DEGREASER
SIMPLE GREEN SAFETY TOWELS (fluid only)

COMPANY NAME: SUNSHINE MAKERS, INC.
15922 Pacific Coast Highway
Huntington Harbour, CA 92649 USA
Telephone: 800-228-0709 • 562-795-6000
Fax: 562-592-3034
Website: www.simplegreen.com

For 24-hour emergency, call Chem-Tel, Inc.: 800-255-3924

USE OF PRODUCT: A specialized cleaner and degreaser for use in the industrial and institutional workplace..

II. INGREDIENT INFORMATION

The only ingredient of Crystal Simple Green® with established exposure limits is undiluted 2-butoxyethanol (<6%) (Butyl Cellosolve; CAS No. 111-76-2): the OSHA PEL and ACGIH TLV is 25 ppm (skin). Note, however, that Butyl Cellosolve is only one of the raw material ingredients that undergo processing and dilution during the manufacture of Crystal Simple Green®. Upon completion of the manufacturing process, Crystal Simple Green® does not possess the occupational health risks associated with exposure to undiluted Butyl Cellosolve. Verification of this is contained in the independent test results detailed under "Toxicological Information" on Page 3 of this MSDS.

The Butyl Cellosolve in Crystal Simple Green® is part of a chemical category (glycol ethers) regulated by the Emergency Planning and Community Right-to-Know Act (SARA, Title III, section 313); therefore, a reporting requirement exists. Based upon chemical analysis, Crystal Simple Green® contains no known EPA priority pollutants, heavy metals, or chemicals listed under RCRA, CERCLA, or CWA. Analysis by TCLP (Toxicity Characteristic Leaching Procedure) according to RCRA revealed no toxic organic or inorganic constituents.

All components of Crystal Simple Green® are listed on the TSCA Chemical Substance Inventory.

III. HAZARDS IDENTIFICATION

UN Number: Not required
Dangerous Goods Class: Nonhazardous

<table>
<thead>
<tr>
<th>Hazard Rating (NFPA/HMIS)</th>
<th>Rating Scale</th>
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<td>Health = 1*</td>
<td>0 = minimal</td>
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<tr>
<td>Reactivity = 0</td>
<td>2 = moderate</td>
</tr>
<tr>
<td>Fire = 0</td>
<td>3 = serious</td>
</tr>
<tr>
<td>Special = 0</td>
<td>4 = severe</td>
</tr>
</tbody>
</table>

*Mild eye irritant, non-mutagenic and non-carcinogenic. None of the ingredients in Crystal Simple Green® are regulated or listed as potential cancer agents by Federal OSHA, NTP, or IARC.
IV. FIRST AID MEASURES

SYMPTOMS OF OVEREXPOSURE AND FIRST AID TREATMENT

Eye contact: Reddening may develop. Immediately rinse the eye with large quantities of cool water; continue 10-15 minutes or until the material has been removed; be sure to remove contact lenses, if present, and to lift upper and lower lids during rinsing. Get medical attention if irritation persists.

Skin contact: Minimal effects. If any; rinse skin with water, rinse shoes and launder clothing before reuse. Reversible reddening may occur in some derma-sensitive users; thoroughly rinse area and get medical attention if reaction persists.

Swallowing: Essentially non-toxic. Give several glasses of water to dilute; do not induce vomiting. If stomach upset occurs, consult physician.

Inhalation: Non-toxic. Exposures to concentrate-mist may cause mild irritation of nasal passages or throat; remove to fresh air. Get medical attention if irritation persists.

V. FIRE FIGHTING MEASURES

Crystal Simple Green® is stable, not flammable, and will not burn.

Flash Point/Auto-Ignition: Not flammable.

Flammability Limits: Not flammable.

Extinguishing Media: Not flammable/nonexplosive. No special procedures required.

Special Fire Fighting Procedures: None required.

VI. ACCIDENTAL RELEASE MEASURES

Recover usable material by convenient method; residual may be removed by wipe or wet mop. If necessary, unrecoverable material may be washed to drain with large quantities of water.

VII. HANDLING, STORAGE & TRANSPORT INFORMATION

No special precautions are required. This product is non-hazardous for storage and transport according to the U.S. Department of Transportation Regulations. Crystal Simple Green® requires no special labeling or placarding to meet U.S. Department of Transportation requirements.

UN Number: Not required

Dangerous Goods Class: Nonhazardous

VIII. EXPOSURE CONTROLS

Exposure Limits: The Crystal Simple Green® formulation presents no health hazards to the user when used according to label directions for its intended purposes. Mild skin and eye irritation is possible (please see Eye contact and Skin contact in Section IV.).

Ventilation: No special ventilation is required during use. Large-scale uses indoors should provide an increased rate of air exchange.

Human Health Effects or Risks from Exposure: Adverse effects on human health are not expected from Crystal Simple Green®, based upon twenty years of use of Simple Green without reported adverse health incidence in diverse population groups, including extensive use by inmates of U.S. Federal prisons in cleaning operations.

Crystal Simple Green® is a mild eye irritant; mucous membranes may become irritated by concentrate-mist.

Crystal Simple Green® is not likely to irritate the skin in the majority of users. Repeated daily application to the skin without rinsing, or continuous contact of Crystal Simple Green® on the skin may lead to temporary, but reversible, irritation.

Medical Conditions Aggravated by Exposure: No aggravation of existing medical conditions is expected; derma-sensitive users may react to dermal contact by Crystal Simple Green®.
IX. PERSONAL PROTECTION

Precautionary Measures: No special requirements under normal use conditions.
Eye Protection: Caution, including reasonable eye protection, should always be used to avoid eye contact where splashing may occur.
Skin Protection: No special precautions required; rinse completely from skin after contact.
Respiratory Protection: No special precautions required except during large-scale spray applications where spray mist levels are high.
Work and Hygienic Practices: Wash or rinse hands before touching eyes or contact lenses. Follow standard hygienic practices for handling cleaning agents.

X. PHYSICAL AND CHEMICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance/odor:</td>
<td>Clear liquid</td>
</tr>
<tr>
<td>Specific Gravity:</td>
<td>1.020</td>
</tr>
<tr>
<td>pH of concentrate:</td>
<td>9.35</td>
</tr>
<tr>
<td>Evaporation:</td>
<td>&gt;1 (butyl acetate = 1)</td>
</tr>
<tr>
<td>Boiling Point:</td>
<td>100.6 °C (212 °F)</td>
</tr>
<tr>
<td>Freezing Point:</td>
<td>-9 °C (16 °F) If product freezes, it will reconstitute without loss of efficacy when brought back to room temperature and agitated.</td>
</tr>
<tr>
<td>VOC Composite Partial Pressure:</td>
<td>0 mm Hg @ 20 °C</td>
</tr>
<tr>
<td>Volatile Organic Compounds (VOCs):</td>
<td>0 g/L per ASTM Method D-2369. Per California AQMD's VOC test method, product must be diluted at least 2 parts of water to 1 part Crystal Simple Green® in order to meet SCAQMD Rule 1171 &amp; Rule 1122 and BAAQMD Regulation 8-16 VOC requirements for solvent cleaning operations.</td>
</tr>
<tr>
<td>Water Solubility:</td>
<td>Completely soluble in water.</td>
</tr>
</tbody>
</table>

Detection: Crystal Simple Green® has a characteristic odor that is not indicative of any hazardous situation.

XI. STABILITY AND REACTIVITY INFORMATION

Nonreactive. Crystal Simple Green® is stable, even under fire conditions, and will not react with water or oxidizers. Hazardous polymerization will not occur.

XII. TOXICOLOGICAL INFORMATION

The information and conclusions cited in this section are based on data and testing of Simple Green®. The data are directly applicable to Crystal Simple Green® because, except for the fragrance and dyes which have been removed, it contains the same ingredients as Simple Green®.

Nonhuman Toxicity

Acute Mortality Studies:
- Oral LD₅₀ (rat): >5.0 g/kg body weight // Dermal LD₅₀ (rabbit): >2.0 g/kg body weight

Dermal Irritation: Only mild, but reversible, irritation was found in a standard 72-hr test on rabbits. A value of 0.2 (non-irritating) was found on a scale of 8.

Eye Irritation: With or without rinsing with water, the irritation scores in rabbits at 24 hours did not exceed 15 (mild irritant) on a scale of 110.

Subchronic dermal effects: No adverse effects, except reversible dermal irritation, were found in rabbits exposed to Simple Green® (up to 2.0 g/kg/day for 13 weeks) applied to the skin of 25 males and 25 females. Only female body weight gain was affected. Detailed microscopic examination of all major tissues showed no adverse changes.

Fertility Assessment by Continuous Breeding: The Simple Green® formulation had no adverse effect on fertility and reproduction in CD-1 mice with continuous administration for 18 weeks, and had no adverse effect on the reproductive performance of their offspring.
XIII. BIODEGRADABILITY AND ENVIRONMENTAL TOXICITY INFORMATION

Biodegradability:
Like Simple Green®, Crystal Simple Green® is readily decomposed by naturally occurring microorganisms. The biological oxygen demand (BOD), as a percentage of the chemical oxygen demand (COD), after 4, 7, and 11 days was 56%, 60%, and 70%, respectively. Per OECD Closed Bottle Test, Crystal Simple Green® meets OECD and EPA recommendations for ready biodegradability.

In a standard biodegradation test with soils from three different countries, Butyl Cellosolve reached 50% degradation in 6 to 23 days, depending upon soil type, and exceeded the rate of degradation for glucose, which was used as a control for comparison.

Environmental Toxicity Information:
Crystal Simple Green® is considered practically non-toxic per EPA’s aquatic toxicity scale.

XIV. DISPOSAL CONSIDERATIONS

Crystal Simple Green® is fully water soluble and biodegradable and will not harm sewage-treatment microorganisms if disposal by sewer or drain is necessary. Dispose of in accordance with all applicable local, state, and federal laws.

XV. OTHER INFORMATION

Containers: Crystal Simple Green® residues can be completely removed by rinsing with water; the container may be recycled or applied to other uses.

Contact Point: Sunshine Makers, Inc., Research and Development Division: 562-795-6000.

*** NOTICE ***

All information appearing herein is based upon data obtained by the manufacturer and recognized technical sources. Judgments as to the suitability of information herein for purchaser’s purposes are necessarily purchaser’s responsibility. Therefore, although reasonable care has been taken in the preparation of this information, Sunshine Makers, Inc. or its distributors extends no warranties, makes no representations and assumes no responsibility as to the suitability of such information for application to purchaser’s intended purposes or for consequences of its use.
Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Fuel Oil No. 4
Chemical Formula: Not given
CAS No.: 68476-31-3
Synonyms: heating oil
Derivation: A petroleum fraction consisting of heavier straight-run or cracked distillates.
General Use: Used in commercial or industrial burner installations not equipped with preheating facilities.
Vendors: Consult the latest Chemical Week Buyers’ Guide. (73)

Section 2 - Composition / Information on Ingredients

Fuel Oil No. 4, ca 100% vol
Trace Impurities: All petroleum fractions contain appreciable amounts of aromatics (toluene, xylene) and saturated rings (cycloparaffins, naphthenes).

OSHA PEL
None established

NIOSH REL
None established

DFG (Germany) MAK
None established

ACGIH TLV
None established

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆
Fuel oil no. 4 is a moderately dark, viscous liquid. It is flammable when exposed to heat or flame. Prolonged or repeated skin contact may cause dermatitis. It is a DOT flammable liquid.

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion.
Target Organs: Skin, CNS (severe exposure).

Acute Effects
Inhalation: Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, increased rate of respiration, tachycardia (excessively rapid heart beat), stupor, convulsions, cyanosis (dark purplish coloration of the skin and mucous membranes caused by deficient blood oxygenation), or unconsciousness, depending on concentration and length of exposure.
Eye: None reported.
Skin: 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.
Ingestion: Ingestion may cause nausea, vomiting, diarrhea, and abdominal pain; occasionally, mild CNS depression or excitement occur after ingestion.

Carcinogenicity: IARC lists fuel oils, residual heavy as a possible carcinogen (2B; limited animal data). OSHA and NTP do not list fuel oil no. 4 as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: Dermatitis.
Chronic Effects: Repeated skin contact may cause defatting and dermatitis.
Comments: Fuel oil no. 4 may be a synergist to pesticides.

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 flowing amounts of tepid water for at least 15 min. If pain and irritation persist, consult an ophthalmologist.
Skin Contact: Remove contaminated clothing. Rinse with flowing amounts of water for at least 15 min. 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, do not induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.

Comments: Following ingestion of hydrocarbons, the primary concern is aspiration into the lungs. Hydrocarbons with the lowest viscosity and surface tension have the greatest risk for aspiration. Fuel oil no. 4 is a viscous liquid and therefore, has a lesser risk for aspiration. Risk for vapor inhalation of fuel oil no. 4 is less than other hydrocarbons such as gasoline or kerosene because fuel oil no. 4 is less volatile. In general, fuel oil no. 4 is more viscous and less toxic than kerosene.
Section 5 - Fire-Fighting Measures

Flash Point: 142-240 °F (61-116 °C); reported by NFPA;
129 °F (54 °C)

Autoignition Temperature: 505 °F (263 °C)

LEL: None reported.
UEL: None reported.

Flammability Classification: Depending on the flash point, fuel oil no. 4 is classified as an OSHA Class II, Class IIIA or IIIB Combustible Liquid.*

Extinguishing Media: For small fires, use dry chemical, CO₂, water spray, or regular foam. For large fires, use water spray, fog, or regular foam.

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

Hazardous Combustion Products: Acid smoke and irritating fumes.

Fire-Fighting Instructions: If feasible and without undue risk, move containers from fire hazard area. Otherwise, apply cooling water to containers until well after fire is extinguished. Withdraw immediately in case of any tank discoloration or rising sound from venting safety device due to fire. For massive fires, use monitor nozzles or unmanned hose holders. 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 firefighter’s protective clothing will provide limited protection.

* You will notice that there is a difference in classifications of a flammable and combustible liquid between OSHA and the DOT. The DOT classifies fuel oil (no. 1, 2, 4, 5, 6) as flammable liquids (See Sec. 14).

Section 6 - Accidental Release Measures

Spill/Leak Procedures: Notify safety personnel of large spills, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Clean up spills promptly to reduce fire hazards. Use nonsparking tools.

Small Spills: Use an inert, noncombustible, absorbent material to pick up small spills or residues.

Large Spills

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

Cleanup: Consider using straw, polyurethane foam, activated carbon, or peat to soak up oil. There is a wide variety of sorbents, dispersants, sinking agents, combustion promoters, and mechanical systems to treat oil spills.

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

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor or mist inhalation or prolonged skin contact.

Storage Requirements: Store in closed containers in a well-ventilated area away from heat and ignition sources. No smoking in storage or use areas.

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.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below 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)

Administrative Controls: Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing.

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, Barrier creams may be helpful. 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.

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 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 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Moderately dark, viscous.
Medium Odor Threshold: 0.5 ppm
Water Solubility: Insoluble
Melting Point: -51 °F (-46 °C)

Section 10 - Stability and Reactivity

Stability: Fuel oil no. 4 is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization cannot occur.
Chemical Incompatibilities: Oxidizing materials.
Conditions to Avoid: Heat and ignition sources.
Hazardous Decomposition Products: Thermal oxidative decomposition of fuel oil no. 4 can produce various hydrocarbons and hydrocarbon derivatives and partial oxidation products including carbon oxides.

Section 11 - Toxicological Information

Toxicity Data: None reported*

* Monitor NIOSH, RTECS (LS8965000), for future toxicity data.

Section 12 - Ecological Information

Aquatic Toxicity:
Striped bass, LC₅₀ 96 hr: 25.1 ppm (static test environment)
Carp, LC₅₀ 24 hr: 50 ppm (static test environment)
Striped bass, LC₅₀ 96 hr: 0.62 ppm (static test environment with 1.5 mg/L LAS)
Carp, LC₅₀ 24 hr: 5.1 ppm (static with 1.5 mg/L LAS)

Section 13 - Disposal Considerations

Disposal: Consider incineration (permit-approved facilities only). 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: Fuel oil (No. 1, 2, 4, 5, or 6)
Shipping Symbols: D
Hazard Class: 3
ID No.: NA1993
Packing Group: III
Label: Flammable Liquid*
Special Provisions (172.102): B1

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 60 L
b) Cargo Aircraft Only: 220 L

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

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Classified as a RCRA Hazardous Waste (40 CFR 261.21): Characteristic of Ignitability [if flash point <140 °F (60 °C)]
CERCLA Hazardous Substance (40 CFR 302.4): Listed if classified as a RCRA Hazardous Waste, Characteristic of Ignitability
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, 101, 103, 126, 132, 136, 164

Prepared by                        MJ Wurth, BS
Industrial Hygiene Review         DJ Wilson, CIH
Medical Review                    J Brent, MD, PhD
Revision Notes:

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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, cyclopentane, olefins, naphthenes, and aromatics. In general, gasoline is produced from petroleum, shale oil, Athabasca tar sands, and coal. Motor gases 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, benzine, gasolene, gasline, motor spirits, natural gasoline, petrol.

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

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/m³
15-min STEL: 500 ppm, 1500 mg/m³

1990-91 ACGIH TLVs
TWA: 300 ppm, 890 mg/m³
STEL: 500 ppm, 1480 mg/m³

1990 NIOSH REL
None established

1985-86 Toxicity Data*
Man, inhalation, TCₙ: 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, LC₅₀: 300 g/m³/5 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, RTCEES (LX3200000), 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 (15.5 °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, the IARC listed 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 toxic 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 hypersensitivities. Inhalation can cause CNS depression. Pulmonary aspiration after ingestion can cause severe pneumonia. In adults, ingestion of 20 to 50 g of 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. Inhalation 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 pneumonia. 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 (hypoesthesia) of the distal extremities followed by motor weakness, muscular degeneration, and diminished tendon reflexes and coordination. Repeated skin exposure can cause blisters, 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 Flushing, 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 absorbent. Dike storage areas to control leaks and spills. Follow applicable OSHA regulations (29 CFR 1910.120).

Aquatic Toxicity: Bluegill, freshwater, LC50: 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.

Respiratory: Wear personal protective 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 chloride 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. 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. Store must meet requirements of OSHA Class IB liquid. Outside or detachedстойлов, storage must not exceed 10% of the plant's annual consumption.

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.

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

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

Transportation Data (49 CFR 172.101, 102)

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

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Material Safety Data Sheet Collection  
Fuel Oil No. 2  
MSDS No. 469
Date of Preparation: 10/81  
Revision: B, 3/98

Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Fuel oil no. 2  
Chemical Formula: Unspecified or Variable
CAS Number: 68476-30-2
Synonyms: #2 home heating oil; API no. 2 fuel oil; diesel oil; gas oil; home heating oil no. 2; number 2 burner fuel; number 2 fuel oil
Derivation: Residue from distillation (straight run or cracked) of crude oil.
General Use: Used as a fuel in atomizing burners for domestic and industrial heating, in engines of heavy units (ships, trucks, trains), as a source of synthesis gas, in drilling muds, and for mosquito control (coats breeding waters).
Vendors: Consult the latest Chemical Week Buyers' Guide. (73)

Section 2 - Composition / Information on Ingredients

Fuel oil no. 2, ca 100% vol (complex mixture (< 95%) of paraffinic, olefinic, naphthenic, and aromatic hydrocarbons)
Trace Impurities: water and sediment (< 0.05% vol), carbon residue (< 0.35%), ash (< 0.01% wt), sulfur (< 0.7% wt) and benzene (< 100 ppm).

OSHA PEL
As petroleum distillates
8-hr TWA: 500 ppm (2000 mg/m^3)

NIOSH REL
As petroleum distillates
10-hr TWA: 350 mg/m^3

ACGIH TLV
As diesel fuel
Notice of impending change (1997): IDLH Level
TWA: 100 mg/m^3, Skin 1,100 ppm

DFG (Germany) MAK
None established

Section 3 - Hazards Identification

ANSI Signal Word: Warning!

⭐⭐⭐⭐⭐ Emergency Overview ⭐⭐⭐⭐⭐
Fuel oil no. 2 is an amber to brown, slightly viscous liquid with a petroleum odor. It can be irritating to the skin and respiratory tract. This low viscosity fuel oil presents a significant aspiration hazard following ingestion, which can result in chemical pneumonitis and respiratory failure. Also Causes: vomiting, diarrhea, central nervous system (CNS) depression, increased rate of respiration, rapid heart beat, and cyanosis (blue coloration of the skin caused by oxygen deficiency). Fuel oil no. 2 can be an environmental hazard if spilled. This flammable liquid is a moderate fire hazard. When heated to decomposition, it will emit acrid smoke and irritating fumes.

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion
Target Organs: Skin, CNS, cardiovascular system (CVS), respiratory system, mucous membranes

Acute Effects

Inhalation: Respiratory tract irritation, headache, dizziness, euphoria, nausea, increased respiration rate, tachycardia (excessively rapid heart beat), cyanosis, stupor, convulsions, and unconsciousness can result from inhalation of fuel oil no. 2 mist.
Eye: Contact may result in irritation.
Skin: Contact may cause irritation.

Ingestion: Gastrointestinal irritation, vomiting, diarrhea, and in severe cases, CNS depression, progressing to coma and death, can result. Since intestinal absorption of longer chain hydrocarbons is minimal, aspiration into lungs following ingestion is a more significant exposure route; it may result in transient CNS depression, hemorrhaging and pulmonary edema, progressing to renal (kidney) involvement, chemical pneumonitis, and respiratory failure.

Carcinogenicity: IARC lists distillate (light) fuel oils as Group 3 (not classifiable as to carcinogenicity to humans). ACGIH lists a notice of impending change for diesel fuels as TLV-A3 (Animal carcinogen). NTP and OSHA do not list fuel oil no. 2 as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: None reported.
Chronic Effects: Prolonged and repeated skin contact can cause dermatitis, irritate the hair follicles and may block the (oil) sebaceous glands, producing a rash of acne pimples, usually on the arms and legs. Repeated exposures producing CNS effects may lead to permanent nervous system damage.

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 and/or irritation develop.
Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water followed by washing the 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. Do not induce vomiting unless the poison control center advises otherwise.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Gastric lavage for treatment of ingestion is contraindicated due to aspiration hazard. Administer charcoal slurry cathartics (30 g/240 mL diluent). In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases and obtain chest x-ray.

Section 5 - Fire-Fighting Measures

Flash Point: 136 °F (57.78 °C)
Flash Point Method: CC
Autoignition Temperature: 494 °F (257 °C)
LEL: 0.6% v/v
UEL: 7.5% v/v
Flammability Classification: OSHA Class II Combustible Liquid.
Extinguishing Media: Use dry chemical, carbon dioxide, foam, water fog or spray. Water may be ineffective in putting out a fire involving fuel oil no. 2, and a solid water stream may spread the flames; however, a water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources.
Unusual Fire or Explosion Hazards: Can form explosive mixtures in air. In still air, the heavier-than-air vapors of fuel oil no. 2 may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Containers may explode in heat of fire.
Hazardous Combustion Products: Heating fuel oil no. 2 to decomposition can produce thick acrid smoke and irritating fumes.
Fire-Fighting Instructions: If tank, rail car or tank truck is involved in fire isolate for 1/2 mile (800 m). 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: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). All equipment used when handling the product must be grounded. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Isolate area for at least 80-160 ft (25-50 m) in all directions. Water spray or fire fighting foam may suppress vapor, but may not prevent ignition in closed spaces. Use natural barriers or oil spill control booms to confine oil slicks on surface water.
Small Spills: Absorb fuel oil no. 2 with vermiculite, earth, sand or similar material.
Large Spills
Containment: For large spills, consider downwind evacuation of at least 1000 ft (300 m). Dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.
Cleanup: Ground all equipment. Spills can be absorbed with materials such as peat, activated carbon, polyurethane foam, or straw. Sinking agents, gelling agents, dispersants, and mechanical systems can also be used to treat oil spills. Use clean non-sparking tools to collect absorbed material.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor or mist inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations as low as possible. Wear protective gloves (or use barrier cream) and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers.
Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (See Sec. 10). Periodically inspect stored materials. Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.106) for a Class II Combustible Liquid.

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.

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.

Administrative Controls: Enclose operations and/or provide local exhaust ventilation at the site of chemical release designed for flammable vapors/mists. Where possible, transfer fuel oil no. 2 from drums or other storage containers to process containers. Minimize sources of ignition in surrounding low-lying areas.

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), use 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 of Viton™ or nitrile rubber, if possible, or alternatively, polyvinyl chloride, chlorinated polyethylene or neoprene to prevent skin contact. Butyl rubber may degrade after contact and is not recommended. Wear protective eyeglasses 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 this material from your shoes and 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 - Physical and Chemical Properties

<table>
<thead>
<tr>
<th>Physical State: Liquid</th>
<th>Freezing Point: -50.8 °F (−46 °C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance and Odor: Amber to brown, slightly viscous; petroleum odor</td>
<td>Viscosity: 268 centistoke at 100 °F (37.8 °C)</td>
</tr>
<tr>
<td>Odor Threshold: 0.082 ppm</td>
<td>Surface Tension: 25 dynes/cm, estimated</td>
</tr>
<tr>
<td>Formula Weight: N/A</td>
<td>Henry's Law Constant (H): 29 to 68 atm-m³/mole at 77 °F (25 °C), estimated</td>
</tr>
<tr>
<td>Specific Gravity (H₂O=1, at 4 °C): 0.8654 at 59 °F (15 °C)</td>
<td>Octanol/Water Partition Coefficient: log Kₐ/w = 8.2 to 9.7</td>
</tr>
<tr>
<td>Water Solubility: Slightly soluble</td>
<td>Soil Sorption Coefficient (Kₑₒ): 1 x 10⁴, estimated</td>
</tr>
<tr>
<td>Boiling Point: 450 °F (232 °C)</td>
<td></td>
</tr>
</tbody>
</table>

Section 10 - Stability and Reactivity

Stability: Fuel oil no. 2 is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include strong oxidizing agents.

Conditions to Avoid: Heat and ignition sources.

Hazardous Decomposition Products: Thermal oxidative decomposition of fuel oil no. 2 can produce various hydrocarbons, hydrocarbon derivatives, partial oxidation products (carbon dioxide (CO₂), carbon monoxide (CO), sulfur dioxide (SO₂)).

Section 11 - Toxicological Information

Toxicity Data:*

<table>
<thead>
<tr>
<th>Skin Effects:</th>
<th>Acute Oral Effects:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabbit, skin, standard Draize test: 500 mg/24 hr, resulted in moderate irritation.</td>
<td>Rat, oral, LD₅₀: 12 g/kg</td>
</tr>
<tr>
<td>Acute Dermal Effects:</td>
<td>Eye Effects:</td>
</tr>
<tr>
<td>Rabbit, skin, LD: &gt; 5 g/kg</td>
<td>Rabbit, eye, standard Draize test: 100 mg/30 seconds, resulted in mild irritation.</td>
</tr>
</tbody>
</table>
Section 11 - Toxicological Information - continued

Toxicity Data:

Tumorigenicity: Mouse, skin: 243 g/kg/97 weeks, administered intermittently, caused skin and appendage tumors (carcinogenic by RTECS criteria).

Multiple Dose Toxicity Data: Rabbit, skin: 100 mL/kg/12 days, continuously, caused irritative dermatitis, weight loss or decreased weight gain, and death.

* See NIOSH, RTEC (LS8930000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Juvenile American shad, TLM/24 hr: 200 ppm; bluegill, LC50 = 95 mg/L/96 hr; carp, LC50 = 8.2 mg/L/24 hr; pumpkin seed, LC50 = 1.9 mg/L/24 hr. Through its coating action, this material can pose a hazard to aquatic biota including water birds, plankton, algae and fish.

Environmental Fate: Based on a calculated BCF (1.0x10^4 to 1.4x10^4), bioconcentration could be an important environmental fate process; however, it may be limited for the chief components of fuel oil no. 2 due to metabolism.

Environmental Degradation: It may biodegrade in water and soil, or volatilize from water (half-life of 4.4-4.8 hours from a model river) and moist soil surfaces, but adsorption may attenuate the rate of these processes. In the atmosphere, fuel oil no. 2 will rapidly degrade by reaction with photochemically produced hydroxyl radicals (estimated half-life 1 day or less).

Soil Adsorption/Mobility: A high Koc indicates significant sorption and low mobility in the soil column.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Material may be sprayed into an incinerator. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Fuel oil (1, 2, 4, 5 or 6)
Shipping Symbols: D
Hazard Class: 3
ID No.: NA1993
Packing Group: III
Label: Flammable Liquid
Special Provisions (172.102): B1

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 60 L
b) Cargo Aircraft Only: 220 L

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

Section 15 - Regulatory Information

EPA Regulations:
Classified as a RCRA Hazardous Waste (40 CFR 261.21), Characteristic of Ignitability
RCRA Hazardous Waste Number: D001
Listed as a CERCLA Hazardous Substance (40 CFR 302.4), Unlisted Hazardous Waste, Characteristic of Ignitability, per
RCRA Section 3001
CERCLA Final 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:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, as petroleum distillates)

Section 16 - Other Information

References: 1, 73, 103, 136, 190, 223, 230, 231

Prepared By: HM Spleithoff, MS
Industrial Hygiene Review: PA Roy, MPH, CIH
Medical Review: T Thoburn, MD, MPH

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Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Diesel fuel oil no. 2-D
Chemical Formula: Unspecified or variable
CAS Number: 68334-30-5
Synonyms: automotive diesel oil; diesel fuel; diesel oil (medium); diesel oil no. 2; diesel oil (petroleum); diesel oils; diesel test fuel; fuels, diesel; no. 2 diesel oil; olej napędowy III (Polish)
Derivation: Fuel oil may be a distilled fraction of petroleum, a residuum from refinery operations, a crude petroleum or a blend of two or more of these.
General Use: This medium viscosity residual fuel oil has both light and heavy grades, and is used in furnaces and boilers of utility and industrial power plants, ships, locomotives, and metallurgical operations.
Vendors: Consult the latest Chemical Week Buyers’ Guide. (73)

Section 2 - Composition / Information on Ingredients

Diesel fuel oil no. 2-D, ca 100% vol; diesel fuels consist primarily of aliphatic (64% vol), aromatic (35% vol), and olefinic (1-2% vol) hydrocarbons.
Trace Impurities: May contain sulfur (< 0.5 %), benzene (<100 ppm), and additives such as sulfurized esters.

OSHA PEL
As petroleum distillates
8-hr TWA: 500 ppm (2000 mg/m³)

NIOSH REL
As petroleum distillates
10-hr TWA: 350 mg/m³

ACGIH TLV
As diesel fuel
Notice of impending change (1997):
TWA: 100 mg/m³, Skin

DFG (Germany) MAK
None established

Section 3 - Hazards Identification

ANSI Signal Word: Caution

★★★★★ Emergency Overview ★★★★★
Diesel fuel oil no. 2-D is a brown, slightly viscous liquid with a kerosene-like odor. It is irritating to the skin and respiratory tract. Inhalation of mist or vapor may result in headache, nausea, vomiting, diarrhea, central nervous system (CNS) depression, tachycardia (rapid heart beat), cyanosis (blue coloring of skin due to oxygen deficiency), pulmonary edema (fluid in the lungs), and liver or kidney injury. Diesel fuel oil no. 2-D is an environmental hazard when spilled. When exposed to heat or flame, this flammable liquid is a fire hazard. When heated to decomposition, diesel fuel oil no. 2-D will emit acrid smoke and irritating vapors.

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin contact/absorption
Target Organs: Skin, CNS, cardiovascular system (CVS), respiratory system, liver, kidneys

Acute Effects

Inhalation: Euphoria, respiratory irritation, cardiac dysrhythmia, increased respiration rates, cyanosis, pulmonary edema, hemoptysis (spitting up blood from the respiratory tract), respiratory arrest, renal (kidney) and liver injury, and CNS toxicity can result from inhalation of diesel fuel oil no. 2-D mist or vapor.

Eye: Contact may result in irritation.

Skin: Contact may cause irritation, systemic effects (see Inhalation), and block the sebaceous (oil) glands, resulting in a rash of acne-like pimples and spots, usually on the arms and legs.

Ingestion: Gastrointestinal irritation, vomiting, diarrhea, and in severe cases, CNS depression progressing to coma and death and other systemic effects (see Inhalation) can result. Aspiration can result in transient CNS depression or excitement, hypoxia, infection, pneumocele (abnormal cavities in lungs) formation, and chronic lung dysfunction.

Carcinogenicity: IARC lists occupational exposure in petroleum refining as Group 2A (Probable human carcinogen) and distillate light (diesel) fuels as Group 3 (Not classifiable as to carcinogenicity to humans). ACGIH lists a notice of impending change for diesel fuels as TLV-A3 (Animal carcinogen). NTP and OSHA do not list diesel fuel oil no. 2-D as a carcinogen.
MSDS No. 470 Diesel Fuel Oil No. 2-D

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

Chronic Effects: Prolonged or repeated skin contact causes dermatitis and possible systemic toxicity. Prolonged or repeated inhalation can cause CNS and peripheral nervous system damage.

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 and/or irritation develops.

Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water followed by washing the 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. Have the conscious and alert person drink 1 to 2 glasses of water. Contact a poison control center. Because of aspiration risk, do not induce vomiting unless the poison control center advises otherwise.

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

Note to Physicians: Gastric lavage is contraindicated due to aspiration risk. Instead, consider administration of charcoal or milk. If ingestion amount is large, gastric emptying in the alert patient can be accomplished through administration of Syrup of Ipecac. Treat overexposure symptomatically and supportively.

Section 5 - Fire-Fighting Measures

Flash Point: 100.4 °F (38 °C)
Flash Point Method: CC
Autoignition Temperature: 351-624 °F (177-329 °C)
LEL: 1.3% v/v
UEL: 75% v/v

Flammability Classification: OSHA Class II Combustible Liquid
Extinguishing Media: Use dry chemical, carbon dioxide, foam, low velocity water fog or spray. Use a smothering technique to extinguish fire. Water may be ineffective in putting out a fire involving diesel fuel oil no. 2-D, and a solid water stream may spread the flames; however, a water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources.

Unusual Fire or Explosion Hazards: Vapor or mist can form explosive mixtures in air. In still air, the heavier-than-air vapors of diesel fuel oil no. 2-D from a large source may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Contaminants may explode in confined spaces.

Hazardous Combustion Products: Heating diesel fuel oil no. 2-D to decomposition can produce acrid smoke and irritating vapors.

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: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Ground all equipment used when handling this product. Do not touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A fire fighting foam may be used to suppress vapors. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Use clean non-sparking tools to collect absorbed material.

Small Spills: Absorb diesel fuel oil no. 2-D with vermiculite, earth, sand or similar material.

Large Spills

Containment: For large spills, consider downwind evacuation of at least 1000 ft (300 m). Dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Cleanup: Ground all equipment. Use non-sparking tools. Spills can be absorbed with materials such as peat, activated carbon, polyurethane foam, or straw. Sinking agents, gelling agents, dispersants, and mechanical systems can also be used to treat oil spills.

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

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor or mist inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations to non-hazardous levels (see Sec. 2). Wear protective gloves (or use barrier cream), and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers.
Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Periodically inspect stored materials. Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.106) for Class II Combustible Liquid.

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.

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.

Administrative Controls: Enclose operations and/or provide local exhaust ventilation appropriately designed for flammable mist and vapor at the site of chemical release. Where possible, transfer diesel fuel oil no. 2-D from drums or other storage containers directly to process containers. Minimize sources of ignition in surrounding low-lying areas.

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), use 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. Wear protective eyeglasses, 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 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 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Brown, slightly viscous; kerosene-like odor
Odor Threshold: 0.7 ppm
Vapor Pressure: < 0.1 mm Hg at 68 °F (20 °C)
Vapor Density (Air=1): > 6
Formula Weight: N/A

Specific Gravity (H₂O=1, at 4 °C): < 0.86
Water Solubility: Insoluble
Boiling Point: 340-676 °F (171-358 °C)
Freezing Point: -29.2 °F (-34 °C)
Viscosity: 1.9-4.1 centistoke at 104 °F (40 °C)
Surface Tension: 23-32 dynes/cm at 68 °F (20 °C)

Section 10 - Stability and Reactivity

Stability: Diesel fuel oil no. 2-D is stable at room temperature in closed containers under normal storage and handling conditions.
Polymerization: Hazardous polymerization cannot occur.
Chemical Incompatibilities: Include strong oxidizing agents.
Conditions to Avoid: Exposure to heat and ignition sources.

Hazardous Decomposition Products: Thermal oxidative decomposition of diesel fuel oil no. 2-D can produce low molecular weight hydrocarbons, hydrocarbon derivatives, carbon oxides (CO₂), and sulfur oxides (SO₂).

Section 11 - Toxicological Information

Acute Oral Effects:
Rat, oral, LD₅₀: 7500 mg/kg

Acute Dermal Effects:
Rabbit, skin, LD₅₀: > 5 mL/kg

Skin Effects:
Rabbit, skin, standard Draize test: 500 µL/24 hr, resulted in severe reaction.

Toxicity Data:
Other Multiple Dose Toxicity Data:
Rat, inhalation: 2 g/m³/6 hr/3 weeks, intermittently, resulted in changes in blood erythrocyte (RBC) count, and focal fibrosis (pneumococcosis) and other changes in the lung, thorax or respiration.
Rat, inhalation: 400 µg/m³/16 hr/2.5 years, intermittently, caused other changes in the blood, and biochemical effects - transaminases.
Rabbit, skin: 80 mL/kg/12 days, continuously, resulted in other changes in the liver, kidney, ureter, and bladder, and death.

* See NIOSH, RTECS (HZ1800000), for additional toxicity data.
**Section 12 - Ecological Information**

Ecotoxicity: Juvenile American shad, salt water TLm: 204 mg/L/24 hr; mallard duck, LD_{50}=20 mg/kg.

Environmental Fate: Diesel fuel oil no. 2-D will evaporate from water or soil. In surface water, it may partition from the water column to suspended sediments.

Environmental Degradation: Biodegradation may occur in soil and water.

**Section 13 - Disposal Considerations**

Disposal: 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):

<table>
<thead>
<tr>
<th>Shipping Name:</th>
<th>Diesel fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Symbols:</td>
<td>D</td>
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<tr>
<td>Hazard Class:</td>
<td>3</td>
</tr>
<tr>
<td>ID No.:</td>
<td>NA1993</td>
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<td>Packing Group:</td>
<td>III</td>
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<tr>
<td>Label:</td>
<td>None</td>
</tr>
<tr>
<td>Special Provisions (172.102):</td>
<td>B1</td>
</tr>
</tbody>
</table>

Packaging Authorizations
- a) Exceptions: 173.150
- b) Non-bulk Packaging: 173.203
- c) Bulk Packaging: 173.242

Quantity Limitations
- a) Passenger, Aircraft, or Railcar: 60 L
- b) Cargo Aircraft Only: 220 L

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

**Section 15 - Regulatory Information**

EPA Regulations:
- Classified as RCRA Hazardous Waste (40 CFR 261.21): Characteristic of Ignitability
- RCRA Hazardous Waste Number: D001
- Listed as a CERCLA Hazardous Substance (40 CFR 302.4), Unlisted Hazardous Waste, Characteristic of Ignitability per RCRA Sec. 3001
- CERCLA Final 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:
- Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A, as petroleum distillates)

**Section 16 - Other Information**

References: 73, 103, 136, 190, 209, 222, 230, 231

Prepared By: HM Spliethoff, MS
Industrial Hygiene Review: PA Roy, MPH, CIH
Medical Review: T Thoburn, MD, MPH

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Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Thallium
Chemical Formula: Tl
CAS Number: 7440-28-0
Synonyms: elemental thallium; Rabor; thallium metal
Derivation: Exists in flue dusts from lead and zinc smelters and pyrite burners. Obtained from thallium compounds by electrolysis, precipitation, or reduction.
General Use: Alloyed with mercury for switches and closures which operate at subzero temperatures; used in the manufacture of thallium salts; of mercury alloys and low-melting glasses; used in cardiac imaging; electrodes in dissolved oxygen analyzers; in photoelectric cells, lamps, and electronics; in scintillation counters; as a catalyst in organic synthesis; in magnesium seawater batteries; as a rodenticide (former use).
Vendors: Consult the latest Chemical Week Buyers’ Guide. (73)

Section 2 - Composition / Information on Ingredients

Thallium, ca 99.9 - 100%
Trace Impurities (technical grade): lead, zinc, nickel, cadmium, indium, germanium, selenium, tellurium, arsenic

OSHA PEL
Thallium, elemental, and soluble compounds, as Tl
8-hr TWA: 0.1 mg/m³, Skin

ACGIH TLV
Thallium, elemental, and soluble compounds, as Tl
TWA: 0.1 mg/m³, Skin
Excursion Limit: Provided the TLV-TWA is not exceeded, exposure may exceed 0.3 mg/m³ for no more than 30 min/day, never exceed 0.5 mg/m³.

NIOSH REL
Thallium, elemental, and soluble compounds, as Tl
10-hr TWA: 0.1 mg/m³, Skin

IDLH Level
15 mg/m³

DFG (Germany) MAK
Thallium, elemental, and soluble compounds, as Tl
TWA: 0.1 mg/m³
Category III: Substances with systemic effects, onset of effect >2 hr half-life > shift length (strongly cumulative).
Danger of cutaneous absorption

Peak Exposure Limit:
1.0 mg/m³, 30 min, average value, frequency per shift: 1

Section 3 - Hazards Identification

ANSI Signal Word: Danger!

Emergency Overview
Thallium is a bluish-white, odorless soft metal or powder. It is toxic by ingestion and may be absorbed in toxic amounts through skin contact or inhalation. Exposure also causes: skin sensitization, central nervous system (CNS) and gastrointestinal (GI) tract effects, kidney damage, and death. Exposure is cumulative. Thallium dust is flammable.

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin contact
Target Organs: Central nervous system (CNS), peripheral nerves, cardiovascular system (CVS), gastrointestinal (GI) tract, hair, eyes, respiratory system, liver, kidneys

Acute Effects

Inhalation: Irritation and systemic effects including thallium poisoning. Symptoms of thallium poisoning are often delayed 12 to 24 hours and reach a maximum in the second and third week after exposure. Symptoms include severe sudden abdominal pain, nausea, vomiting, diarrhea, headache, chest pain or tightness, excessive salivation, bloody vomit and stools, sensory nerve disorders, painful tingling in extremities, leg pains, insomnia, hypertension (high blood pressure), tachycardia (rapid heart beat), respiratory failure, decreased visual clarity, impaired color vision, weakness, depression, hair loss, green color to urine, kidney damage, and, in severe cases, tremors, delirium, hallucinations, convulsions, paralysis, coma and death, sometimes within 1 to 2 days. Thallium (metal) is not as toxic as some thallium salts.

Eye: Irritation; may cause vision loss.
**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 min. Consult a physician or ophthalmologist if pain, irritation, swelling, or photophobia persist.

**Skin Contact:** Quickly remove contaminated clothing. Rinse with flooding amounts of water. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Monitor for systemic effects.

**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. Seek medical attention.

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

**Note to Physicians:** If overexposure is suspected, monitor cardiac, renal and hepatic function; medical observation for several days is suggested. The most reliable urine test for thallium is a 24-hour urine quantitative assay. Diethylthiocarbamate has been reported to result in dangerous redistribution of thallium to the CNS and is contraindicated.

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**Section 5 - Fire-Fighting Measures**

**Flash Point:** Not applicable, probable noncombustible solid

**Autoignition Temperature:** None reported.

**LEL:** None reported.

**UEL:** None reported.

**Flammability Classification:** Probable noncombustible solid

**Extinguishing Media:** For small fires, use dry chemical, carbon dioxide (CO₂) or water spray. For large fires, use water spray, fog, or regular foam. Fire involving tanks or car/trailer loads: fight fire from maximum distance or use unmanned hose holders or monitor nozzles. *Do not* get water inside containers. Cool containers with flooding quantities of water until well after fire is out.

**Unusual Fire or Explosion Hazards:** Thallium dust is flammable when exposed to heat or flame. Reacts violently with fluorine.

**Hazardous Combustion Products:** Toxic fumes of thallium.

**Fire-Fighting Instructions:** *Do not* release runoff from fire control methods to sewers or waterways. *Do not* scatter thallium.

**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. Thoroughly decontaminate equipment after use.

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**Section 6 - Accidental Release Measures**

**Spill/Leak Procedures:** Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources. Isolate and ventilate area, deny entry, stay upwind. Tag container as defective and return to supplier. Use spark-proof tools and explosion proof equipment. Cleanup personnel should protect against exposure.

**Small Spills:** *Do not* sweep! Carefully scoop up or vacuum (with a HEPA filter). Absorb liquid spill with an inert, noncombustible absorbent such as sand or vermiculite. Collect in sealed containers 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:** If possible, recover for reuse or recycling.

**Regulatory Requirements:** Follow applicable OSHA regulations (29 CFR 1910.120).
Section 7 - Handling and Storage

Handling Precautions: Avoid any exposure to thallium. To avoid dust inhalation, use only with exhaust ventilation sufficient to reduce airborne concentrations to nonhazardous levels (see Sec. 2). Wear personal protective clothing and equipment to prevent contact with skin and eyes, or dust inhalation (see Sec. 8). Remove contaminated clothing and equipment immediately for proper decontamination. Practice good personal hygiene procedures to prevent inadvertently ingesting this material. Wash any areas which might have come in contact with thallium at the end of the work shift. Do not attempt to handle broken containers without proper protective equipment. Whenever possible, transfer thallium directly from storage containers to process containers.

Storage Requirements: Store in tightly closed containers in a cool, well-ventilated area away from heat, ignition sources, incompatibles, and food and foodstuffs.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose operations and exhaust ventilate to avoid dust dispersion into the work area. To prevent static sparks, electrically ground and bond all containers and equipment.

Ventilation: Provide local exhaust ventilation systems equipped with appropriate dust collectors or scrubbers to maintain airborne concentrations below OSHA PEL (see Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Educate workers about the health and safety hazards associated with this material. Train in work practices and PPE which minimize exposure. Consider preplacement and periodic medical exams with emphasis on the eyes, nervous and respiratory systems, liver, kidneys, gastrointestinal tract, and hair. Monitor workplace exposures.

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. Exposure Range: >0.1 to 1 mg/m³; air purifying, negative pressure, half mask; >1 to 10 mg/m³; air purifying, negative pressure, full face; >10 to <15 mg/m³; supplied air, constant flow/pressure demand, full face; 15 to unlimited mg/m³; SCBA, pressure demand, full face; cartridge color: dust/mist filter (use P100 or consult supervisor for appropriate dust/mist filter). 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 any skin contact.

Wear protective eyeglasses or chemical safety goggles and face shield, 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 this material from your shoes and clean personal protective equipment.

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

Section 9 - Physical and Chemical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical State</td>
<td>Solid</td>
</tr>
<tr>
<td>Appearance and Odor</td>
<td>Bluish white powder; odorless</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>1 mm Hg at 1517 °F (825 °C)</td>
</tr>
<tr>
<td>Formula Weight</td>
<td>204.38</td>
</tr>
<tr>
<td>Density</td>
<td>11.85 g/cm³</td>
</tr>
<tr>
<td>pH</td>
<td>Moderately strong base</td>
</tr>
<tr>
<td>Water Solubility</td>
<td>Insoluble</td>
</tr>
<tr>
<td>Other Solubilities</td>
<td>Slightly soluble in hydrochloric acid, 100 parts nitric acid; soluble in sulfuric acid.</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>2655 °F (1457 °C)</td>
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<tr>
<td>Melting Point</td>
<td>578.3 °F (303.5 °C)</td>
</tr>
<tr>
<td>Ionization Potential (eV)</td>
<td>6.10829</td>
</tr>
</tbody>
</table>

Section 10 - Stability and Reactivity

Stability: Thallium is stable at room temperature in closed containers under normal storage and handling conditions. Exposure to air will result in surface oxidation.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include strong acids and strong oxidizing agents. Reacts violently with fluorine (F₂). Reacts with steam or moist air to produce toxic thallium hydroxide (TlOH), with air to produce thallium (I) oxide (Tl₂O).

Conditions to Avoid: Avoid contact with chemical incompatibles, heat, and sources of ignition.

Hazardous Decomposition Products: Thermal oxidative decomposition of thallium can produce thallium fumes.
Section 11 - Toxicological Information

Toxicity Data:

Acute Oral Effects:
Man, oral, TD50: 5714 µg/kg produced toxic effects: peripheral nerve and sensation - structural change in nerve or sheath; sense organs and special senses - change in extra-ocular muscles; skin and appendages - hair.

Acute Effects:
Man, unreported exposure route, LD50: 4412 mg/kg

* See NIOSH, RTECS (XG3425000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Freshwater: Atlantic salmon, LD50: 0.03 ppm; daphnia, 72 hr threshold: 2-4 ppm; gamma ratus, 72 hr threshold: 4 ppm; perch, 72 hr threshold: 60 ppm. Saltwater: brown shrimp, 96 hr LC50: 10 ppm.

Environmental Fate: May persist indefinitely as cation. Thallium bioaccumulates.

Section 13 - Disposal Considerations

Disposal: If possible, recover for reuse or recycling. Contact your supplier or a licensed contractor for detailed recommendations for disposal. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Handle empty containers carefully as hazardous residues may still remain. Triple rinse containers and dispose of wash wastewater appropriately.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Thallium compounds, n.o.s.
Shipping Symbols: –
Hazard Class: 6.1
ID No.: UN1707
Packing Group: II
Label: POISON
Special Provisions (172.102): –

Packaging Authorizations
a) Exceptions: None
b) Non-bulk Packaging: 173.212
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 25 kg
b) Cargo Aircraft Only: 100 kg

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

Section 15 - Regulatory Information

EPA Regulations:
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA, Sec. 307(a)
CERCLA Final 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:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

Section 16 - Other Information

References: 1, 73, 99, 103, 124, 136, 149, 176, 190, 209, 216, 222, 223, 224, 227, 230

Prepared By: S Fleming, BS/HM Spliehoff, MS
Industrial Hygiene Review: PA Roy MPH, CIH
Medical Review: T Thoburn, MD, MPH

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Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Mercury
Chemical Formula: Hg
CAS No.: 7439-97-6
Synonyms: colloidal mercury, hydrargyrum, liquid silver, Quicksilver
Derivation: Obtained by roasting cinnabar (mercury sulfide) and purified by distillation, or as a by-product of gold mining.
General Use: Used in agricultural poisons, anti-fouling paint, dental amalgams, mining amalgamation (to remove gold and other metals from ore), thermometers, barometers, dry cell batteries, chlorine and caustic soda production, electrical apparatus, and as a neutron absorber in nuclear power plants.
Vendors: Consult the latest Chemical Week Buyers’ Guide. (73)

Section 2 - Composition / Information on Ingredients

Mercury, ca 100 %wt

OSHA PEL
Ceiling: 0.1mg/m³ (vapor and inorganic Hg)
8-hr TWA: 0.05 mg/m³ (vapor), skin. (Vacated 1989 Final Rule Limit)

ACGIH TLVs
TWA: 0.025 mg/m³ (inorganic compounds), skin

NIOSH REL
10-hr TWA: 0.05 mg/m³ (vapor), skin

DFG (Germany) MAK
TWA: 0.01 ppm (0.1 mg/m³)
Category III: Substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:
0.1 ppm (1 mg/m³), 30 min. average value, 1/shift

IDLH Level
28 mg/m³

Section 3 - Hazards Identification

⭐⭐⭐⭐⭐ Emergency Overview ⭐⭐⭐⭐⭐

Mercury exists as a heavy, odorless, silver-white liquid metal. It is highly toxic by both acute and chronic exposure. Exposure can cause corrosion of the eyes, skin, and respiratory tract and may result in irreversible nervous system damage. It readily forms amalgamations with most metals except iron.

Potential Health Effects

Primary Entry Routes: Inhalation, eye and skin contact/absorption.
Target Organs: Central nervous system, eyes, skin, respiratory system, liver, kidneys.

Acute Effects
Inhalation: Exposure to high vapor concentrations can cause severe respiratory damage. Other symptoms include wakefulness, muscle weakness, anorexia, headache, ringing in the ear, headache, diarrhea, liver changes, fever, gingivitis, chest pain, difficulty breathing, cough, inflammation of the mouth (stomatitis), salivation, bronchitis, and pneumonia. Acrodermatitis (pink or Swifts disease), characterized by redness and peeling of the skin on the toes and fingers, was commonly seen in children in the 1950s and is still infrequently seen in workers.
Eye: Irritation and corrosion.
Skin: Skin can become severely irritated if allowed to remain in contact with mercury. Skin absorption will occur at 2.2% of the rate of absorption through the lungs.
Ingestion: Mercury generally passes through the digestive tract uneventfully. However, large amounts may get caught up in the intestine and require surgical removal. If an abscess or other perforation is present along the digestive tract, absorption into the bloodstream with subsequent mercury poisoning is possible.
Carcinogenicity: IARC, NTP, and OSHA do not list mercury as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.

Chronic Effects: Chronic exposure appears more common than acute and is primarily associated with central nervous system damage which can be permanent (ex. ataxia of the hands, lips, feet). Early signs of toxicity include weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. If exposure levels are high, characteristic tremors of the fingers, eyelids, and lips occur with progression to generalized tremors of the entire body. Psychotic disorders are noticeable and characterized by behavior and personality changes, increased excitability, memory loss, insomnia, and depression. In severe cases, delirium and
hallucinations may occur. Kidney damage is observed with oliguria (decreased urine output) progressing to anuria (urine cessation) and may require dialysis. The cornea and lens of the eyes may take on a brownish discoloration and the extraocular muscles may be damaged. This syndrome has been termed Asthenic-vegetative Syndrome or Micromercurialism. Chronic symptoms occur increasingly with exposures to 0.1 mg/m^3 or higher. Mutation: Aneuploidy and other chromosomal aberrations have been observed in the lymphocytes from whole blood cultures in workers exposed to mercury. Reproductive: Mercury has been detected in stillborn babies of women treated with mercury for syphilis. In a study of six men acutely exposed (occupationally) to mercury levels as high as 44 mg/m^3, all suffered impaired sexual function. Repeated skin contact may cause allergic dermatitis in some individuals. 

NOTE: Spilled mercury will release sufficient vapor over time to produce chronic poisoning.

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 with flooding amounts of water and then wash exposed area with soap. 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. In general, mercury will pass through the digestive tract uneventfully.

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

Note to Physicians: B/E: blood (15 µg/L), urine: (35 µg/g creatinine). Extremely high urine levels of 0.5 to 0.85 mg Hg/L are indicative of polyneuropathy. 0.4 to 22 µg/L is reported to be the human lethal blood level. Obtain urinalysis including at a minimum: albumin, glucose, and a microscopic examination of centrifuged sediment. Use BAL or 2, 3-dimercaptosuccinic acid as chelators. Do not use calcium sodium EDTA because of nephrotoxicity. An electromyograph may determine extent of nerve dysfunction. It has been noted that exposure to mercury may predispose persons to development of carpal tunnel syndrome.

Section 5 - Fire-Fighting Measures

Flash Point: Nonflammable
Autoignition Temperature: Nonflammable
LEL: None reported.
UEL: None reported.
Extinguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: None reported.
Hazardous Combustion Products: Toxic mercury vapor and mercuric oxide.
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: Keep a mercury spill kit readily available in areas where mercury is used. Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind.
Small and Large Spills: Follow instructions on mercury spill kit. Most kits come with an aspiration-driven vacuum trap with a mercury "sweeper" (copper or copper-plated brush). Wash spill area with a dilute calcium sulfide or nitric acid solution. If spill cannot be taken up readily, dust the top of the spill with flowers of sulfur or preferably, calcium polysulfide. This will produce a surface coating of mercury sulfide which will reduce mercury vapor dispersion into the air.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use appropriate PPE when working with mercury. Do not use on porous work surfaces (wood, unsealed concrete, etc.) to prevent spills from lodging in cracks.
Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and incompatibles (Sec. 10). Store on non-porous floors and wash them regularly with a dilute calcium sulfide solution. Because mercury will form amalgamations with most metals except iron, metal shelves should be painted with a sufficiently thick coating to prevent this from happening.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Wherever possible, enclose processes to prevent mercury vapor dispersion 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 pre-placement and periodic medical exams of exposed workers with emphasis on the skin, eyes, central nervous system, 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. For ≤ 0.5 mg/m^3, use any chemical cartridge.
respirator with cartridges providing protection against mercury and equipped with an ESLI (end of service life indicator), any SCBA, or any SAR (supplied-air respirator). For ≤ 1.25 mg/m³, use any SAR operated in continuous-flow mode, any PAPR (powered, air-purifying respirator) with an ESLI. For ≤ 2.5 mg/m³, use any SCBA or SAR with a full facepiece, any SAR with a tight-fitting facepiece and operated in continuous-flow mode, or any chemical cartridge respirator with a full facepiece, chemical cartridges providing protection against mercury, and equipped with an ESLI. For ≤ 528 mg/m³, use any SAR operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA with full facepiece and 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 made of butyl rubber, nitrile rubber, fluorocarbon rubber, neoprene rubber, polyvinyl chloride, chlorinated polyethylene, or polycarbonate 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 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 - Physical and Chemical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical State</td>
<td>Liquid metal</td>
</tr>
<tr>
<td>Appearance and Odor</td>
<td>Silvery-white, odorless</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>0.0018 mm Hg at 77 °F (25 °C)</td>
</tr>
<tr>
<td>Formula Weight</td>
<td>200.59</td>
</tr>
<tr>
<td>Density (H₂O=1)</td>
<td>13.534 g/cm³ at 77 °F (25 °C)</td>
</tr>
<tr>
<td>Boiling Point</td>
<td>674.09 °F (356.72 °C)</td>
</tr>
<tr>
<td>Freezing Point</td>
<td>-37.97 °F (-38.87 °C)</td>
</tr>
<tr>
<td>Viscosity</td>
<td>15.5 mPa s at 77 °F (25 °C)</td>
</tr>
<tr>
<td>Electrical Resistivity</td>
<td>95.76 µohm at 68 °F (20 °C)</td>
</tr>
<tr>
<td>Water Solubility</td>
<td>0.28 µmol/L at 77 °F (25 °C)</td>
</tr>
<tr>
<td>Other Solubilities</td>
<td>Soluble in boiling sulfuric acid, nitric acid (reacts); slightly in lipids, and 2.7 mg/L in pentane. Insoluble in alcohol, ether, cold sulfuric acid, hydrogen bromide, and hydrogen iodide.</td>
</tr>
<tr>
<td>Surface Tension</td>
<td>484 dyne/cm at 77 °F (25 °C)</td>
</tr>
<tr>
<td>Critical Temperature</td>
<td>2664 °F (1462 °C)</td>
</tr>
<tr>
<td>Critical Pressure</td>
<td>1587 atm</td>
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</tbody>
</table>

### Section 10 - Stability and Reactivity

**Stability:** Mercury does not tarnish at ordinary temperatures but when heated to near its boiling point, it slowly oxidizes to mercuric oxide.

**Polymerization:** Hazardous polymerization does not occur.

**Chemical Incompatibilities:** Mercury forms alloys (amalgamates) with most metals except iron. It is incompatible with oxidizers such as bromine, 3-bromopropyne, methylisocyanate + oxygen, chlorine, chlorine dioxide, nitric acid, or peroxyformic acid; tetracarbonyl nickel + oxygen, alkynes + silver perchlorate, ethylene oxide, acetylene compounds (explosive), boron phosphodiiodide, methyl azide, nitromethane, and ground sodium carbide.

**Conditions to Avoid:** Exposure to high temperatures, metal surfaces or incompatibles.

**Hazardous Decomposition Products:** Thermal oxidative decomposition of mercury can produce mercuric oxide.

### Section 11- Toxicological Information

**Toxicity Data:**

**Reproductive:**
Rat, inhalation: 890 ng/m³/24 hr for 16 weeks prior to mating had an effect on spermatogenesis.

**Acute Dermal Toxicity:**
Man, skin, TDL₉₀: 129 mg/kg for 5 continuous hours caused ringing in the ears, headache, and allergic dermatitis.

**Acute Oral Toxicity:**
Man, oral, TDL₉₀: 43 mg/kg caused tremor and jaundice or other liver changes.

* See NIOSH, RTECS (OV455000), for additional toxicity data.

**Acute Inhalation Effects:**
Woman, inhalation, T(50): 150 µg/m³/46 days caused anorexia, diarrhea, and wakefulness.
Man, inhalation, T(50): 44300 µg/m³/8 hr caused muscle weakness, liver changes, and increased body temperature.

**Chronic Effects:**
Rat, inhalation: 1 mg/m³/24 hr for 5 continuous weeks caused proteinuria.
Section 12 - Ecological Information

Ecotoxicity: Catfish, LC₅₀ = 0.35 mg/L/96 hr; mollusk (Modiolus carvalhoi), LC₅₀ = 0.19 ppm/96 hr; tadpole (Rana hexadactyla), LC₅₀ = 0.051 ppm/96 hr. Mercury is transformed to methyl mercury by bacteria in the environment and undergoes bioaccumulation readily. BCF for freshwater fish = 63,000; for saltwater fish = 10,000; and for marine and freshwater invertebrates = 100,000.

Environmental Degradation: Mercury is expected to volatilize rapidly when deposited on soil surfaces. Once in the air, it can be transported long distances before being redeposited on soil or in water. In water, mercury appears to bind to particulates where it eventually becomes deposited on the bed sediment. In general, mercury entering the environment can be deposited and volatilized several times.

Section 13 - Disposal Considerations

Disposal: Incineration is not an appropriate disposal method. Wastewater may be treated by addition of chlorine to oxidize the mercury to its ionic state. The water can then be passed through an absorbent (an activated charcoal concentrate with a sulfur coating or peanut shell charcoal) to collect the ionic mercury, followed by distillation to recover the mercury. Sodium borohydride, a reducing agent, can be used to precipitate mercury from waste solutions. Bioremediation, using Pseudomonas putida, has also been suggested. 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: Mercury
Shipping Symbols: A, W
Hazard Class: 8
ID No.: UN2809
Packing Group: III
Label: Corrosive
Special Provisions (172.102): —

Packaging Authorizations
a) Exceptions: 173.164
b) Non-bulk Packaging: 173.164
c) Bulk Packaging: 173.240

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 35 kg
b) Cargo Aircraft Only: 35 kg

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: 40, 97

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33): U151
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
SARA 311/312 Codes: 1, 2
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, 103, 124, 132, 136, 148, 149, 159, 167, 176, 187, 189

Prepared By ...................... M Gannon, BA
Industrial Hygiene Review .......... RE Langford, PhD, CHI
Medical Review ................... T Thoburn, MD, MPH

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Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Asbestos
Chemical Formula: actinolite, Ca₂(Fe²⁺, Mg)₅Si₃O₂₂(OH)₂; amosite, (Fe²⁺,Mg)₇Si₈O₂₂(OH)₂; anthophyllite, (Mg, Fe²⁺)₇Si₈O₂₂(OH)₂; chrysotile, Mg₅Si₃O₁₃(OH)₄; crocidolite, (Fe²⁺,Mg)₃Fe³⁺₂Si₈O₂₂(OH)₂; tremolite, Ca₂Mg₂Si₅O₁₁(OH)₂;
CAS Number: CAS No. 1332-21-4, asbestos; CAS No. 12172-73-5, amosite, brown asbestos; CAS No. 12001-29-5, chrysotile, white asbestos; CAS No. 12001-28-4, crocidolite, blue asbestos; CAS No. 17068-78-9, anthophyllite; CAS No. 13768-00-8, actinolite
Synonyms: actinolite; ascarite; amosite; anthophyllite; chrysotile; crocidolite; earth flax; mountain cork; stone flax; tremolite
Derivation: Asbestos is a generic term applied to many naturally occurring, hydrated silicates (minerals) found in rock which separate into flexible fibers when crushed or processed. Commercially important forms are amosite, anthophyllite (mined and used only in Finland), chrysotile, and crocidolite. Other types include tremolite and actinolite.

General Use: Chrysotile was most widely used in US industry. Since asbestos is sensitive to chemical attack and incompatible, asbestos has been used in more than 5,000 products including thermal and electrical insulation, roofing, cement pipe and sheet flooring, friction materials, gaskets, coatings, plastics, textiles, and paper products. However, due to its health hazards, other materials are now replacing it wherever possible. Under TSCA, EPA proposed to prohibit or phase out the manufacture and use of asbestos in certain products. EPA issued a final rule banning the manufacture, importation, processing, and distribution of most asbestos-containing products. Between 1950 and 1972 asbestos was used as spray insulation in buildings, but OSHA now prohibits spray application of actinolite, anthophyllite, asbestiform, or tremolite (29 CFR 1910.1001).

Section 2 - Composition / Information on Ingredients

Asbestos, ca 100 %wt
Trace Impurities: Metals including nickel, cobalt, chromium, manganese, beryllium, cadmium, copper, and thallium; other fibrous materials including tremolite and brucite; and oils and waxes.

OSHA PELs*
8-hr TWA: 0.1 f/cc
30-min STEL: 1 f/cc
Carcinogen - See 29 CFR 1910.1001

NIOSH REL
10-hr TWA: 0.1 f/cc
Carcinogen - Use 29 CFR 1910.1001

ACGIH TLVs†
Amosite (12172-73-5): TWA: 0.5 f/cc ‡
Chrysotile (12001-29-5): TWA: 2 f/cc
Crocidolite (12001-28-4): TWA: 0.2 f/cc
Asbestos, other forms: TWA: 2 f/cc

ACGIH TLVs — Occupational Exposure Limits

IDLH Level
Not determined

*The following limits are applicable for amosite (12172-73-5), chrysotile (12001-29-5), crocidolite (12001-28-4), and asbestos, other forms.
† Notice of Intended Change: 0.1 f/cc
‡ Fibers longer than 5 μm; aspect ratio ≥ 3:1 as determined by the membrane filter method at 400-450X magnification (4-mm objective) phase contrast illumination.

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆
White or greenish (chrysotile), blue (crocidolite), or gray-green (amosite) fibrous, odorless solids. Asbestos causes three specific diseases: asbestosis (fibrous lung scarring), lung cancer, and mesothelioma (cancer of the chest lining and abdominal cavities). These diseases typically develop decades (20 to 40 yr) after exposure begins, but may occur sooner. Prevent or minimize asbestos exposure.

Potential Health Effects
Primary Entry Routes: Inhalation, ingestion, skin and/or eye contact
Target Organs: Respiratory system, eyes; possibly digestive system

Acute Effects
Inhalation: Nose and throat irritation are possible with high exposure.
Eye: Irritation.
Skin: Irritation with exposure to high concentrations.
Ingestion: Gastrointestinal tract irritation is possible.

Carcinogenicity: IARC, NTP, OSHA, ACGIH, NIOSH, EPA, and MAK list asbestos as IARC-1 (carcinogenic to humans), NTP-1 (known to be a carcinogen), OSHA-X (carcinogen defined with no further categorization),
ACGIH-TLV-A1 (confirmed human carcinogen), EPA-A (human carcinogen), and MAK-A1 (capable of inducing malignant tumors as shown by human experience).

Medical Conditions Aggravated by Long-Term Exposure: Long-term, high-level exposure may aggravate any chronic lung (asthma, emphysema, bronchitis) or heart condition.

Chronic Effects: Asbestos may cause 1) asbestosis, 2) lung cancer, 3) mesothelioma, 4) pleural plaques, and 5) several other forms of cancer. Asbestosis is fibrosis (scarring) of lung tissue after many years of high-level occupational exposure. Scarring may be progressive even after exposure ceases. Even though detectable in lungs of a high proportion of adults in industrialized areas, asbestosis does not result from lower level environmental exposure. Its symptoms range from mild shortness of breath and dry cough to severe disabling breathlessness, heart failure, and ultimately death. Lung scarring can be seen on X-ray and alterations in lung function can be detected with spirometry (a medical test). Examination typically detects rales (crackling sounds in lungs). Severe cases may have cyanosis (bluish skin discoloration) and clubbing of fingertips. Lung cancer can result from lower exposure levels than asbestosis, but also takes many years to develop. Smokers exposed to asbestos are at 5 to 10X higher risk than exposed nonsmokers. Mesothelioma is a very aggressive cancer of the pleura (lining around the lungs) or peritoneum (lining of the abdomen), and develops after decades of (sometimes low level) exposure. Symptoms may include chest and abdominal pain, weight loss, and/or shortness of breath, with death within 2 years of diagnosis. Pleural plaques are thickenings, sometimes with calcium deposits, of the lung's lining and may be seen on X-ray. While not associated specifically with health effects, they indicate significant exposure. Other sites of cancer include larynx (vocal cords), portions of digestive tract, and possibly the kidney. Asbestos's toxicity depends on fiber type (crocidolite > amosite > chrysotile), size (longer > shorter), shape (long, thin needle-like > curly), and solubility. Health effects depend on dose (exposure concentration and duration), smoking habits, and individual susceptibility.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air. Clean any fibers from nose and mouth. Encourage victim to cough, spit, and blow nose to remove fibers.

Eye Contact: Do not rub. Gently lift eyelids and flush with flooding amounts of water.

Skin Contact: Shower with water and soap. Wet contaminated clothing prior to removal and seal in a plastic bag for disposal as hazardous waste. If rash develops, consult physician.

Ingestion: Induce vomiting only if awake and alert. Consult a physician.

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

Note to Physicians: Asbestosis diagnosis is based on chest X-ray with an abnormal ILO "B" reading (small irregular opacities), rales, restrictive pattern spirometry, adequate exposure history, and symptoms. Consider pneumovax, annual flu shot, and other supportive treatment as needed. See Sec. 8, Administrative Controls for specific recommendations for medical surveillance.

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

Section 5 - Fire-Fighting Measures

Flash Point: Not applicable (NA); noncombustible solid.

Autoignition Temperature: NA

LEL: NA

UEL: NA

Extinguishing Media: Use extinguishing media appropriate for surrounding fire. Wet asbestos fibers with water spray to prevent dust generation. Do not scatter spilled asbestos with high-pressure water streams.

Unusual Fire or Explosion Hazards: None reported.

Hazardous Combustion Products: None; noncombustible solid.

Fire-Fighting Instructions: Isolate hazard area and deny entry. Avoid asbestos dust generation and inhalation; it may have damaging effects on the lungs. Do not release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because there may be airborne asbestos fibers, 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 and evacuate all unnecessary personnel. Cleanup personnel should protect against dust inhalation and skin or eye contact. Avoid dust generation, blowing, dry brushing, and dry mopping. Provide HEPA-filtered (high-efficiency particulate air) portable ventilation systems. Use wet cleaning methods or approved HEPA vacuum cleaning system to pick up spills. The techniques used must collect particulate without dispersing dust into air. Place waste in properly labeled dust-tight containers or sealed, heavy-gauge, impervious plastic bags for disposal.

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

Section 7 - Handling and Storage

Handling Precautions: Avoid any exposure to asbestos. Work with asbestos only in a sufficient wet state to prevent emission of airborne fibers. Practice good personal hygiene and housekeeping procedures. Use only with ventilation sufficient to reduce airborne concentrations to the lowest feasible level. Wear personal protective clothing and equipment and respiratory protection. Inhaling or ingesting asbestos fibers from contaminated clothing or skin can be hazardous. Do not allow dusts and asbestos-containing wastes to accumulate.
Storage Requirements: Store in closed (dust-tight) containers or heavy-gauge impervious plastic bags in a clean, secure area protected from physical damage. Do not open containers that can release asbestos dust without providing proper enclosure or control measure.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Enclose all operations and provide local exhaust ventilation and dust collection systems at the site of release to prevent airborne dispersion.

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: Educate workers about asbestos and asbestos-containing materials' hazards. Inform employees of asbestos standard (29 CFR 1910.1001). Exposure to asbestos, tremolite, anthophyllite, and actinolite in construction work is covered by 29 CFR 1926.58. Instruct employees in proper practices for handling asbestos-containing materials and correct use of protective equipment. Prevent or minimize asbestos exposure. Regulate areas where exposure in excess of the PEL is likely. Post warning signs in all regulated areas. Do not substitute personal protective equipment for proper handling and engineering controls. If exposures exceed the PEL, ensure employees wear appropriate protective clothing. Monitor work areas that expose employees to airborne concentrations at or above the action level (Sec. 2). Whenever production, process, control equipment, personnel, or work practices change, institute new monitoring. Medical surveillance is required for all employees possibly exposed at or above the action level. Provide preplacement medical examination that includes complete medical and work history, complete physical examination that emphasizes respiratory and cardiovascular systems and digestive tract, the respiratory disease standardized questionnaire, a posterior-anterior 14" x 17" chest roentgenogram, and pulmonary function tests [FVC and FEV(1)]. Annual periodic medical examinations shall include all these elements and an abbreviated questionnaire. Encourage smoking cessation due to synergistic effects of smoking and asbestos exposure. If it is 10+ years since first asbestos exposure, an individual should have a chest roentgenogram: every 5 years (ages 15 to 35), every 2 years (ages 35 to 45), every year (age 45+). Within 30 days of employment termination, an individual should receive a periodic medical examination with the elements listed above. Keep medical surveillance records for duration of employment, plus 30 years.

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. At concentrations above the NIOSH REL or at any detectable concentration, wear any SCBA that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode (assigned protection factor = 10,000); 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 or other positive-pressure mode (assigned protection factor = 10,000). For escape wear an air-purifying, full-facepiece respirator with a high-efficiency particulate filter; or any appropriate escape-type, SCBA. 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 coveralls or gauntlets made of cotton polyester material; head-coverings; and foot coverings such as canvas boots, rubber galoshes or safety shoes. 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 contact lenses.

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

Contaminated Equipment: Place contaminated protective devices or work clothing in labeled, impermeable, and sealed containers or bags. Separate contaminated work clothes from street clothes. Do not remove asbestos from clothing by blowing or shaking. Launder contaminated clothing before wearing. Inform laundring service of asbestos-contaminated clothing and of asbestos' potential harmful effects (29 CFR 1910.1001). A vacuum with HEPA filter may be used to remove asbestos fibers.

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 - Physical and Chemical Properties

Physical State: Solid
Appearance and Odor: White or greenish (chrysotile), blue (crocidolite), or gray-green (amosite) fibrous, odorless solids

Formula Weight: Varies with asbestos form (See Sec. 1)
Water Solubility: Insoluble
Melting Point: Decomposes

Section 10 - Stability and Reactivity

Stability: Asbestos is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Strong acids can attack chrysotile and rapidly extract its MgO and H2O content; glacial acetic acid can decompose it. Hot water slowly breaks down chrysotile. Like other asbestos forms, it resists strong alkali [(SM NaOH at least up to 212 °F (100 °C)].

Conditions to Avoid: Airborne dispersion of asbestos fibers.

Hazardous Decomposition Products: It is heat resistant, but decomposes and alters its microscopic fiber structure above 1112 °F (600 °C). Chrysotile dehydroxylates at 1112 to 1436 °F (600 to 780 °C); the "asbestos anhydride" in turn breaks down to a mixture of silica (SiO2) and festerite (Mg2SiO4) at 1472 to 1562 °F (800 to 850 °C). Above 1832 °F (1000 °C), magnesium pyroxenes form and melt at ~2642 °F (1450 °C).
Section 11 - Toxicological Information

Toxicity Data:*  

Acute Inhalation Effects:  
Human, inhalation, TC_{50}: 1.2 fb/cc/19 yr/continuous; toxic effects: pleural effusion, dyspnea, and sputum.

Genetic Effects:  
E. coli: 10 mg/plate (+/-S9) produced mutations.

Tumorigenicity:  
Rat, implant: 750 mg/kg; toxic effects: equivocal tumorigenic agent by RTECS criteria; tumors at site of application.  
Mouse, intraperitoneal: 80 mg/kg; toxic effects: equivocal tumorigenic agent by RTECS criteria; tumors at site of application.  
*NIOSH, RTECS (C16475000; CAS No.: 1332-21-4)

Section 12 - Ecological Information

Environmental Fate: As a mineral asbestos is not affected by photolytic processes. It is considered to be nonbiodegradable by aquatic organisms; no evidence was found regarding bioaccumulation in aquatic organisms.

Soil Adsorption/Mobility: Although some trace metals and organic compounds have an affinity for asbestos minerals, asbestos itself does not have an adsorptive affinity for the solids normally found in natural water systems.

Section 13 - Disposal Considerations

Disposal: Asbestos is a poor candidate for incineration. Place asbestos and asbestos-containing wastes into good quality plastic bags and bury in a landfill. 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):

<table>
<thead>
<tr>
<th>Shipping Name: Asbestos</th>
<th>Packaging Authorizations</th>
<th>Quantity Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipping Symbols: D</td>
<td>a) Exceptions: 173.155</td>
<td>a) Passenger, Aircraft, or Railcar: 200 kg</td>
</tr>
<tr>
<td>Hazard Class: 9</td>
<td>b) Non-bulk Packaging: 173.216</td>
<td>b) Cargo Aircraft Only: 200 kg</td>
</tr>
<tr>
<td>ID No.: NA2212</td>
<td>c) Bulk Packaging: 173.240</td>
<td>Vessel Stowage Requirements</td>
</tr>
<tr>
<td>Packing Group: III</td>
<td></td>
<td>a) Vessel Stowage: A</td>
</tr>
<tr>
<td>Label: CLASS 9</td>
<td></td>
<td>b) Other: 34, 40</td>
</tr>
<tr>
<td>Special Provisions (172.102): None listed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Section 15 - Regulatory Information

EPA Regulations:  
RCRA Hazardous Waste (40 CFR 261.33): Not listed  
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA, Sec. 307(a) and CAA, Sec. 112.  
CERCLA Final Reportable Quantity (RQ), 1 lb (0.454 kg); the RQ is limited to friable forms only  
Listed as a SARA Toxic Chemical (40 CFR 372.65), as asbestos (friable); effective date 1/1/87.  
SARA EHS ( Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:  
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)  
Listed as an OSHA Specifically Regulated Substance (29 CFR 1910.1001)

Section 16 - Other Information

References: 73, 103, 124, 136, 139, 147, 167, 184, 190, 197, 198, 209, 223

Prepared By ......................... MJ Wurth, BS
Industrial Hygiene Review ........... DJ Wilson, CIH
Medical Review ..................... G Kelafant, MD

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Section 1. Material Identification

Arsenic Description: Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an N₂ current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for diodes and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.

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

Manufacturer: Contact your supplier or distributor. Consult the latest Chemicalweek Buyers’ Guide for a suppliers list.

Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

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

NIOSH REL, 1987
Ceiling: 0.002 mg/m³

ACGIH TLV, 1989-90
TLV-TWA: 0.2 mg/m³

Toxicity Data†
- Man, oral, TD₅₀: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)
- Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes
- Rat, oral, TC₅₀: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

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

Section 3. Physical Data*

Boiling Point: sublimes at 1134 °F/612 °C
Melting Point: 1497 °F/814 °C
Vapor Pressure: 1 mm at 702 °F/372 °C (sublimes)

Atomic Weight: 74.92
Density: 5.724 at 57 °F/14 °C
Water Solubility: Insoluble†

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

* This data pertains to arsenic only.
† Arsenic is soluble in nitric acid (HNO₃).

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, CO₂, water spray, or foam to fight fires.

Unusual Fire or Explosion Hazards: Flammable and slightly explosive in the form of dust when exposed to heat or flame.

Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

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

Chemical Incompatibilities: Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, and diborane acetylide, zinc, and platinum.

Hazardous Products of Decomposition: Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.
Section 6. Health Hazard Data

Carcinogenicity: The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorogenic and teratogenic effects in laboratory animals.

Summary of Risks: Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or purulent eruption. Epidermal carcinoma is a reported effect. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, paresthesia, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.

Medical Conditions Aggravated by Long-Term Exposure: Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood) systems in the body system may be permanent. Pulmonary and lymphatic cancer may also occur.

Target Organs: Liver, kidneys, skin, lungs, lymphatic system.

Primary Entry Routes: Inhalation, ingestion of dust and fumes, skin contact, and eye contact.

Acute Effects: Acute industrial intoxication is more likely to arise from inhalation of arsenic. However, with corrosive arsenical vapors, conjunctivitis, eye pain, and even death may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours. If ingestion of food, acute poisoning may result in acute hemolysis (breakdown of red blood cells).

Chronic Effects: Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratosis (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.

FIRST AID

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

Skin: Quickly remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

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

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

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

Physical Injuries: There is no evidence that exposure is harmful through inhalation, ingestion, or smoking, for persons exposed to normal occupational exposure. Skin contact is not harmful if exposed to normal occupational exposure. Physical injuries are usually self-limiting.

Section 7. Spill, Leak, and Disposal Procedures

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

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

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: Gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airbrohe concentrations below the OSHA PELS, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.

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

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

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

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.

Engineering Controls: Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide supplementary and annual physical examination with emphasis on the skin, respiratory system, and blood.

DOT Shipping Data (49 CFR 172.101, 102)

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

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

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Section 1. Material Identification

Chromic Acid (Cr₂O₃) Description: Produced by roasting chromite ore with alkali or lime, leaching with calcium oxide, crystallizing the chromate or dichromate, and then treating it with an excess of sulfuric acid. Used in ceramic glazes, colored glass, dyes, batteries, explosives, water treatment, wood treatment and preservatives, refractories, copper striping, aluminum anodizing, photomechanical processing, chromium metal plating, purifying oil and acetylene, hardening microscopic preparations, and manufacturing chromated copper arsenate; as a corrosion inhibitor, a catalyst, an oxidizing agent in organic chemistry, and an etchant for plastics.

Other Designations: CAS No. 1333-82-0; chromic acid; chromic acid, solid (DOT); chromium anhydride; chromium (VI) oxide; chromium trioxide; chromium trioxide; chromium trioxide; monochromium trioxide; perchromium trioxide. Chromium acid is the commonly used name, although true chromic acid (Cr₂O₃, CAS No. 7738-94-5) cannot be isolated from solution. Chromium acid and chromates (as Cr₂O₃, CAS No. 7744-0-7) are very unstable and may disproportionate in the presence of water.

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

Caution: A powerful oxidizer, chromic acid may explode on contact with reducing agents and cause ignition on contact with organic materials. This poison and human carcinogen is corrosive to skin and irritating to mucous membranes. Eye contact may cause permanent blindness.

Section 2. Ingredients and Occupational Exposure Limits

Chromic acid, 99% Cr₂O₃
1990 OSHA PEL Ceiling: 0.1 mg Cr₂O₃/m³
1987 IDLH Level 30 mg/m³

1990 ACGIH TLVs TWA: 0.05 mg (Cr₂O₃)/m³ Ceiling: 0.1 mg/m³
1990 NIOSH REL TWA: 0.025 mg (Cr₂O₃)/m³ Ceiling: 0.05 mg/m³

1985-86 Toxicity Data
Rat, oral, LD₅₀: 80 mg/kg
Mouse, oral, LD₅₀: 177 mg/kg
Human, inhalation, LC₅₀: exposed continuously to 110 μg over 3 years. Toxic effects include tumorogenic (carcinogenic by RTECS criteria); sense organs and special senses (olfaction tumors); lungs, thorax, or respiration (tumors).

Dogs, subcutaneous, LD₅₀: 330 mg/kg

* See NIOSH, RTECS (GB6650000), for additional mutative, reproductive, toxicity and tumorogenic data.

Section 3. Physical Data

Boiling Point: Decomposes at 482 °F (250 °C) to Cr₂O₃ + O₂
Melting Point: 385 °F (196 °C)
Molecular Weight: 99.98

* These physical data apply only to chromic acid (CAS No. 1333-82-0).

Section 4. Fire and Explosion Data

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

Extinguishing Media: Chromic acid is noncombustible, but accelerates burning of combustibles (wood, paper, oil). For small fires, use only water, not dry chemical, carbon dioxide (CO₂), or halon.

Unusual Fire or Explosion Hazards: A powerful oxidizer, chromic acid ignites on contact with acetic acid and alcohol. It may react rapidly with combustible materials to cause ignition. Containers may explode if involved in fire.

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. Cool fire-exposed containers with flooding amounts of water since the decomposing material may form a hot, viscous foam that can cause containers to rupture and explode. Use caution! For larger fires, flood area from a safe distance, and cool containers from the side with a water spray until after fire is well out. If possible without risk, move containers. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holder. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polimerization: Chromic acid is generally stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: This material is incompatible with acetic acid, acetic anhydride, acetone, alcohols, alkali metals, ammonia, arsenic, anthracene, benzene, bromine pentafluorine, butyric acid, camphor, chromous sulfide, diethyl ether, glycerol, hydrogen sulfide, methyl alcohol, naphthalene, peroxycyric acid, phosphorus, potassium hexacyanoferrate, pyridine, sodium, and turpentine. Chromic acid oxidizes ethyl alcohol and many hydrocarbons.

Conditions to Avoid: Avoid excess heat and contact with combustible or organic materials.

Hazardous Products of Decomposition: Thermal oxidative decomposition of chromic acid can produce carbon dioxide, smoke, and irritating toxic fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC and NTP list chromic acid and other forms of hexavalent (VI) chromium as human carcinogens.

Summary of Risks: Chromic acid is a poison and a powerful irritant to skin, eyes, and respiratory tract. Skin or lung sensitization (allergic reactions) may occur. Exposure can cause dermatitis (skin rash), asthma, pulmonary edema (fluid in lungs), kidney damage, a "chrome hole," or a perforation of the nasal septum (tissue between nostrils).

Medical Conditions Aggravated by Long-Term Exposure: Any chronic lung or skin condition.

Target Organs: Skin, respiratory tract (including nose, throat, airways, and lungs), and kidney.

Primary Entry Routes: Eyes, skin contact, inhalation, and ingestion.

Acute Effects: Inhalation may cause irritation or burning of nose, throat, and air passages, cough, wheezing, and shortness of breath. Higher exposures may cause pulmonary edema (fluid in lungs). Skin exposure may cause dermatitis (skin rash), irritation, burning, itching, redness, and ulceration (skin destruction) which may penetrate. Eye contact can cause irritation, burning, lacrimation (watering), loss of sight and permanent blindness if not removed quickly.

Chronic Effects: Chronic inhalation of excessive levels may cause epistaxis (nosebleed), "chrome holes," nasal congestion, tooth enamel erosion, chest pain, asthma (via allergic sensitization), bronchitis, or respiratory tract cancer. Chronic eye exposure may cause conjunctivitis. Skin contact

Continue on next page
Section 6. Health Hazard Data, continued

can cause irritant or allergic contact dermatitis, or skin ulceration. Chronic systemic absorption could cause liver or kidney damage.

FIRST AID

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

Skin: Rinse with flowing amounts of water for at least 15 min, and wash with a gentle soap. Promptly remove contaminated clothing. For redness, blistering, or persistent irritation, 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. If ingested, have that conscious person drink 1 to 2 glasses of water. Do not induce vomiting since this worsens the victim’s condition. Do not neutralize this acid.

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

Note to Physicians: After decontamination and neutralization, treatment of acid burns is similar to that of thermal burns, although bullae and loose necrotic tissue may be debrided. Update tetanus status for severe acid burns; fluid resuscitation is critical to prevent mortality from hypovolemia and renal failure. Monitor serial vital signs, urine output, electrolytes, blood count, and urinalysis as clinically indicated. Neurovascular compromise distal to a circumferential extremity burn may require escharotomy or fasciotomy. For inhalation exposures to acids, a CXR, EKG, ABGs, PFTs, SMA, and CBC may aid in treatment. Evaluate and treat as indicated for reactive Airways, upper airway obstruction and noncardiogenic pulmonary edema (possibly delayed onset). Although literature documentation is inadequate, a burst of steroids may help prevent development of sequelae such as reactive Airways dysfunction syndrome or bronchiolitis obliterans. For ocular exposures to acids, ensure adequate decontamination. Determination of pH may be helpful. A Morgan Lens® and topical anesthesia may aid in irrigation. Perform fluorescein staining and slit lamp evaluation and consult an ophthalmologist. Antibiotic ointments, mydriatics/cycloplegics, topical corticosteroids (after epithelial recovery), patching, and possibly anterior chamber paracentesis may be indicated depending on clinical presentation. Acutely and in follow-up, evaluate as indicated for intraocular pressure, laceral, lid, and conjunctival function, corneal integrity and infection. Urinary chromium is of questionable value.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel. Cleanup personnel should protect against dust inhalation and eye contact. Do not handle broken packages unless wearing appropriate personal protective equipment. Keep combustibles (wood, paper, etc.) away from spillage material. Whenever possible, use wet cleanup methods; if not, use vacuum cleanup. Remove spills immediately to prevent dust dispersion. For a water spill, neutralize with agricultural lime, crushed limestone, or sodium bicarbonate. This material’s surfactant makes it hazardous to the environment in its hexavalent state. For transportation, the recommended disposal method is incineration, precipitation, or ion exchange. Landfill disposal is not recommended since it raises soil acidity.

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 261.22): Corrosive waste

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 10 lb (4.54 kg) [*per Clean Water Act, Sec. 311(b)(4)]

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, Tables Z-1-A and Z-2)

* Chronic acid (CAS No. 7738-94-5) is 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, wear a NIOSH-approved respirator. For 0.5 mg/m³ concentrations, use any dust and mist respirator except single-use and quarter-mask respirators. For 1.25 mg/m³ concentrations, use any powered air-purifying respirator with a high-efficiency particulate filter. For 2.5 mg/m³ concentrations, use any air-purifying full facepiece respirator with a high-efficiency particulate filter. For 30 mg/m³ concentrations, use any supplied air respirator with fresh air supplied to its source.

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below occupational exposure levels. Local exhaust ventilation is recommended. It prevents permanent lung damage from exposure.

Other: Provide approved respirators to workers in chlorine environments.

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

Other: Contact lenses may minimize or worsen eye injuries. In some cases, soft lenses can actually protect eyes, not worsen corneal damage, due to strong chemicals. In other cases, chemical entrapment is presumed a possible hazard. Since contact lens use in industry is controversial, establish your own policy. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Other: 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 glass bottles, cans, or drums. Protect against physical damage. Separate from combustible, organic, or other easily oxidizable materials. Protect from excess moisture which could cause containers to rust. Do not store on wooden floors. Store away from foods and flammable liquids and solids.

Engineering Controls: Avoid dust inhalation and skin or eye contact. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good housekeeping procedures.

Other Precautions: Institute preplacement and periodic medical exams of exposed workers with attention to the skin and respiratory tract. Consider preplacement and periodic chest radiographs.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Chronic acid, solid

IMO Shipping Name: Chromium trioxide, anhydrous

DOT Hazard Class: Oxidizer

IMO Hazard Class: 5.1

ID No. = NA1463

DOT Label: Oxidizer

IMO Label: Oxidizer, Corrosive

DOT Packaging Exclusions: 173,153

IMDG Packaging Group: II

DOT Packaging Requirements: 173,164

MSDS Collection References: 26, 38, 73, 85, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 139, 140, 143, 142, 145, 148, 159

Prepared by: M Gannon, BA; Industrial Hygiene Review: DJ Wilson, CHI; Medical Review: MJ Upfal, MD, MPH; Edited by: JR Stuart, MS

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Section 1. Material Identification
Hydrogen cyanide Description: Large-scale preparation by the catalytic oxidation of ammonia-methane mixtures. Used in the fumigation of ships, railroad cars, orchards, buildings, tobacco, and various foods. Can be produced in petroleum refining, electroplating, metallurgy, and photographic development.
Other Designations: Hydrocyanic acid; prussic acid; anhydrous hydrogen cyanide; HCN; CAS No. 0074-90-8.
Manufacturer: Contact your supplier or distributor. Consult the latest Chemical Week Buyers’ Guide (Genium ref. 73) for a suppliers list.

Section 2. Ingredients and Occupational Exposure Limits
Hydrogen cyanide, ca 100%

OSHA PEL (Skin*) Ceiling: 10 ppm, 10 mg/m³
ACGIH TLV (Skin*), 1988-89 TLV Ceiling: 10 ppm, 10 mg/m³

NIOSH REL, 1976 10-min ceiling: 4.7 ppm CN, 5 mg CN/m³

Toxicity Data†
Human, oral, LD₅₀: 570 µg/kg
Human, inhalation, LC₅₀: 200 mg/m³/10 min
Rat, inhalation, LC₅₀: 484 ppm/5 min

*Molecular Weight: 27 g/mol
Specific Gravity (H₂O = 1): 0.7
Water Solubility: Miscible
% Volatile by Volume: 100

Appearance and Odor: A colorless gas or blue-white liquid; a characteristic fond odor resembling bitter almonds for those individuals able to perceive its presence by smell.

Section 3. Physical Data
Boiling Point: 79 °F (29 °C)
Melting Point: 7.88 °F (-13.4 °C)
Vapor Pressure: 620 torr at 68 °F (20 °C)
Vapor Density (Air = 1): 0.941

Section 4. Fire and Explosion Data
Flash Point: 0 °F (-17.8 °C) CC
Autoignition Temperature: 1000 °F (538 °C)
LEL: 5.6% v/v
UEL: 40% v/v

Extinguishing Media: Hydrogen cyanide is an extremely toxic, flammable material. In advanced or massive fires, firefighting should be done from a safe, protected location. Use carbon dioxide (CO₂), dry chemical, or foams to put out hydrogen cyanide fires. Use water sprays to cool fire-exposed containers, protect the personnel attempting to seal the source of the leaking gas, flush spills away from sensitive exposures (heat, sources of ignition, or incompatible chemicals), disperse the vapors, and dilute spills to nonflammable mixtures.

Unusual Fire or Explosion Hazards: This gas is extremely poisonous and flammable. Consider evacuation of the incident area in large fires.

Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Firefighters must wear a complete set of personal protective equipment to prevent virtually any contact with this deadly poison. They must not have exposed skin surfaces since their skin can absorb fatal amounts of hydrogen cyanide.

Section 5. Reactivity Data
Stability/Polymerization: Hydrogen cyanide is stable at room temperature in dry routine operations. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Hydrogen cyanide can react dangerously with acetaldehyde.

Conditions to Avoid: Specially trained personnel must handle hydrogen cyanide. Never permit inexperienced workers to handle it. Never expose this material to any heat or ignition sources such as lighted cigarettes or pipes, open flames, or uninsulated heating elements.

Hazardous Products of Decomposition: Thermal oxidative degradation of hydrogen cyanide can produce carbon dioxide, toxic oxides of nitrogen (NOₓ) and carbon monoxide (CO). Hydrogen cyanide is a very toxic material even when not decomposed during fires.

Section 6. Health Hazard Data
Carcinogenicity: Neither the NTP, IARC, nor OSHA lists hydrogen cyanide as a carcinogen.

Summary of Risks: Inhalation of high concentrations of hydrogen cyanide causes tachypnea (rapid breathing) resulting in increased cyanide intake; then dyspnea, paralysis, convulsions, and respiratory arrest. Death may occur within minutes. Lesser concentrations can cause headache, vertigo, nausea, and vomiting. Concentrations of 270 ppm are immediately fatal; 181 ppm in 10 min are fatal; 135 ppm in 30 min are fatal; 110 to 135 ppm in 1 hr are potentially fatal; 45 to 54 ppm are tolerable for 30 to 60 min without immediate or late effects; and 18 to 36 ppm cause slight symptoms after several hours of exposure. Medical Conditions Aggravated by Long-Term Exposure: None reported. Target Organs: All body cells. Primary Entry: Inhalation, skin contact/absorption. Acute Effects: Burning sensation in mouth and throat. Initially rapid pulse and high blood pressure followed by decreasing blood pressure and pulse. Cherry-red mucous membranes may be noted. Headache, weakness, mental
Section 6. Health Hazard Data (continued)
can be caused by skin contact with the substance. Inhalation: Remove the exposed person to fresh air and support breathing as needed. Have qualified medical personnel administer oxygen as required. Ingestion: Never induce vomiting or perform mouth-to-mouth respiration. Provide 100% oxygen as soon as possible. Institute gastric lavage after endotracheal intubation. After first aid, get appropriate in-plant, paramedic, or community medical attention and support. Seek prompt medical assistance for further observation and treatment.

Physician's Notes: Tread all exposures as life-threatening emergencies. An antidote to hydrogen cyanide is sodium nitrite and sodium thiosulfate. Commercially available cyanide poisoning first-aid kits should be purchased. Competent medical personnel should carefully train appropriately selected workers on how to use these kits in emergencies. Several detailed medical treatments are available for cyanide poisoning. After reviewing the specific uses of hydrogen cyanide in their operation, the safety personnel and/or the industrial hygienists should develop a precise emergency first-aid treatment protocol before an incident occurs. Heart monitorings should be instituted.

Section 7. Spill, Leak, and Disposal Procedures
Spill Leak: Design and practice a hydrogen cyanide spill control and countermeasure plan (SCCP). Immediately evacuate the incident area and alert the appropriate local officials to the specifics of the hydrogen cyanide release. When a spill occurs, notify safety personnel, eliminate heat or ignition sources, provide optimal explosion-proof ventilation, and implement the SCCP. Cleanup personnel must wear a complete ensemble of personal protective equipment (Sec. 8), including self-contained breathing apparatus and total body-covering clothes, to prevent skin contact or inhalation. Use nonsparking tools and equipment. Use water sprays to protect personnel attempting to locate and seal the source of the escaping hydrogen cyanide gas. Waste Management/Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

OSHA Designations
Listed as Air Contaminant (29 CFR 1910.1000, Subpart Z)

EPA Designations
Listed as RCRA Hazardous Waste No. P063 (40 CFR 261.33)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 10 lb (4.54 kg) [* per CWA, Sec. 311(b)(4) and RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355), Threshold Planning Quantity (TPQ): 100 lb
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 Data
Goggles: Always wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Respirator: Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (leaks or cleaning reactor vessels and storage tanks), wear an SCBA. Warning: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

Safety Stations: Make available in the work area emergency eye wash 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. Other: Use hydrogen cyanide in closed-confinement, pressurized engineering systems. Automatic shutoff valves/sensors to the main feed lines are recommended in the event of a catastrophic pressure drop from the rupture of a pressurized HCN pipeline. 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 hydrogen cyanide in tightly closed, airtight, moisture-proof containers in a cool, dry, well-ventilated, fireproof area away from heat or ignition sources and incompatible chemicals (Sec. 5). Protect these containers from physical damage; shield them from direct sunlight. Limit access to the storage area to authorized personnel only. Special Handling/Storage: Proper stock rotation of hydrogen cyanide is vital for safety. Individual HCN cylinders should not be stored longer than 90 days. Check with your supplier for detailed recommendations concerning proper shelf rotation of stock, and proper dispensing equipment such as valves, flanges, and manifolds. Engineering Controls: To prevent static sparks, electrically ground and bond all containers, cylinders, and pipelines used in shipping, receiving, or transferring operations in production and storage areas. Other Precautions: Consider installing automatic sensing equipment which alerts workers to airborne concentrations of hydrogen cyanide greater than the 10 ppm ceiling (Sec. 2).

Transportation Data (49 CFR 172.101-2)
DOT Shipping Name: Hydrocyanic acid solution
DOT Hazard Class: Poison A or Poison B
DOT ID No.: UN1613 or NA1051
DOT Label: Poison gas and flammable gas
IMO Shipping Name: Hydrogen cyanide
IMO Hazard Class: 6.1
IMO Label: Poison and flammable liquid
IMDG Packaging Group: I
Proper shipping names, hazard classes, labels, and identification numbers vary with the hydrogen cyanide's concentration or strength.

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

Hydrogen Sulfide (H₂S) Description: Formed as a byproduct of many industrial processes (breweries, tanneries, slaughterhouses), around oil wells, where petroleum products are used, in decaying organic matter, and naturally occurring in coal, natural gas, oil, volcanic gases, and sulfur springs. Derived commercially by reacting iron sulfide with dilute sulfuric or hydrochloric acid, or by reacting hydrogen with vaporized sulfur. Used in the production of various inorganic sulfides and sulfuric acid, in agriculture as a disinfectant, in the manufacture of heavy water, in precipitating sulfides of metals; as a source of hydrogen and sulfur, and as an analytical reagent.

Other Designations: CAS No. 7783-06-4, dihydrogen monosulfide, hydrogensulfuric acid, sewer gas, stink damp, sulfitreduced hydrogen, sulfur hydride.

Manufacturer: Contact your supplier or distributor. Consult latest Chemical Week Buyers’ Guide(70) for a suppliers list.

Cautions: Hydrogen sulfide is a highly flammable gas and reacts vigorously with oxidizing materials. It is highly toxic and can be instantly fatal if inhaled at concentrations of 1000 ppm or greater. Be aware that the sense of smell becomes rapidly fatigued at 50 to 150 ppm, and that the strong rotten-egg odor is not noticeable even at very high concentrations.

Section 2. Ingredients and Occupational Exposure Limits

Hydrogen sulfide: 98.5% technical, 99.5% purified, and CP (chemically pure grade)

1991 OSHA PELs
8-hr TWA: 10 ppm (14 mg/m³)
15-min STEL: 15 ppm (21 mg/m³)

1992-93 ACGIH TLVs
TWA: 10 ppm (14 mg/m³)
STEL: 15 ppm (21 mg/m³)

1990 IDLH Level
300 ppm

1990 NIOSH REL
10-min Ceiling: 10 ppm (15 mg/m³)

See NIOSH, RTECS (MX1255000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: -76 °F (-60 °C)
Freezing Point: -122 °F (-86 °C)
Vapor Pressure: 18.5 atm at 68 °F (20 °C)
Vapor Density (Air = 1): 1.175
pH: 4.5 (freshly prepared saturated aqueous solution)
Viscosity: 0.01160 cp at 32 °F/0 °C and 1 atm
Liquid Surface Tension (es): 30 dynes/cm at -77.8 °F/-61 °C

Molecular Weight: 34.1
Density: 1.54 g/L at 32 °F (0 °C)
Water Solubility: Soluble; 1g/187 mL (50 °F/10 °C), 1g/242 mL (68 °F/20 °C), 1g/314 mL (86 °F/30 °C)
Other Solubilities: Soluble in ethyl alcohol, gasoline, kerosene, crude oil, and ethylene glycol.
Odor threshold: 0.06 to 1.0 ppm

Section 4. Fire and Explosion Data

Flash Point: None reported
Autoignition Temperature: 500 °F (260 °C)
LEL: 4.3% v/v
UEL: 46% v/v

Extinguishing Media: Let small fires burn unless leak can be stopped immediately. For large fires, use water spray, fog, or regular foam. Use a dry chemical fire extinguisher.

Unusual Fire or Explosion Hazards: H₂S burns with a blue flame giving off sulfur dioxide. Its burning rate is 2.3 mm/min. Gas may travel to a source of ignition and flash back. 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 for fires involving H₂S. If possible without risk, stop leak. Use unmanned device to cool containers until well after fire is out. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Reactivity: H₂S is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Chemical Incompatibilities: Hydrogen sulfide attacks metals forming sulfides and is incompatible with 1,1-bis(2-azidoethoxy) ethane + ethanol, 4-bromobenzamidazonium chloride, powdered copper + oxygen, metal oxides, finely divided tins, and copper, nitrogen trichloride, silver fulminate, rust, soda-lime, and all other oxidants. Conditions to Avoid: Exposure to heat and contact with incompatible materials. Hazardous Products of Decomposition: Thermal oxidative decomposition of hydrogen sulfide can produce toxic sulfur dioxide.

Section 6. Health Hazard Data

Carcinogenicity: The IARC(169), NTP(160), and OSHA(160) do not list hydrogen sulfide as a carcinogen. Summary of Risks: H₂S combines with the alkali present in moist surface tissues to form caustic sodium sulfide, causing irritation of the eyes, nose, and throat at low levels (50 to 100 ppm). Immediate death due to respiratory paralysis occurs at levels greater than 1000 ppm. Heavy exposure has resulted in neurological problems, however recovery is usually complete. H₂S exerts most of its toxicity on the respiratory system. It inhibits the respiratory enzyme cytochrome oxidase, by binding iron and blocking the necessary oxydo-reduction process. Electrocardiograph changes after over-exposure have suggested direct damage to the cardiac muscle, however some authorities debate this. Medical Conditions Aggravated by Long-Term Exposure: Eye and nervous system disorders. Target Organs: Eyes, respiratory system and central nervous system. Primary Entry Routes: Inhalation, eye and skin contact.

Acute Effects: Inhalation of low levels can cause headache, dizziness, nausea, cramps, vomiting, diarrhea, sneezing, staggering, excitation, pale
Section 6. Health Hazard Data, continued

complexion, dry cough, muscular weakness, and drowsiness. Prolonged exposure to 50 ppm, can cause rhinitis, bronchitis, pharyngitis, and pneumonia. High level exposure leads to pulmonary edema (after prolonged exposure to 250 ppm), asphyxia, tremors, weakness and numbness of extremities, convulsions, unconsciousness, and death due to respiratory paralysis. Concentrations near 100 ppm may be odorless due to olfactory fatigue, thus the victim may have no warning. Lactic acidosis may be noted in survivors. The gas does not affect the skin although the liquid (compressed gas) can cause frostbite. The eyes are very susceptible to H2S keratoconjunctivitis known as "gas eye" by sewer and sugar workers. This injury is characterized by palpebral edema, bulbar conjunctivitis, mucous-puss secretions, and possible reduction in visual capacity. Chronic Effects: Chronic effects are not well established. Some authorities have reported repeated exposure to cause fatigue, headache, inflammation of the conjunctiva and eyelids, digestive disturbances, weight loss, dizziness, a grayish-green gum line, and irritability. Others say these symptoms result from recurring acute exposures. There is a report of encephalopathy in a 20 month old child after low-level chronic exposure.

FIRST AID: Eyes: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flowing amounts of water. Treat with boric acid or isotonic physiological solutions. Serious exposures may require adrenaline drops. Olive oil drops (3 to 4) provide immediate treatment until transported to an emergency medical facility. Consult a physician immediately. Skin: Quickly remove contaminated clothing and rinse with flowing amounts of water. For frostbite, rewarm in 107.6°F (42°C) water until skin temperature is normal. Do not use dry heat. Inhalation: Remove exposed person to fresh air and administer 100% oxygen. Give hyperbaric oxygen if possible. Ingestion: Unlikely since H2S is a gas above -60°C. Note to Physicians: The efficacy of nitrile therapy is unproven. Normal blood contains < 0.05 mg/L H2S; reliable tests need to be taken within 2 hr of exposure.

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. Use water spray to cool, dilute, and disperse vapors. Neutralize runoff with crushed limestone, agricultural (slaked) lime, or sodium bicarbonate. If leak can't be stopped in place, remove cylinder to safe, outside area to safety, repair or let empty. Follow applicable OSHA regulations (29 CFR 1910.120).

Ecotoxicity Values: Bluegill sunfish, TLm = 0.0448 mg/L@96 hr at 71.6°F @22°C; fathead minnow, TLm = 0.0071 to 0.55 mg/L@96 hr at 24°C Environmental Degradation: In air, hydrogen sulfides residency (1 to 40 days) is affected by temperature, humidity, sunshine, and the presence of other pollutants. It does not undergo photoysis but is oxidized by oxygen containing radicals to sulfur dioxide and sulfates. In water, H2S converts to elemental sulfur. In soil, due to its low boiling point, much of H2S evaporates quickly if spilled. Although, if soil is moist or precipitation occurs at time of spill, H2S becomes slightly mobile due to its water solubility. H2S does not bioaccumulate but is degraded rapidly by certain soil and water bacteria. Disposal: Aerate or oxygenate with compressor. For in situ amelioration, carbon removes some H2S. Anion exchanges may also be effective. A candidate for rotary kiln incineration (1508 to 2912 °F/820 to 1600 °C) or fluidized bed incineration (842 to 1796 °F/450 to 980 °C). 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. U135
SARA Toxic Chemical (40 CFR 372.65): Not listed
Listed as a SARA Extremely Hazardous Substance (40 CFR 355): TPQ: 500 lb
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 10 lb (45.4 kg) * per RCRA, Sec. 3001 & CWA, Sec. 311 (b)(4)

OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A & Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). 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 < 100 ppm, use a supplied-air respirator (SAR) or SCBA. For < 25 ppm, use a SAR operated in continuous-flow mode. For < 300 ppm, use a 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 respiratory protection program that includes at least a written program, medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient access to storage areas. Other: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Poly carbonate, butyl rubber, polyvinyl chloride, and neoprene are suitable materials for PPE. Ventilation: Provide general & local exhaust ventilation systems to maintain air 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.(109) 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. 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: Prevent physical damage to containers. Store in cool, dry, well-ventilated area away from incompatibles (Sec. 5). Install electrical equipment of Class I, Group C. Outside or detached storage is preferred. Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to keep levels as low as possible. Enclose processes and continuously monitor H2S levels in the plant air. Keep pipes clear of rust as H2S can ignite if passed through rusty pipes. Purge and determine H2S concentration before entering a confined area that may contain H2S. The worker entering the confined space should have a safety belt and life line and be observed by a person from the outside. Following applicable OSHA regulations (1910.146) for confined spaces, H2S can be trapped in sludge in sewers or process vessels and may be released during agitation. Calcium chloride or ferrous sulfate should be added to neutralize process wash water each time H2S formation occurs. Control H2S emissions with a wet flare stack/scrubbing tower. Administrative Controls: Consider preplacement and periodic medical exams of exposed workers emphasizing the eyes, nervous and respiratory system.

DOT Shipping Name: Hydrogen sulfide, liquefied
DOT Hazard Class: 2.3
ID No.: UN1053
DOT Packaging Group: II
DOT Label: Poison Gas, Flammable Gas
Special Provisions (172.102): 2, B9, B14

Transportation Data (49 CFR 172.101)

Packaging Authorizations
Exceptions: --
Non-bulk Packaging: 304
Bulk Packaging: 314, 315

Vessel Stowage Requirements
Vessel Stowage: D
Other: 40

Quantity Limitations
Passenger, Aircraft, or Railcar: Forbidden
Cargo Aircraft Only: Forbidden

MSDS Collection References: 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 135, 140, 148, 149, 153, 159, 163, 164, 168, 171, 180
Prepared by: M. Gannon, BA; Industrial Hygiene Review: PA Roy, MPH, CIH; Medical Review: AC Darlington, MPH, MD

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### Material Safety Data Sheets Collection:

- **Sheet No. 713**
- **Lead (Inorganic)**

**Issued:** 8/90

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### Section 1. Material Identification

**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 melting, dressing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and other 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 construction 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. 7459-92-1, lead oxide; lead salts, inorganic; metallic lead; plumblum.

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

**Cautions:** Inorganic lead is a potent systemic poison. Organic lead (for example, tetraethyl lead) has severe, but different, health effects. *Sec. 8*

**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.**

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### Section 2. Ingredients and Occupational Exposure Limits

- **1989 OSHA PELs (Lead, inorganic compounds)**
  - 8-hr TWA: 50 μg/m³
- **1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)**
  - TLV-TWA: 150 μg/m³

**1985-86 Toxicity Data†**

- Human, inhalation, TC₅₀: 10 μg/m³ affects gastrointestinal tract and liver
- Human, oral, TD₅₀: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
- Rat, oral, TD₅₀: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, RTECS (OPT525000), for additional mutative, reproductive, and toxicity data.

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### 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)

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

* Lead dissolves more easily at a low pH.

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### 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.

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### Section 5. Reactivity Data

**Stability/Pyrolysis:** 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 Incompatibility:** Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, dichloro 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.

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### 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 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 pressure can aggravate cardiovascular disease.

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*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 in the general population. Overexposure to lead may cause 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 flowing amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: Quickly remove contaminated clothing. Rinse with flowing 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 (PbL), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urine analysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival line. Use CaEDTA 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 dust conditions. Water sprays may be used to control quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mapping 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 eye guards 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 impermeable 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, employee monitoring, employee adjustment, and physician’s written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbL) and zinc protoporphyrin (ZPP) are useful indicators of your body’s lead absorption level. Maintain worker PbLs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetuses, maintain the PbLs of workers intending to have children below 30 µg/100 g. Elevated PbLs increase your risk of disease, and the longer you have elevated PbLs, 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.: UN2921

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, CHI; Medical Review: MJ Uptal, MD, MPH; Edited by: JR Stuart, MS

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Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Selenium
Chemical Formula: Se
CAS Number: 7782-49-2
Synonyms: C.I. 77805; colloidal selenium; elemental selenium; EPA pesticide chemical code 072001; gray selenium; selen (Polish); selenate; selenium alloy; selenium base; selenium (colloidal); selenium dust; selenium elemental; selenium homopolymer; selenium powder; Vanex
Derivation: Recovered by roasting anode muds from electrolytic copper refineries with soda or sulfuric acid, or by smelting them with soda and niter.
General Use: Used as a pigment and decolorizing agent in the glass industry; in toning baths in photography; in making electrodes for arc lights, electrical instruments and apparatus; rectifier in radio and television sets; in semiconductor fusion mixtures, selenium cells, telephotographic apparatus; rubber vulcanizing agent; catalyst in determination of Kjeldahl nitrogen; for dehydrogenation of organic compounds; in steel and copper (degasifier and machineability improver); as a dietary supplement; in the manufacture of pigments, textiles, petroleum, and medical therapeutic agents.
Vendors: Consult the latest Chemical Week Buyers’ Guide.

Section 2 - Composition / Information on Ingredients

Selenium, > 99% wt (commercial grade)
Trace Impurities (commercial grade): > 0.2% tellurium, 0.1% iron, 0.005% lead and 0.005% copper.

OSHA PEL
8-hr TWA: 0.2 mg/m³
ACGIH TLV
TWA: 0.2 mg/m³
Excursion Limit: Provided the TLV-TWA is not exceeded, exposure may exceed 0.6 mg/m³ for no more than 30 min/day; never exceed 1.0 mg/m³.

NIOSH REL
10-hr TWA: 0.2 mg/m³
IDLH Level
1 mg/m³

DFG (Germany) MAK
TWA*: 0.1 mg/m³
Category III: Substances with systemic effects (Onset of effect > 2 hr); Half-life > shift length (strongly cumulative)
Peak Exposure Limit:
1.0 mg/m³, 30 min, average value, 1/shift

Section 3 - Hazards Identification

ANSI Signal Word: Caution

eníEmergency Overview

Selenium exists as an amorphous red or black solid, or red, gray or black crystals; upon heating, it emits an odor of garlic or rotten horseradish. Selenium fumes or dust are irritating to the eyes, skin, and mucous membranes. Inhalation of fumes may also result in respiratory system impairment, and central nervous system (CNS) and psychological effects. This combustible solid may burn, but does not ignite readily. Heating selenium can produce fumes of toxic selenium oxides (e.g., selenium dioxide (SeO₂)).

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin and/or eye contact/absorption
Target Organs: Eyes, skin, CNS, cardiovascular system (CVS), respiratory system, blood, liver, kidneys, spleen
Acute Effects
Inhalation: Inhalation of selenium dust or fumes (fumes contain selenium dioxide - see Skin, below) may cause mucous membrane irritation, coughing, sneezing, breathing difficulty, shortness of breath, "metal fume fever" (chills, fever, headaches), hypotension (low blood pressure), psychological effects (depression, irritability, etc.), liver and kidney damage, and in extreme cases, pulmonary edema (accumulation of fluid in the lungs), CNS depression, and coma. Note that toxicity of selenium (elemental) is considerably less than that of selenium compounds. Toxic effects of selenium fume inhalation may largely be due to selenium dioxide content of fumes.
Eye: Exposure to dust or fumes may result in irritation, swelling and redness of the eyelids.
Skin: Exposure to selenium fumes causes irritation, contact dermatitis and burns (fumes contain selenium dioxide which forms selenium acid (irritant) upon contact with moist skin or mucous membranes. Both selenium dioxide and selenious acid can also be absorbed through the skin, and produce systemic toxicity).
Ingestion: Acute systemic effects (see Inhalation) may result, although intestinal absorption of elemental selenium is minimal. Toxic effects have been reported following excessive consumption of dietary supplements.

Carcinogenicity: IARC lists selenium as Group 3 (Not classifiable as to carcinogenicity to humans); NTP, Class 2B (Reasonably anticipated to be a carcinogen, sufficient evidence of carcinogenicity from studies in experimental animals); EPA, Class D (Not classifiable as to human carcinogenicity). OSHA does not list selenium as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: Asthma, allergies, known sensitization to selenium, chronic respiratory disease, gastrointestinal disturbances, liver or kidney disorders, dermatitis.

Chronic Effects: Bronchial irritation (through inhalation), inflammation of eye lining and lids, gastrointestinal distress, persistent garlic odor on breath, increased dental caries, mottled teeth, metallic taste, pallor, skin lesions, lowered blood clotting efficiency and hemoglobin levels, irritability, excessive fatigue, anorexia, pain or anesthesia in extremities, and, in extreme cases of “selenosis,” skin discoloration (reddish), fingernail and hair discoloration or loss can result. Some individuals may be more sensitive than others to selenium toxicity. Reported daily ingestion of 27 to 2310 mg resulted in nausea, vomiting, nail changes, fatigue, and irritability. Lower selenium intake (700-800 μg/day) has not been found to produce toxic effects. Animal testing suggests spleen, liver and kidney damage, and reproductive effects.

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 and/or irritation develop.
Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. 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. Consider also administration of charcoal slurry cathartic.

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

Note to Physicians: Treat overexposure symptomatically and supportively. Monitor whole blood selenium levels.

Section 5 - Fire-Fighting Measures

Flash Point: Not applicable; combustible solid.
Autoignition Temperature: None reported.
LEL: None reported.
UEL: None reported.

Flammability Classification: Combustible solid
Extinguishing Media: Use extinguishing agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: Containers may explode in heat of fire.

Hazardous Combustion Products: Heating selenium can produce toxic selenium oxides (e.g., selenium dioxide (SeO₂)).

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: Isolate spill area for at least 80-160 feet (25-50 m). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Cover with plastic sheet to prevent spreading. Do not get water inside containers.

Small Spills: Vacuum or carefully scoop up material and deposit in sealed containers.

Large Spills

Containment: Dike far ahead of spill for later disposal. Do not release into sewers or waterways.

Cleanup: Spills of selenium in waterways may be remediated by dredging.

Regulatory Requirements: None reported.

Section 7 - Handling and Storage

Handling Precautions: Avoid dust or fume inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations to non-hazardous levels (see Sec. 2). Wear protective gloves and clothing (see Sec. 8). Keep away from heat and ignition sources.

Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Periodically inspect stored materials.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).
Section 8 - Exposure Controls / Personal Protection

**Engineering Controls:** Enclose operations and/or provide local exhaust ventilation at the site of chemical release.

**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.

**Administrative Controls:** Where possible, use a contained transfer method for transferring selenium from drums or other storage containers to process containers. Arrange pre-employment and annual medical examinations emphasizing urinary selenium (should be < 0.1 mg/L), eyes, skin (chronic disorders), respiratory system, liver, kidneys, blood, and medical conditions aggravated by long-term exposure to selenium (see Sec. 3). Give special consideration to women of childbearing age, because of possible reproductive effects. Remove workers from selenium exposure if exposure-related garlic odor of breath is detected.

**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 concentrations ≤ 1 mg/m³, use a dust and mist, or dust, mist and fume respirator, or air-purifying full face-piece respirator with high efficiency particulate (HEP) filter, or powered air-purifying respirator with dust and mist filter, or powered air-purifying respirator with dust, mist and fume filter, supplied air respirator, or SCBA with full facepiece; > IDLH/unknown/emergency, SCBA with full facepiece operated in pressure-demand or other positive-pressure mode, or supplied air respirator with full facepiece operated in pressure-demand or other positive-pressure mode in combination with SCBA. For escape, use an air-purifying, full facepiece respirator with HEP filter. **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 impervious, chemically protective neoprene or rubber gloves, boots, aprons, gauntlets and body-covering clothing to prevent skin contact. Wear protective eyeglasses, 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 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 - Physical and Chemical Properties

**Physical State:** Amorphous or crystalline solid

**Appearance and Odor:** Red to bluish black, dark red, gray, or black, crystals odorless

**Vapor Pressure:** > 0.001 mm Hg at 68 °F (20 °C)

**Formula Weight:** 78.96 +/- 3

**Specific Gravity (H2O=1, at 4 °C):** 4.26 to 4.81

**Water Solubility:** Insoluble

**Other Solubilities:** Soluble in sulfuric acid, carbon disulfide, ether, methylene iodide, benzene, quinoline, chloroform, aqueous potassium cyanide solution, potassium sulfite solution, caustic alkali solution. Insoluble in alcohol.

**Boiling Point:** 1274 °F (690 °C)

**Melting Point:** 338 °F (170 °C) to 422.6 °F (217 °C) (crystals)

**Surface Tension:** 92.5 dynes/cm at 423 °F (217 °C)

**Ionization Potential (eV):** 9.75238

Section 10 - Stability and Reactivity

**Stability:** Selenium is stable at room temperature in closed containers under normal storage and handling conditions.

**Polymerization:** Hazardous polymerization cannot occur.

**Chemical Incompatibilities:** Include acids, fluorine, oxygen, cadmium, potassium, sodium, chlorine trifluoride, chromium trioxide, chromic oxide, lithium silicate, nitric acid, nitrogen trichloride, potassium bromate (explosive), silver bromate, bromine pentafluoride, and more materials. Contact with metal amides can be explosive. Metal carbides and chlorates incandesce in selenium vapor upon heating. Freshly precipitated amorphous selenium can react with water, producing selenous acid and hydrogen.

**Conditions to Avoid:** Unintended contact in storage areas or reactor vessels.

**Hazardous Decomposition Products:** Thermal oxidative decomposition of selenium can produce selenium dioxide.

Section 11- Toxicological Information

**Toxicity Data:**

**Genetic Effects:** Human, blood cultures: selenium (more than any tested selenium compounds) induced sister chromatid exchange.

**Tumorigenicity:**

Mouse, oral: 480 mg/kg/60 days continuous, resulted in tumors of the skin and appendages (equivocal tumorigenic agent by RTECS criteria).
Section 11 - Toxicological Information, continued

Reproductive Effects:
Mouse, oral: 134 mg/kg, over multigenerations resulted in fetotoxicity, and fetal death.

Acute Inhalation Effects:
Rat, inhalation, LC50: 33 mg/kg/8 hr resulted in hemorrhage, emphysema, and acute pulmonary edema.

* See NIOSH, RTECS (VS7700000), for additional toxicity data.

Acute Oral Effects:
Rat, oral, LD50: 6700 mg/kg resulted in somnolence (general depressed activity), dyspnea, other changes in nutrition and gross metabolism.
Mouse, oral, LD50: 134 mg/kg

Section 12 - Ecological Information

Ecotoxicity: Scenedesmus, TLM96=2.5 ppm; E. Coli, TLM96=90 ppm. Selenium toxicity occurs frequently among livestock ("alkali disease") of the Great Plains of the US, Canada and Mexico.

Environmental Fate: Selenium undergoes complex chemical and biological cycling through surface water and bottom sediments. It has been found to concentrate in some plants and fish.

Soil Adsorption/Mobility: Elemental selenium is insoluble in water and will have low mobility in the soil column.

Section 13 - Disposal Considerations

Disposal: 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 substance, solid, n.o.s.*
Shipping Symbols: –
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: Class 9
Special Provisions (172.102): 8, B54

*Classified as a hazardous substance when this material is one package which equals or exceeds the CERCLA RQ (see Sec. 15).

Section 15 - Regulatory Information

EPA Regulations:
Classified as a RCRA Hazardous Waste (40 CFR 261.24): Characteristic of Toxicity*
RCRA Hazardous Waste Number: D010
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per CWA Section 307(a)†
CERCLA Final Reportable Quantity (RQ), 100 lb. (45.55 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65 as Selenium compounds)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

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

*May or may not be characterized as a hazardous waste when subjected to the Toxicant Extraction Procedure (40 CFR 261.24).
†No reporting of release is required if diameter of solid pieces is equal to or exceeds 0.004 inches (100 μm).

Section 16 - Other Information

References: 1, 73, 103, 124, 136, 149, 176, 190, 209, 216, 222, 223, 224, 227, 230

Prepared By: HM Splietstoff, MS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: G Kelafant, MD

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Community Air Monitoring Plan
Williamsburg Works Former MGP
Remedial Investigation
Brooklyn, New York

In accordance with NYSDEC and NYSDOH requirements for a Community Air Monitoring Plan (CAMP), a perimeter air-monitoring plan, will be implemented at the site during each phase of the field activities. The objective of the perimeter air-monitoring plan is to provide a measure of protection for the downwind community (i.e., off-site receptors, including residences and businesses and on-site workers not involved with the site field activities) from potential airborne contaminant releases as a direct result of field activities. The perimeter air-monitoring plan is a stand-alone document and will be available on site. The VOC Monitoring, Response Levels, and Actions are presented as follows.

Air Monitoring Response Levels and Actions

<table>
<thead>
<tr>
<th>VOCs</th>
<th>Response Level</th>
<th>Actions</th>
</tr>
</thead>
</table>
| VOCs | >5 ppm above background for 15-minute average | • Temporarily halt work activities  
• Continue monitoring  
• If VOC levels decrease (per instantaneous readings) below 5 ppm over background, work activities can resume |
| Persistent levels >5 ppm over background <25 ppm | • Halt work activities  
• Identify source of vapors  
• Corrective action to abate emissions  
• Continue monitoring  
• Resume work activities if VOC levels 200 feet downwind of the property boundary or half the distance to the nearest potential receptor is <5 ppm for a 15-minute average  
• If VOC levels are >25 ppm at the perimeter of the work area, activities must be shutdown |

| Particulate | >100 mcg/m3 above background for 15-minute average or visual dust observed leaving the site | • Apply dust suppression  
• Continue monitoring  
• Continue work if downwind PM-10 particulate levels are <150 mcg/m3 above upwind levels and no visual dust leaving site |
| >150 mcg/m3 above background for 15-minute average | • Stop work  
• Re-evaluate activities  
• Continue monitoring  
• Continue work if downwind PM-10 particulate levels are <150 mcg/m3 above upwind levels and no visual dust leaving site |

Sources:
During excavating and materials handling operations, the air in work areas will also be sampled periodically for the presence of contaminants. A portable photoionization detector (PID) will be utilized to periodically monitor the levels of organic vapors in the ambient air and a Mini RAM™ PM-10 (or equivalent) particle detector will be used to count inhalable particles (0.1-10 micrometer range) of dust during the field work. PID and Mini RAM readings will be taken hourly during excavation or more frequently if air quality measurements approach action levels as defined herein. Measurements will be monitored from the breathing zone (4 to 5 feet above ground level) at worker locations to determine working conditions (and whether there is a need to change levels of worker protection).

In addition to VOCs and particulates, cyanide will be monitored in the work zone. The cyanide monitoring methods will be determined prior to mobilization.

In order to make a conservative assessment of when different levels of respiratory protection are needed during the field work, it will be assumed that the organic vapors detected by the air monitoring instruments consist of the most toxic volatile compounds expected to be found on the site. Preliminary evaluation of the risks expected at the site indicates that the most toxic volatiles that are probably present are VOCs (particularly BTEX). Based on data published by the Occupational Safety and Health Administration (OSHA) and the American Conference of Government Industrial Hygienists (ACGIH), and previous experience with MGP wastes, the following PPE will be employed when the given concentrations of organic vapor are detected in the breathing zone.

<table>
<thead>
<tr>
<th>Compound of Concern</th>
<th>Level D</th>
<th>Level C</th>
<th>Level B</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTEX and other photoionizable VOCs</td>
<td>M &lt; X ppm</td>
<td>X &lt; Y &lt; M &lt; Y ppm</td>
<td>M &gt; Y ppm</td>
</tr>
</tbody>
</table>

Where: M = concentration of organic vapor measured in the field
X,Y = concentrations at which different levels of respiratory protection are necessary.

The PPE requirements may be modified based on compound-specific monitoring results information, with the written approval of the Corporate Health and Safety Specialist (CHSS).

Respiratory protection from dusts will be required when inhalable particulate concentrations from potentially contaminated sources exceed 150 µg/m³.

Odors or dusts derived from site contaminants may cause nausea in some site workers, even though the contaminants are at levels well below the safety limits as defined above. Workers may use dust masks or respirators to mitigate nuisance odors with the approval of the SSO.

Whenever practical, work areas should be positioned upwind of organic vapor and dust sources to reduce the potential for worker exposure.