SAFETY - FIRST AND ALWAYS

FLUOR DANIEL GTI, INC.
HEALTH AND SAFETY PLAN
REQUESTED AND PREPARED FOR

PALL CORPORATION
30 SEA CLIFF AVENUE
GLEN COVE, NEW YORK 11542

FOR SITE ACTIVITIES AT

PALL CORPORATION
30 SEA CLIFF AVENUE
GLEN COVE, NEW YORK 11542

PROJECT NO. 107933

DAN SMITH, PE
PROJECT MANAGER

JOHN REINEMANN, CIH
HEALTH AND SAFETY REPRESENTATIVE

The information in this HASP is provided solely for the protection of the health and safety of Fluor Daniel GTI employees and subcontractors working under the direct supervision and control of Fluor Daniel GTI on this project. Fluor Daniel GTI assumes no liability for, or responsibility to, any other parties for the accuracy or completeness of the information contained herein for any use or reliance upon this HASP by any other party.

TABLE OF CONTENTS

TABLES

APPENDICES

LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
BP	Breath pipe
BT	Body temperature
BTEX	Benzene, Toluene, Ethyl benzene, and Xylene
BWL	Body water loss
BWT	Body water temperature
CET	Certified Environmental Trainer
CFR	Code of Federal Regulations
CGI	Combustible gas indicator
CHMM	Certified Hazardous Materials Manager
CIH	Certified Industrial Hygienist
COHN	Certified Occupational Health Nurse
CNS	Central nervous system
CPR	Cardio-pulmonary resuscitation
CRZ	Contaminant reduction zone
CSE	Confined space entry
CSP	Certified Safety Professional
CZ	Clean zone
DM	Dust-particulate monitor
DOT	Department of Transportation
DT	Detector tube
DZ	Decontamination zone
EKG	Electrocardiogram
EMR	Environmental Medical Resources
EMS	Emergency Medical Services
EPA	Environmental Protection Agency
EZ	Exclusion zone
FID	Flame ionization detector
FP	Flashpoint
GFCI	Ground fault circuit interrupter
GM	Geiger-Mueller
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HBV	Hepatitis B-virus
HEPA	High efficiency particulate air-purifying
HR	Heart rate
HSM	Health and Safety Manager
HSR	Health and Safety Representative
HSS	Health and Safety Specialist

LIST OF ACRONYMS (continued)

HVDPE	High vacuum dual-phase extraction
HZ	Hot zone
IDLH	Immediately dangerous to life or health
ILO	International Labor Organization
IP	Ionization potential
JSA	Job safety analysis
LEL	Lower explosive limit
LO/TO	Lockout/tagout
mg/M_3	Milligrams per cubic meter
mg/L	Milligrams per liter
MSDS	Material Safety Data Sheet
MSHA	Mine Safety and Health Administration
N	NIDA drug screen
NA	Not available
NBR	Nitrile butyl rubber
NEC	National Electrical Code
NIDA	National Institution on Drug Abuse
NIOSH	National Institute for Occupational Safety and Health
NFPA	National Fire Prevention Association
NL	NIDA-like drug screen
NRR	Noise reduction rating
O_2	Oxygen
O_3	Ozone
OM	Operations Manager
OJT	On the job training
OT	Oral temperature
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
PID	Photoionization detector
PIR	Preliminary incident report
PM	Project Manager
ppb	Parts per billion
PPE	Personal protective equipment
ppm	Parts per million
RB	Random breathalyser
RBP	Random breath pipe
RCRA	Resource Conservation and Recovery Act of 1976
REL	Recommended exposure limit
RN	Registered Nurse

LIST OF ACRONYMS (continued)

RR	Relative responses
RT	Random ten panel drug screen
SHSO	Site Health and Safety Officer
SLM	Sound level meter
SOW	Scope of work
SPL	Sound pressure level
STEL	Short-term exposure limit
SZ	Support zone
TLV	Threshold limit value
TP	Fluor Daniel GTI ten panel drug screen
TSF	Tons per square foot
TWA	8-hour time-weighted average
UEL	Upper explosive limit
ug/L	Micrograms per liter
UST	Underground storage tank
VP	Vapor pressure
WBGT	Wet bulb globe temperature

SITE EMERGENCY FORM

Contaminants of Concern: **Chlorinated solvents including tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (TCA), 1,2-dichloroethene (DCE), 1,1-dichloroethane (DCA), and vinyl chloride (VICL) and trace levels of petroleum constituents including benzene, ethyl benzene, xylenes and toluene**

Minimum Level of Protection: Level D

Hazard Determination: Serious _____ Moderate _____ Low XXXX

Do not endanger your own life. Survey the situation before taking any action.

Fluor Daniel GTI Office Telephone	516-472-4000
Site Location Address	Glen Cove, NY
Telephone Located at	FDGTI mobile unit and Paul Corp. Offices

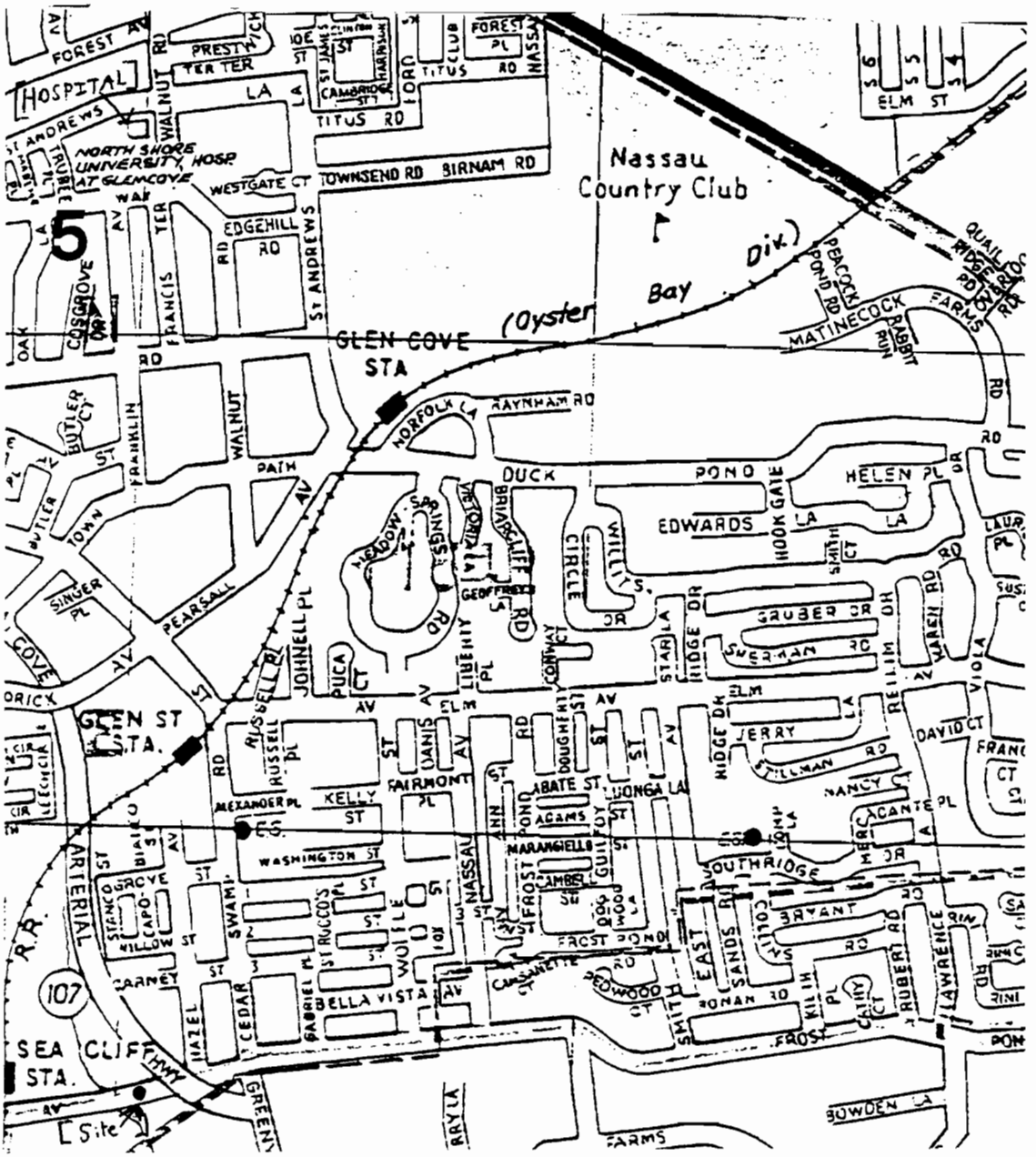
EMERGENCY PHONE NUMBERS **IN THE EVENT OF ANY EMERGENCY CONTACT PROJECT MANAGER (PM) OR HEALTH AND SAFETY REPRESENTATIVE**

Ambulance	911
Fire	911
Police	911
Poison Control Center	800-336-6997
Hospital Name	North Shore University Hospital
Hospital Phone Number	516-674-7306
Project Manager	Dan Smith, PE, 516-472-4000
Site Safety Officer	Matt Bernstein, 516-472-4000
Health and Safety Manager	John Reinemann, CIH, 518-783-1996
Client Contact	Mary Ann Bartletti, Esq., 516-484-5400
State Agency	NYSDEC, 516-444-0354

UTILITY MARKER EMERGENCY TELEPHONE NUMBERS

Utility	Color Code	Telephone Number
Water	Blue	800-272-4480
Gas	Yellow	"
Electric	Red	"
Telephone/Cable	Orange	"
Sewer	Green	"
Dig Safe Telephone Number: 800-272-4480		

HOSPITAL LOCATION MAP



HOSPITAL DIRECTIONS:

Turn onto Sea Cliff Ave Eastbound
Turn Left into Cedar Swamp Rd.
Continue Northbound to Pearsall Ave.
Turn right onto Pearsall Ave.
Pearsall Avenue turns into St. Andrews Lane.
Continue on St. Andrews Lane to North Shore Hospital.

HOSPITAL INFORMATION:

Name: North Shore University Hospital
Address: 101 St. Andrews Lane
City, State Glen Cove, NY 11542

Phone: Emergency: 516-674-7306

EMERGENCY FIRST AID

FIRST AID

Ingestion:	DO NOT INDUCE VOMITING. Call Poison Control - follow instructions. Administer cardiopulmonary resuscitation (CPR), if necessary. Seek medical attention.
Inhalation:	Remove person from contaminated environment. Administer CPR if necessary. Seek medical attention. DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME UNLESS PROPERLY EQUIPPED AND A STANDBY PERSON IS PRESENT.
Skin Contact:	Brush off dry material, remove wet or contaminated clothing. Flush skin thoroughly with water. Seek medical attention if irritation persists.
Eye Contact:	Flush eyes with water for 15 minutes. Seek medical attention.
Exposure Symptoms:	Headache, dizziness, nausea, drowsiness, irritation of eyes, nose, throat, breathing difficulties.
Contingency Plan:	Report incident to PM and Health and Safety Specialist (HSS) after emergency procedures have been implemented.

RESPONDER MUST HAVE A CURRENT CERTIFICATE TO ADMINISTER FIRST AID OR CPR

1. Survey the situation. Do not endanger your own life. DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME UNLESS PROPERLY EQUIPPED AND TRAINED. ENSURE ALL PROTOCOLS ARE FOLLOWED INCLUDING THAT A STANDBY PERSON IS PRESENT.

2. Call 911 (if available) or the fire department **IMMEDIATELY**. Explain the physical injury, chemical exposure, fire, or release.

3. Decontaminate the victim without delaying life-saving procedures.

4. If the victim's condition appears to be noncritical, but seems to be more severe than minor cuts, he/she should be transported to the nearest hospital by trained Emergency Medical Services (EMS) personnel: let the doctor assume the responsibility for determining the severity of the injury. If the condition is obviously serious, EMS must transport the victim.

5. Notify the PM and the HSS. Complete the Fluor Daniel GTI Preliminary Incident Report (PIR) within 24 hours.

EMERGENCY FIRST AID PROCEDURES	
To Stop Bleeding	**CPR**
1. Give medical statement.	1. Give medical statement.
2. Assure airway, breathing, circulation.	2. Arousal: Check for consciousness.
3. Use **DIRECT PRESSURE** over the wound with clean dressing or your hand (use nonpermeable gloves). Direct pressure will control most bleeding.	3. Open airway with chin-lift.
	4. Look. listen, and feel for breathing.
4. Bleeding from an artery or several injury sites may require **DIRECT PRESSURE** on a **PRESSURE POINT**. Use pressure points for 30 - 60 seconds to help control severe bleeding.	5. If breathing is absent, give 2 slow, full rescue breaths.
	6. Check the pulse for 5 to 10 seconds.
	7. If pulse is present, continue rescue breathing: **1 breath every 5 seconds.**
5. Continue primary care and seek medical aid as needed.	8. If pulse is absent, initiate CPR; 15 compressions for each two breaths.

1.0 INTRODUCTION

The Pall Corporation has retained Fluor Daniel GTI, Inc. (Fluor Daniel GTI) to perform environmental services at its research and development facility located at 30 Sea Cliff Avenue, Glen Cove, New York, 11542.

The Health and Safety Plan (HASP) is written to ensure the well-being of all field personnel and the community surrounding the site. Accordingly, project staff and approved Fluor Daniel GTI subcontractors must follow the policies and procedures established in the HASP. All Fluor Daniel GTI personnel and subcontractors assigned to this project must sign the Agreement and Acknowledgment Sheet (Appendix A) to confirm that they understand and agree to abide by the provisions of the plan.

All work will comply with Fluor Daniel GTI health and safety guidelines in concurrence with all applicable sections of the Occupational Safety and Health Act (OSHA), 29 Code of Federal Regulations (CFR) 1910 and 1926; specifically 29 CFR 1910.120 and 1926.65 Standards, "Hazardous Waste Operations and Emergency Response," (29 CFR 1910.120) as well as other federal, state, and local regulations that require the development and implementation of a HASP. Generation of this document certifies that the workplace has been evaluated for the hazards as described. A hazard assessment has been performed and the adequacy of the personal protective equipment (PPE) selected is hereby certified per 29 CFR 1910.132(d) and is duly noted by the signature(s) and date appearing on the cover page of this document.

This HASP addresses the safety issues associated with this active research and development facility related to filtration product manufacture and surrounding properties, and involving a phase II environmental site assessment, site survey, installation of monitoring wells, Geoprobe borings, sampling which incorporates the following site tasks:

- Gauging existing monitoring wells;
- Sampling existing monitoring wells;
- Drilling and advancing soil borings;
- Installing monitoring wells;
- Hand auguring;
- Surveying; and,

Based upon the historical groundwater monitoring data, the minimum level of protection for this site is Level D. For each task, the potential hazards for employee exposure to site contaminants and/or air monitoring results, will determine the level of protection. Modified Level D will be worn during tasks that may have the potential for skin contact with contaminated media (soil or water). Upgrade to Level C and/or B will occur when the possibility of exposure exists from the onset of site-specific tasks or results of real-time monitoring exceed established action levels listed in Table 7, Air Monitoring Action Levels. This HASP must be modified or amended when circumstances or conditions develop that are beyond the scope of this plan.

Any changes in project work scope and/or site conditions as described must be amended in writing by the Health and Safety Representative (HSR) on the HASP Amendment Sheet (Appendix A).

Table 1, Responsibilities of On-Site Personnel, lists those accountable and responsible for the implementation of the HASP. Table 2, Hazard Analysis Matrix, presents an overview of site-specific job tasks and the associated hazards. Table 3, Contaminants of Concern Profile presents an overview of the hazards and control measures associated with the site contaminants of concern. Lastly, Table 4, presents an overview of the Fluor Daniel GTI health and safety programs in which all field personnel are required to participate. These include the medical surveillance and comprehensive training programs in accordance with OSHA Hazardous Waste Operations and Emergency Response standard, 29 CFR 1910.120.

1.1 Site Description/Background Information

The Pall facility is located at 30 Sea Cliff Avenue, approximately 1/8 mile west of Route 107 and 1/4 mile south-southeast of the Carney Street Well Field. The current Pall property is bordered on the north by the August Thomsen portion of the site, the south by Sea Cliff Avenue, the east by Route 107, and on the west by the Associated Draperies Facility. Photocircuits Corporation (Photocircuits) and Pass and Seymour (formerly Slater Electric Company and now owned by Photocircuits) are located south and upgradient of the site, across Sea Cliff Avenue. Glen Cove Creek is situated parallel to the west side of the site and runs from the southwest corner, through the site, to the northwest corner. Areas surrounding the site consist primarily of industrial areas with some residential areas located approximately 1 to 2 miles north, south, east, and west of the site.

Pall has operated it's Sea Cliff Avenue facility since the early 1950s. The Pall facility is currently used as a research and development facility for the manufacture of filtration products. The August Thomsen property was owned by Pall until 1971. During the period that Pall owned the August Thomsen property, it was used by Pall's subsidiary, Glen Components, Inc., as a precision machine shop providing parts to Pall's other divisions, primarily Aircraft Porous Media, Inc. According to Pall personnel, there are no chlorinated solvents currently being used at the site. Chlorinated solvents had been used at the site until approximately 1971 at which time their use was discontinued.

The topography of the site is relatively flat with a gentle slope from the southwest corner of the site (grade elevation approximately 55 feet above mean sea level [msl]) toward the northeast corner of the site (approximately 51 feet above mean sea level). Based upon historic groundwater elevation data, groundwater flows predominantly from southeast to northwest across the site. However, local groundwater elevation variations imply that there may also be a southwesterly component of the

groundwater flow direction along Glen Cove Creek. On the basis of the predominant groundwater flow direction, it appears that Photocircuits and the former Slater properties are located hydraulically upgradient from the Pall Corporation site.

Industrial activities have occurred in the past and are currently occurring on neighboring properties, including Photocircuits, Pass and Seymour (the former Slater facility currently owned by Photocircuits), and Associated Draperies. These industrial properties are subject to NYSDEC regulatory enforcement action. Pall, Photocircuits, and the former Slater properties are listed as Class 2 Inactive Hazardous Waste Disposal Sites (IHWDS) by the NYSDEC. Associated Draperies is listed as a NYSDEC Spills site.

1.2 Project Personnel and Responsibilities

Fluor Daniel GTI will oversee and act accordingly during all phases of the project. The following management structure will be instituted for the purpose of successfully and safety completing this project.

Technical Advisors

John Reinemann, CIH Fluor Daniel GTI, Albany, NY	(518) 783-1996
David Crowley, CSP, CET, CHMM Fluor Daniel GTI, Norwood, MA	(781) 769-7600

The specific duties of the technical advisors include:

- providing technical input into the design and implementation of the site HASP,
- advising on potential for worker exposure to project hazards along with appropriate methods and/or controls to eliminate site hazards.

A site health and safety officer (SHSO) will be assigned on a full time basis to each site during site activities and shall assist and shall represent the Health and Safety Manager (HSM). The SHSO shall have the responsibility and authority to implement and enforce the approved HASP, this includes modifying/halting work, and removal of personnel from the site if work conditions change and effect on-site/off-site health and safety matters. The SHSO will serve as the main contact for any on-site emergency situation.

Table 1. Responsibilities of On-Site Personnel

Title	General Description	Responsibilities
Project Manager (PM) Dan Smith, PE	Reports to upper-level management. Has authority to direct response operations. Assume total control over site activities.	☐ Prepares and organizes background review of the project, the work plan, the HASP, and the field team. ☐ Obtains permission for site access and coordinates activities with appropriate officials. ☐ Sees that the work plan is properly carried out and on schedule. ☐ Briefs the field personnel on specific assignments. ☐ Together with the SHSO sees that health and safety requirements are met. ☐ Prepares final report and follow up on Preliminary Incident Report (PIR) events.
SHSO Matt Bernstein	Advises the PM on all aspects of health and safety on site. Stops work if site operations threaten worker or public health and safety. Informs health and safety specialist of any changes in site conditions or project status.	☐ Periodically inspects protective clothing and equipment. ☐ Sees that protective clothing and equipment are properly stored and maintained. ☐ Controls entry and exit at the access control points. ☐ Monitors the workers for signs of stress, including heat stress, cold exposure, and fatigue. ☐ Implements the HASP. ☐ Conducts periodic inspections to assess whether the HASP is being followed. ☐ Enforces the "buddy" system. ☐ Informed of emergency procedures, evacuation routes, and telephone number of local hospital, poison control center, fire department, and police department. ☐ Notifies, when necessary, local public emergency officials. ☐ Submits PIRs promptly to site supervisor and PM. ☐ Maintains communication with health and safety representative on site activities.

Title	General Description	Responsibilities
SHSO (continued)		☐ Coordinates emergency medical care. ☐ Sets up decontamination lines and decontamination solutions appropriate for the chemical contaminants encountered. ☐ Controls the decontamination of equipment, personnel, and samples from contaminated areas. ☐ Facilitates the proper disposal of contaminated clothing and materials. ☐ Maintains the availability of required equipment. ☐ Advises Fluor Daniel GTI Technology health services and medical personnel of potential exposures. ☐ Notifies emergency response personnel in the event of an emergency. ☐ Maintains and oversees operation of monitoring equipment and interpretation of data from the monitoring equipment.
Project Supervisor Matt Bernstein	Reports to PM. Has authority to direct response operations. Assumes total control over site activities.	☐ Conducts Daily Safety Tailgate Meeting and documents attendance (Appendix M). ☐ Conducts periodic field health and safety inspections (Appendix L). ☐ Manages field operations. ☐ Executes the work plan and schedule. ☐ Enforces safety procedures. ☐ Coordinates with the SHSO in enforcing worker protection levels. ☐ Enforces site control. ☐ Documents field activities and sample collection. ☐ Notifies when necessary, local public emergency officials. ☐ Submits PIRS and initiates follow up with PM and SHSO.
Work Team	Reports to project supervisor for on-site activities. Work parties must comprise at least two people for high hazard operations.	☐ Safely completes on-site tasks required to fulfill the work plan. ☐ Complies with the HASP. ☐ Attends and participates in Daily Safety Tailgate Meetings. ☐ Notifies SHSO or supervisor of suspected unsafe conditions. ☐ Submits PIRs to SHSO and Project Supervisor.

Hazards and Controls provide guidelines to follow when conducting the tasks involved with this project.

Table 2. Hazard Analysis Matrix

Hazards	Tasks				
	Geoprobe, Drilling, Boring, Auguring	Gauge Wells	Monitoring Well Install.	Sampling Wells	Survey Wells
Contaminants of Concern Exposure	X	X	X	X	X
OSHA Chemicals Exposure	X	X	X	X	
Mechanical Equipment/ Construction	X		X		
Electrical	X		X		
Fire and Explosion	X	X	X	X	
Heat/Cold Stress	X	X	X	X	X
Vehicular Traffic	X	X	X	X	X
Pedestrian Traffic	X	X	X	X	X
Overhead Utilities	X		X		
Underground Utilities	X		X		
Noise	X		X		
Poisonous Plants	X	X	X	X	X

Site-Specific Health and Safety Program Requirements

Based upon the site-specific hazard analysis, the following programs must be implemented and the accompanying forms, found in the appendices of the HASP, completed. The completed forms can then be attached to this document.

SITE-SPECIFIC PROGRAM	HASP APPENDIX
Incident Report Guide	B
Air Monitoring Program	E
Noise Monitoring Program	E
Site-Specific Lockout/Tagout (LO/TO) Procedures	C
Underground Utility Contact Prevention and Management Plan	F
Heat/Cold Stress Procedure	I
Daily Safety Tailgate Meeting	M

1.4 Contaminants of Concern Profile

Based upon information received from the background information, site history, and site characterization is a summary profile of the hazards and control measures to follow for the contaminants of concern. Summarized in Table 3, the profile provides an overview of the hazards associated with potential exposure to the contaminants of concern and the preventative measures. For more detailed and specific information, always refer to the Material Safety Data Sheet (MSDS) or equivalent information for the compound located in Appendix D.

Table 3. Contaminants of Concern Profile

Contaminant of Concern	Profile of Hazards and Control Measures to Follow
Perchloroethylene (PCE)	A CNS depressant, causes liver and kidney damage and is considered a suspected human carcinogen. Target organs include liver, kidneys, eyes, upper respiratory tract, skin and CNS. Acute exposure may cause liver damage, smarting of eyes and throat. Skin contact may produce dermatitis. Chronic effects include impaired memory, extremity weakness, peripheral neuropathies, impaired vision, muscle cramps, liver damage. OSHA PEL is 25 ppm. See MSDS in Appendix D for additional health hazard information and control measures to follow.
Trichloroethene (TCE)	Irritating and toxic to CNS. Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. Liquid is absorbed through the skin. Suspected human carcinogen. Skin contact may product dermatitis. Chronic toxicity has been observed in victims increasing intolerance to alcohol, characterized by a transient redness of the face, trunk and arms. Target organs include the respiratory, central and peripheral nervous, and cardiovascular systems, liver, kidney and skin. OSHA PEL is 50 ppm. See MSDS in Appendix D for additional hazards information and control measures.

Table 3. Contaminants of Concern Profile (continued)

Contaminant of Concern	Profile of Hazards and Control Measures to Follow
1,1,1-Trichloroethane (TCA)	Skin, eye and respiratory tract irritant and can become narcotic with an anesthetic effect at high concentrations. An anesthetic capable of causing death at high concentrations. TCA sensitizes the heart to epinephrine and may induce cardiac arrhythmias and arrest. Target organs include skin, eyes, CNS and cardiovascular (CVS) systems. OSHA PEL is 350 ppm. See MSDS in Appendix D for additional information on hazards and control measures to follow.
1,2-Dichloroethene (DCE)	Primary health effect is the irritation of the CNS and narcosis. Irritating to the eyes. Acute effects from inhalation of vapors include respiratory tract irritation, nausea, vomiting, tremor, weakness, CNS depression, and abdominal cramps. Target organs include CNS, eyes, respiratory system. OSHA PEL is 200 ppm. See MSDS in Appendix D for additional information on health effects and control measures to follow.
1,1-Dichloroethane (DCA)	Volatile and highly flammable. Irritating to eyes and respiratory tract. Acts as an anesthetic at high concentrations. Acute exposure may cause kidney and liver damage. Acute effects from inhalation of vapors include eye, nose and throat irritation, headache, dizziness, coughing, staggering, disturbed vision, irregular heartbeat, unconsciousness, narcosis, coma and death due to cardiac or respiratory failure. Long-term exposure may result in chronic respiratory and skin disease, neurological damage and liver or kidney disorders. Target organs include skin, CNS, liver and kidneys. OSHA PEL is 100 ppm. See MSDS in Appendix D for additional information on hazards and control measures to follow.
Vinyl chloride (VICL)	A human carcinogen. Vapor inhalation leads to CNS depression. Flammable gas at room temperature. OSHA PEL is 1 ppm. Target organs include liver, CNS, respiratory and lymphatic systems, bone and connective tissue of the skin. Acute effects include CNS impacts including fatigue, headache, vertigo, ataxia, euphoria, visual disturbances, dulling of auditory cues, numbness and tingling in the extremities, narcosis, unconsciousness and death due to respiratory failure. Chronic effects include liver cancer. See MSDS in Appendix D for additional hazards and control measures to follow.
Benzene	Benzene is a confirmed human carcinogen with a PEL of 1 ppm. Chronic low level exposure may cause leukemia, bone marrow damage and injury to blood-forming tissues. Flammable. Prolonged skin contact or excessive inhalation of vapors may cause headache, weakness, appetite loss, and fatigue. Exposure to elevated levels may irritate the respiratory tract and central nervous system (CNS). Target organs include bone marrow, blood, CNS, eyes, upper respiratory tract and skin. See MSDS in Appendix D for additional hazards and control measures to follow.

Contaminant of Concern	Profile of Hazards and Control Measures to Follow
Ethyl benzene	Skin, eye and mucous membrane irritant. Inhalation causes acute and chronic CNS effects. Highly flammable. Liquid is absorbed through the skin. Target organs include eyes, respiratory system, CNS, blood. Repeated skin contact may cause dermatitis. Repeated vapor inhalation may result in blood disorders, particularly leukopenia and lymphocytosis. OSHA PEL is 100 ppm. See MSDS in Appendix D for additional hazard information and control measures to follow.
Xylenes	Skin, eye and mucous membrane and respiratory tract irritant and may be narcotic in high concentrations. Flammable. Target organs include CNS, eyes, GI tract, liver, kidneys and skin. Inhalation of high concentrations may cause dizziness, nausea, vomiting and abdominal pain, eye, nose and throat irritation, respiratory tract irritation leading to pulmonary edema, and transient CNS depression. Chronic effects include headache, fatigue, irritability, chronic bronchitis and GI disturbances. OSHA PEL is 100 ppm. See MSDS in Appendix D for additional health hazards and control measures to follow.
Toluene	Eye irritant, skin and respiratory tract irritant, becoming narcotic at high concentrations. May cause liver and kidney damage. Highly flammable. May produce teratogenic effects. Readily absorbs through the skin. Target organs include CNS, liver, kidney and skin. Excessive vapor inhalation causes respiratory tract irritation, fatigue, weakness, confusion, dizziness, headache, dilated pupils, watering eyes, nervousness, insomnia, parasthesis and vertigo progressing to narcotic coma. Chronic effects include mucous membrane irritation, headache, vertigo, nausea, appetite loss and kidney dystrophy. OSHA PEL is 100 ppm; ACGIH TLV is 50 ppm. Flammable liquid. See MSDS in Appendix D for additional hazard information and control measures to follow.

Table 4. Fluor Daniel GTI Health and Safety Training Programs

Training Program	Requirement/Action
☐ Specific training program requirements are described in Fluor Daniel GTI's Health and Safety Procedure Manual, Policy and Procedure #8, "Safety Training." ☐ Training requirements and programs comply with the OSHA Hazardous Waste Operations and Emergency Response standard, 29 CFR 1910.120.	☐ Field personnel must complete a minimum of 40 hours of hazardous waste activity instruction. ☐ Field personnel must complete a minimum of 3 days supervised field instruction. ☐ Field personnel assigned to the site will also receive 8 hours of refresher training each year. ☐ On-site managers and supervisors directly responsible for employees engaged in hazardous waste operations receive an additional 8 hours of supervisory training. ☐ Field personnel assigned to site also receive first aid/cardio-pulmonary resuscitation (CPR) and blood borne pathogen training. ☐ Field personnel and subcontractors assigned to site must participate in "Daily Safety Tailgate Meeting" and document their attendance.
☐ Competent person training for excavation/trenching operations meet requirements outlined in 29 CFR 1926, Subpart P.	☐ On-site managers and supervisors directly responsible for employees engaged in excavation/trenching operations receive the Fluor Daniel GTI 4-hour "Competent Person Training Seminar."
☐ Authorized supervisor, attendant, and entrant training for permit required confined space entry meet requirements outlined in 29 CFR 1910.146.	☐ Field personnel assigned to site who must supervise, watch over and/or enter permit required confined spaces receive the Fluor Daniel GTI 8-hour (or equivalent) "Confined Space Entry" course.
☐ Fall protection training that meets requirements in 29 CFR 1926.503	☐ Field personnel assigned to site who must work in areas with fall hazards six feet or greater must receive the Fluor Daniel GTI 2-hour "Fall Protection" course.
☐ Fluor Daniel GTI requirement for removing underground storage tanks (UST).	☐ Field personnel assigned to site who are tasked with the assessment and removal of USTs must complete the 4-hour Fluor Daniel GTI "Underground Storage Tank Removal" course.

Training Program	Requirement/Action
☐ Orientation of plant operations, hazards, safe work practices, and emergency procedures to follow that meets the requirements of the OSHA Process Safety Standard, 29 CFR 1910.119.	☐ Project personnel who are on the project site that falls under the Process Safety Standard will receive orientation by a company representative.

2.0 HAZARD IDENTIFICATION AND CONTROL

Based upon the hazard analysis of the tasks that will be conducted for the project, Table 5 lists the general procedures and practices to follow to prevent injury or illness. Appropriate training for specific hazards must be completed by field personnel prior to initiating work activities. Precautions must be taken to prevent injuries and exposures to the following potential hazards. For additional information, refer to the Fluor Daniel Health and Safety Policies and Procedures, or consult with your health and safety professional.

Table 5. Potential Hazards and Control

Potential Hazard	Control
Exposure to Chemical Products (See Appendix E: MSDS Definitions and MSDSs)	1. Stand up-wind of chemical products whenever possible. 2. Minimize direct contact and contact time with contaminated media to prevent exposure. 3. Avoid walking through discolored areas, puddles, leaning on drums, or contacting anything that is likely to be contaminated, unless wearing the appropriate PPE. 4. Do not eat, drink, smoke and/or apply cosmetics in the hot or warm zones. 5. Wear appropriate PPE when it is required to come in contact with contaminated media or surfaces. 6. Level D PPE must be worn as a minimum when on project site. 7. > 1 parts per million (ppm) organic vapors, sustained for 5 minutes, in breathing zone requires monitoring for vinyl chloride and benzene with colorimetric indicator tubes. If either compound is present above 0.5 ppm, upgrade to Level C. 8. >25 ppm organic vapors, sustained for 5 minutes, in breathing zone requires additional colorimetric tube monitoring for perchloroethylene and upgrading from Level D to Level C, if PCE >12.5 ppm. 9. >50 ppm organic vapors, sustained for 5 minutes, in breathing zone requires upgrade in PPE to Level C. 10. >100 ppm organic vapors, sustained for 5 minutes, in breathing zone requires upgrade to Level B, upon approval from HSR. 11. If unknown materials are encountered, call the HSR.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Exposure to OSHA Defined Hazardous Materials (See Appendix D: MSDS Definitions and MSDSs)	1. All chemicals brought on-site by Fluor Daniel GTI personnel or their subcontractors, such as pipe glues, solvents, reagents, decontamination solutions, or any other OSHA defined hazardous material must be adequately labeled and the MSDSs available on-site. 2. MSDSs brought on-site can be attached in Appendix D or in the MSDS binder that is kept in the company vehicle. 3. Training on OSHA defined hazardous materials must be completed and documented. Use the Daily Safety Tailgate Meeting Form in Appendix M to record training attendance.
Exposure to Surface/ Subsurface Airborne Dust	1. Stand up-wind whenever intrusive activities occur and generate visible signs of airborne dust. 2. Monitor air for airborne soil dust (surface or subsurface soil) with portable aerosol dust-direct reading instrument. 3. > 2.5 mg/M^3 in breathing zone requires upgrade to Level C. 4. >50 mg/M^3 in breathing zone requires upgrade to Level B. Approval for Level B must first be approved by HSR. 5. Utilize wet methods (spraying ground, wet drilling, etc.) when visible signs of airborne dust are generated.
Vehicular Traffic	1. Wear traffic safety vest when vehicle hazard exists. 2. Use cones, flags, barricades, and caution tape to define work area. 3. Use vehicle to block work area. 4. Engage police detail for high-traffic situations. 5. Refer to section 5.3 for specific details and guidance.
Fall Protection (not currently anticipated for this project)	1. Assess the work to determine if there is a potential for falling. 2. Make a determination of the distance of the potential fall. 3. A fall protection system must be used for potential falls greater than 6 feet. 4. Consult a competent person, such as the HSR, regarding the applicability requiring fall protection and what type of protection systems should be used. 5. Inspect all fall protection equipment and anchoring points prior to their use. 6. Ensure Fall Protection training for applicable employees is completed prior to initiating work activities.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
CSE (not currently anticipated for this project)	1. Ensure personnel assigned meet CSE training requirements. 2. Complete CSE Hazard Analysis Form in Appendix G. 3. Complete CSE permit. Post sign. 4. Ensure pre-entry CSE safety meeting is conducted. 5. Remove vault cover using proper lifting techniques. 6. Promote natural ventilation by opening the space to fresh air, if needed utilize mechanical purge ventilation. 7. Conduct remote air monitoring prior to entry. 8. Attendant can act as CSE Supervisor and must be present at CSE entry point all times when entrant is in CSE. 9. Access work for fall hazards and ensure provisions for non-entry rescue have been met. 10. Enter only when safe; conduct continuous air monitoring.
Inclement Weather	1. Stop outdoor work during electrical storms and other extreme weather conditions such as extreme heat or cold temperatures. 2. Take cover indoors or in vehicle. 3. Listen to local forecasts for warnings about specific weather hazards such as tornados, hurricanes, and flash floods.
Drum Handling/ Staging	1. Follow safe lifting guidelines and use mechanical aids when lifting/moving drums. 6. Review JSA listed in Appendix J for safely handling drums.
Utility Lines Contact	1. Contact Dig Safe to have utility lines marked prior to excavation/trenching 2. Refer to site drawings or customer interviews if on private property for utility locations. 3. Hand dig 3 to 5 feet down and 5 feet each side of utility marker to avoid breaking utility lines. 4. Refer to Appendix F for Underground Utility Contact Prevention Management Plan.
Noise	1. Wear hearing protection when equipment such as a drill rig, jackhammer, cut saw, air compressor, blower or other heavy equipment is operating on the site. 2. Wear hearing protection whenever you need to raise your voice above normal conversational speech due to a loud noise source; this much noise indicates the need for protection. 3. Hearing protection is required when measured sound pressure levels (SPL) exceed 85 dB(A) where employees stand or conduct work. 4. Conduct noise monitoring of suspected high noise operations at the beginning of the workday or start up of new operations to verify noise control/hearing protection requirements. 5. Refer to Section 3.2, Noise Monitoring for guidance.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Electric Shock	1. Maintain appropriate distance from overhead utilities; **20-foot minimum clearance from power lines required; 10-foot minimum clearance from shielded power lines.** 2. Use ground-fault circuit interrupters as required. 3. Perform LO/TO procedures (Appendix C). 4. Use three-pronged plugs and extension cords. 5. Contact your local underground utility-locating service. 6. Follow code requirements for electrical installations in hazardous locations.
Physical Injury	1. Wear hard hats and safety glasses when on-site. 2. Maintain visual contact with the equipment operator and wear orange safety vest when heavy equipment is used on-site. 3. Avoid loose-fitting clothing (driller and driller's helper). 4. Prevent slips, trips, and falls; keep work area uncluttered. 5. Keep your hands away from moving parts (i.e., augers). 6. Test the emergency shut-off switch on the drill rig daily.
Back Injury	1. Use a mechanical lifting device or a lifting aid where appropriate. 2. If you must lift, plan the lift before doing it. 3. Check your route for clearance. 4. Bend at the knees and use leg muscles when lifting. 5. Use the buddy system when lifting heavy or awkward objects. 6. Do not twist or jerk your body while lifting.
Heat Stress (not currently anticipated for this project)	1. Increase water intake while working. 2. Minimize and/or avoid alcohol intake the night before working in heat stress situations. 3. Increase number of rest breaks and/or rotate workers in shorter work shifts; take breaks in shaded areas. 4. Watch for signs and symptoms of heat exhaustion and fatigue. 5. Plan work for early morning or evening during hot months. 6. Use ice vests when necessary. 7. Rest in cool, dry areas. 8. In the event of heat stroke, bring the victim to a cool environment and initiate first aid procedures. Refer to Appendix I.
Cold Stress	1. Take breaks in heated shelters when working in extremely cold temperatures. 2. Remove the outer layer of clothing and loosen other layers to promote evaporation of perspiration, upon entering the shelter. 3 Be aware of cold stress symptoms such as shivering, numbness in the extremities, and sluggishness. 4. Drink warm liquids to reduce the susceptibility to cold stress. Refer to Appendix I.
High Crime Areas	1. Be aware of surroundings. 2. Use the buddy system. 3. Request police detail when appropriate.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Insects (not anticipated to be a concern during the cooler months)	1. Tuck pants into socks. 2. Wear long sleeves. 3. Use insect repellent. 4. Avoid contact by always looking ahead to where walking, standing, sitting, leaning, grabbing, lifting or reaching-in-to. 5. Check for signs of insect/spider bites, such as redness, swelling, and flu-like symptoms. 6. Use buddy system to check each other for signs of insect/spider bites. 7. Remove ticks immediately with fine tipped tweezers by grasping the tick as close to your skin as possible and gently pulling straight out. Do not squeeze the tick's body as this may inject fluids into you. Wash the bite area of skin and apply antiseptic.
Poisonous Plants (Such as Poison Ivy, Oak or Sumac)	1. Don't enter areas infested with poisonous plants. 2. Immediately wash any areas that come into contact with poisonous plants. 3. Protect exposed skin area with gloves and Tyvek® suits. 4. Be aware that the oil from the plant can be carried on boots, clothes and equipment. Always protect skin from contact. 5. If you have known or suspected allergies, carry an Epi-Pen at all times and notify co-workers that you are allergic.
Poisonous Snakes (not currently anticipated due to cooler ambient temperatures)	1. Avoid walking in areas where snake may nest or hide. Always look ahead to where walking for signs of snakes. 2. Use extreme caution when moving or lifting objects which could be used by snakes as cover. 3. Never reach under or behind objects or into other areas where snakes may hide. 4. Wear sturdy leather boots.
Ladders	1. Assess work areas for fall hazards. 2. Make sure ladder rungs are sturdy and free of cracks. 3. Use ladders with secure safety feet. 4. Pitch ladders at a 4:1 ratio. 5. Secure ladder at the top or have another person at the bottom to help stabilize it. 6. Do not use ladders for access to air stripper towers. 7. Use non-conductive ladders near electrical wires.
Fire Control	1. Smoke only in designated areas. 2. Keep flammable liquids in closed containers. 3. Keep site clean; avoid accumulating combustible debris such as paper. 4. Follow Hot Work Safety Procedures when welding or performing other activities requiring an open flame. 5. Isolate flammable and combustible materials from ignition sources. 6. Ensure fire safety integrity of equipment installations.

Line Manager must check incident type:

Class I _____

Class II _____

Class III _____

PRELIMINARY INCIDENT REPORT

Person Completing Report _____ Office _____ Date _____ Incident Date _____

Incident Time: _____ Location _____ Home Dept. # _ _ _ _ _ _ Visiting Dept. # _ _ _ _ _ _

Person Involved in Incident _____ Telephone _ _ _ - _ _ _ - _ _ _ _

Driver Name (if motor vehicle accident) _____ Telephone _ _ _ - _ _ _ - _ _ _ _

Type of Incident:

Personal Injury/Illness	Near Miss Event	Other
Chemical Exposure	Unsafe Condition/Action	Motor Vehicle Accident
Equipment Damage	Fire/Explosion	Assoc. Leasing Vehicle #: _ _ _ _ _ _ _ _ _
Theft	Spill/Release	VIN # _____
Property Damage	Customer Incident	If FDGTI vehicle, call Associates Leasing at 800-255-2607.
Permit/Code Compliance	Newspaper/Radio/TV	Circle one based on initial findings: Preventable/Non-preventable

Personal Injury Yes No (If no, go to next section)

First Aid Only
Hospitalization
Medical Treatment
Possible Injury, Not Confirmed

Person Injured:
Fluor Daniel GTI Employee (If so, complete First Report of Injury)
Subcontractor
Customer/Public/Other

Nature of Injury, Illness or Exposure: _____

Describe nature of incident, how it occurred, who was involved, witnesses and possible causal factors: (Attach additional sheets if necessary)

First Report of Injury Attached Police Report Attached

Describe immediate actions taken and persons notified: (Attach additional sheets if necessary)

Line Manager (responsible for follow-up) _____ Office _____

DISTRIBUTION

Provide this report to the line manager immediately. The line manager is responsible for the proper distribution of the PIR form per the Incident Reporting Guide (see reverse side). Notify the Norwood Health and Safety Department of all Class II and III incidents immediately by phone at (800) 876-0647, Mailbox *11911, and fax a copy of the PIR to (617) 769-9861 .

Rev. 9/96

INCIDENT REPORTING GUIDE

Incident Class	Class I: A minor incident that is dealt with at the local level	Class II: A serious incident requiring immediate distribution and notification as described below and on the first page.	Class III: A highly significant incident requiring immediate notification and assistance from Regional Manager and Corporate
Examples of Incidents	First Aid injury Minor damage <$200 Non-reportable quantity spill Near miss event Unsafe condition or action	Personal injury (more than first aid to employee, subcontractor or public) Any motor vehicle accident Damage to property greater than $200 but less than $10,000 Near miss incident that could have been very serious Fire/Explosion Non-emergency notification of regulatory agency is required Served with subpoena (**DO NOT ACCEPT**; have subpoena delivered to CT Corporation System, our Registered Agent at 800-336-3376 or contact Legal Dept. in Norwood for additional assistance; no written investigation report is required for a subpoena.)	Possible Lost Work Day Injury Hospitalization (of one or more persons) Multiple injury of employees, subcontractors or public Unprotected chemical exposure Death Damage to property greater than $10,000 Reportable quantity spill release Emergency notification of regulatory agency Regulatory agency response to incident site (inspection) Contact or appearance of news or public media
Notification Actions	1. On-scene person notifies Line Manager* immediately by phone. 2. Provide PIR form to Line Manager and H&S Representative(s)** immediately following the incident. 3. Line Manager investigates and follows up within 48 hours.	1. On-scene person notifies Line Manager* immediately by phone. 2. Line Manager notifies the District Manager; Regional Manager, H&S Representative(s)**, Human Resources Representative, Corporate H&S Director and CEO with PIR form immediately following the incident. 3. Line Manager provides a detailed final investigation report within 48 hours after the original PIR is submitted. The final report must be submitted to District Manager, Regional Manager, H&S Representative(s), Human Resources Representative, Corporate Director H&S and CEO.	1. On-scene person notifies Line Manager* immediately by phone. 2. Line Manager immediately notifies District Manager, Regional Manager, H&S Representative(s)**, Human Resources and Corporate Director H&S. PIR form is provided by fax immediately to (617-769-9861) addressed to Corporate Director H&S. 3. Incident management team conferences by phone and formulates an action plan.

Notes: If there is a question as to Class I or II, follow Class II notification actions. Rev. 9/96

All Class II and III incidents must be communicated to the Norwood Health and Safety Department immediately by phone at (800) 876-0647, Mailbox *11911; leave a voice message. This will activate a digital pager which is carried by a company health and safety professional 24 hours a day.

All lost-time injury events will be investigated by the respective Regional Manager with a final report to the CEO.

*Line management = reporting manager, project manager, or operations/office manager.
**H&S representative = includes District H&S representatives and Regional H&S manager

APPENDIX C

LO/TO PROCEDURES

This form is required to be completed when equipment (i.e. electrical, mechanical, pneumatic, chemical, thermal) that requires maintenance, which has stored energy, could be set in motion, thereby causing an injury. To complete the form:

Identify all equipment (i.e. blower motor, recovery pump, etc);
Describe the operation to be conducted (i.e. change fuse, change motor brushes, etc.)
Describe the lockout method/location (i.e. circuit breaker panel outside remediation compound shed, using a single-pole, red plastic lockout clip)

SITE-SPECIFIC LO/TO PROCEDURES		
Equipment	**Operation**	**Lockout Method/Location**

APPENDIX D

MSDS DEFINITIONS
MSDS

MSDS DEFINITIONS

(TLV-TWA)	***Threshold Limit Value - Time Weighted Average***. The time-weighted average concentration for a normal 8-hour work day and a 40-hour work week, to which nearly all workers may be repeatedly exposed without adverse effect.
(PEL)	Time-weighted average concentrations similar to (and in many cases derived from) the Threshold Limit Values.
(REL)	***Recommended Exposure Limit*** as defined by NIOSH similar to the Threshold Limit Values.
(IDLH)	***Immediately dangerous to life or health.*** Any atmospheric condition that poses an immediate threat to life, or which is likely to result in acute or immediate severe health effects. Oxygen deficiency is **IDLH**.
(LEL)	***Lower Explosive Limit.*** The minimum concentration of vapor in air below which propagation of a flame will not occur in the presence of an ignition source.
(UEL)	***Upper Explosive Limit.*** The maximum concentration of vapor in air above which propagation of a flame will not occur in the presence of an ignition source.
Flash Point (FP)	The lowest temperature at which the vapor of a combustible#liquid can be made to ignite momentarily in air.
Vapor Pressure (VP)	The pressure characteristic at any given temperature of a vapor in equilibrium with its liquid or solid form, often expressed in millimeters of mercury (mm Hg).
Odor Threshold	A property displayed by a particular compound. Low detection indicates a physiological sensation due to molecular contact with the olfactory nervous system (based on 50% of the population).
Ionization Potential (IP)	The amount of ionization characteristic a particular chemical compound displays.

MSDS

The following MSDS are for hazardous materials that will be encountered at this site. Contact your local HSR if you need additional information on these materials.

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

Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

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

Section 1. Material Identification

Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.

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

NFPA

HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

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

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

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

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

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

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

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

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

Section 3. Physical Data

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

Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
% Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

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

Section 4. Fire and Explosion Data

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

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

Section 5. Reactivity Data

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

Section 6. Health Hazard Data

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

Section 7. Spill, Leak, and Disposal Procedures

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

Section 8. Special Protection Data

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

Section 9. Special Precautions and Comments

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

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)
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 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

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

Material Safety Data Sheets Collection:

Sheet No. 830
1,1-Dichloroethane

Issued: 6/92

Section 1. Material Identification

1,1-Dichloroethane (CH_3CHCl_2) Description: Derived by various methods; by direct chlorination of ethane, as a side product of chloral manufacture, by treating ethylene and chlorine with calcium chloride, by action of phosphorus chloride on acetaldehyde, and the reaction of hydrogen chloride and vinyl chloride at 20 to 55 °C in the presence of an aluminum, ferric, or zinc chloride catalyst. Found as an air contaminant in submarines and space craft. Its largest industrial use is in the production of 1,1,1-trichloroethane. Also used as a cleansing agent, degreaser, solvent for plastics, oils, and fats, grain fumigant, chemical intermediate; in insecticide sprays, rubber cementing, fabric spreading, paint and varnish removers, in ore flotation, vinyl chloride production, and as a coupling agent in anti-knock gasoline. Formerly used as an anesthetic.

R 1
I 3
S 2
K 4

NFPA

HMIS
H 2
F 3
R 0
PPG*
* Sec. 8

Other Designations: CAS No. 75-34-3; assymetrical dichloroethane; chlorinated hydrochloric ether; ethylidene chloride; ethylidene dichloride.

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

Cautions: 1,1-Dichloroethane is volatile and highly flammable. It is irritating to the eyes and respiratory tract and inhalation of high concentrations causes an anesthetic effect.

Section 2. Ingredients and Occupational Exposure Limits

1,1-Dichloroethane, reagent grade (99.7%). Impurities consist of ethyl chloride (0.02%), trichloroethylene (0.08%), butylene oxide (0.08%), ethylene dichloride (0.01%), and unknown (0.14%).

1991 OSHA PEL
8-hr TWA: 100 ppm (400 mg/m³)

1990 IDLH Level
4000 ppm

1990 NIOSH REL
8-hr TWA: 100 ppm (400 mg/m³)

1991-92 ACGIH TLVs*
TWA: 200 ppm (810 mg/m³)
STEL: 250 ppm (1010 mg/m³)

1990 DFG (Germany) MAK
100 ppm (400 mg/m³)
Half-life: < 2hr
Peak Exposure Limit: 200 ppm/30 min. average value/maximum of 4 peaks per shift

1985-86 Toxicity Data†
Mouse, oral, TD_{Lo}: 185 g/kg administered intermittently for 78 wk produced uterine tumors.
Rat, oral, LD_{50}: 725 mg/kg; toxic effects not yet reviewed.‡
Rat, inhalation, TC_{Lo}: 6000 ppm/7 hr administered during 6 to 15 days of pregnancy caused developmental abnormalities of the musculoskeletal system.

* Notice of intended change to 100 ppm/405 mg/m³.
†See NIOSH, *RTECS* (KI0175000), for additional reproductive, tumorigenic and toxicity data.
‡ Considered a possible error since subsequent studies at higher concentrations failed to produce comparative results.[133]

Section 3. Physical Data

Boiling Point: 135 °F (57.3 °C)
Melting Point: -143 °F (-96.98 °C)
Vapor Pressure: 230 mm Hg at 77 °F (25 °C)
Saturated Vapor Density (air = 1.2 kg/m³ or 0.075 lbs/ft³): 2.076 kg/m³ or 0.129 lbs/ft³
Refraction Index: 1.4166 at 68 °F (20 °C)
Surface Tension: 24.75 dyne/cm at 68 °F (20 °C)
Molecular Weight: 98.97
Specific Gravity: 1.174 at 68 °F (20/4 °C)
Water Solubility: Slightly, 0.5%
Other Solubilities: Very soluble in alcohol and ether, soluble in acetone, benzene, and fixed and volatile oils.
Relative Evaporation Rate (BuAc=1): 11.6
Odor Threshold: 49 to 1359 ppm; odor is not sufficient to warn against overexposure

Appearance and Odor: Colorless, mobile, oily liquid with a chloroform odor and a saccharin taste.

Section 4. Fire and Explosion Data

Flash Point: 17 °F (-8.33 °C) CC*	Autoignition Temperature: 856 °F (493 °C)	LEL: 5.6% v/v	UEL: 11.4% v/v

Extinguishing Media: A Class 1B Flammable Liquid. For small fires, use dry chemical, carbon dioxide (CO_2), or "alcohol-resistant" foam. For large fires, use fog or "alcohol-resistant" foam. Water may be ineffective unless used as a "blanket".

Unusual Fire or Explosion Hazards: Vapors may travel to an ignition source and flash back. Container may explode in heat of fire.

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 only limited protection. If possible without risk, move container from fire area. Apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if 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 (explosion) or waterways.

* 22 °F (-5.5 °C), OC[148]

Section 5. Reactivity Data

Stability/Polymerization: 1,1-Dichloroethane is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: Incompatible with strong oxidizers and forms acetaldehyde in contact with caustics. 1,1-Dichloroethane will attack some forms of plastics, rubber, and coatings.

Conditions to Avoid: Exposure to heat and ignition sources and contact with incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of 1,1-dichloroethane can produce carbon dioxide (CO_2), irritating hydrogen chloride (HCl) and toxic phosgene ($COCl_2$) fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list 1,1-dichloroethane as a carcinogen. However, the National Cancer Institute has recommended caution due to analogy to other chloroethanes such as 1,2-dichlorothane which are shown to cause cancer in animals.

Summary of Risks: 1,1-Dichloroethane is irritating to the eyes and respiratory system. It causes varying degrees of central nervous system (CNS) disturbance depending on the concentration and duration of exposure. Liver and kidney toxicity is controversial.

Continue on next page

Section 6. Health Hazard Data, *continued*

Some sources report that severe, acute exposures can cause damage, some quote recent detailed chronic studies which indicate little capacity for damage; still others refute the possibility of acute damage even from very high exposures. In reviewing the data it appears likely that chronic exposure will not cause kidney or liver damage but acute exposures to high concentrations may. There is definite evidence that 1,1-dichloroethane produces liver damage in monkeys, dogs, and rats when exposed to 98 ppm/90 days. It is also unclear whether or not 1,1-dichloroethane is absorbed through the skin. There are reports of absorption (although not in toxic amounts) and others claiming there is no absorption. Given this controversial data it is best to take precautions as if skin absorption, and liver and kidney damage were proven to occur. **Medical Conditions Aggravated by Long-term Exposure:** Chronic respiratory and skin disease, neurological damage, and liver or kidney disorders. **Target Organs:** Skin, CNS, liver, kidney. **Primary Entry Routes:** Inhalation and skin contact. **Acute Effects:** Inhalation symptoms include eye, nose, and throat irritation, headache, dizziness, coughing, staggering, disturbed vision, irregular heartbeat (can result in sudden death), unconsciousness, narcosis, coma, and death due to cardiac or respiratory failure. There is the risk of pulmonary edema (fluid in lungs). Skin contact is irritating and causes defatting, redness and swelling. Vapor contact with the eyes causes irritation, watering eyes and lid inflammation. Splashes to the eyes produces a burning sensation, watering, and lid inflammation. **Chronic Effects:** Repeated skin contact can cause a rash and scaliness. Repeated inhalation may have neurological effects.

FIRST AID *Emergency personnel should protect against contamination.*

Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Do *not* allow victim to rub or keep eyes tightly shut. Immediately consult an ophthamlologist. **Skin:** 1,1-Dichloroethane vaporizes easily and poses an inhalation hazard as well. *Quickly and carefully* remove contaminated clothing; *1,1-dichloroethane is flammable!* 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. **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. After vomiting, give 2 tbsp activated charcoal in 8 oz water to drink.

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

Note to Physicians: Proper ventilation is the main treatment for acute exposure. Be prepared to support respiration if needed. Monitor liver function studies, urine analysis, and creatinine with acute and chronic 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 ignition sources. Cleanup personnel should protect against inhalation and skin contact. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and using nonsparking tools, place in a suitable container. For large spills, dike far ahead of liquid spill for disposal or reclamation. Do not allow 1,1-dichloroethane to enter confined areas such as a sewer because of potential explosion. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Degradation:** In soil, 1,1-dichloroethane volatilizes rapidly but may leach into groundwater. In water it will volatilize from a pond, lake, or river with a half-life of 6 to 9 days, 5 to 8 days, and 24 to 32 hr, respectively. In the atmosphere it will degrade by reaction with photochemically produced hydroxyl radicals with a 62 day half-life. It may also be carried back to soil via rain.

Ecotoxicity Values: *Artemia salina*, brine shrimp, TLm 320 mg/L/24 hr; *Lagodon rhomboides*, pinperch, TLm 160 mg/L/24 hr; *Poecilia reticulata*, guppies, LC_{50} 202 ppm/7 days.

Disposal: 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): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U076

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg)

[* per RCRA, Sec. 3001 & CWA, Sec. 307(a)]

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH/MSHA-approved respirator. For < 1000 ppm, use any supplied-air respirator or SCBA. For < 2500 ppm, use any supplied-air respirator operated in a continuous flow mode. For < 4000 ppm, use any supplied-air respirator or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent repeated or prolonged skin contact. Polyvinyl alcohol is recommended as suitable material for PPG. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Thoroughly decontaminate personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from ignition sources and incompatibles (Sec. 5). Label containers to indicate the contents' high flammability. Periodically inspect containers for cracks and leaks. To prevent static sparks, electrically ground and bond all equipment used in 1,1-dichloroethane 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.

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers emphasizing the skin, CNS, liver, and kidney. Educate workers about the hazards of 1,1-dichloroethane and the necessary precautions to reduce or prevent exposure.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: 1,1-Dichloroethane

IMO Hazard Class: 3.2

ID No.: UN2362

IMO Label: Flammable Liquid

IMDG Packaging Group: II

MSDS Collection References: 73, 89, 101, 103, 126, 127, 131, 132, 133, 136, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171

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

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

Material Safety Data Sheets Collection:

Sheet No. 703
1,2-Dichloroethylene

Issued: 4/90

Section 1. Material Identification

1,2-Dichloroethylene Description: An industrial solvent composed of 60% cis- and 40% trans-isomers. Both isomers, cis and trans, are made by partial chlorination of acetylene. Used as a general solvent for organic materials, lacquers, dye extraction, thermoplastics, organic synthesis, and perfumes. The trans-isomer is more widely used in industry than either the cis-isomer or the mixture. Toxicity also varies between the two isomers.
Other Designations: CAS No. 0540-59-0; $C_2H_2Cl_2$; acetylene dichloride; *cis*-1,2-dichloroethylene; *sym*-dichloroethylene; *trans*-1,2-dichloroethylene, dioform.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R	1
I	2
S	2
K	1

NFPA

HMIS
H 2
F 3
R 1
PPG*
* Sec.

Section 2. Ingredients and Occupational Exposure Limits

1,2-Dichloroethylene, ca 100%

OSHA PEL
8-hr TWA: 790 mg/m³, 200 ppm

ACGIH TLV, 1989-90
TLV-TWA: 790 mg/m³, 200 ppm

NIOSH REL, 1987
790 mg/m³, 200 ppm

Toxicity Data*
Rat, oral, LD_{50}: 770 mg/kg; toxic effects not yet reviewed
Frog, inhalation, TC_{Lo}: 117 mg/m³ inhaled for 1 hr affects the peripheral nerve and sensation (flaccid paralysis without anesthesia); behavior (excitement); lungs, thorax, or respiration (respiratory depression)

* See NIOSH, *RTECS* (KV9360000), for additional toxicity data.

Section 3. Physical Data

Boiling Point: 119 °F/48 °C
Melting Point: -56 to -115 °F/-49 to -82 °C/
Vapor Pressure: 180 to 264 torr at 68 °F/20 °C
Vapor Density (Air = 1): 3.4

Molecular Weight: 96.95 g/mol
Specific Gravity (H_2O = 1 at 39 °F/4 °C): 1.27 at 77 °F/25 °C
Water Solubility: Insoluble

Appearance and Odor: A colorless, low-boiling liquid with a pleasant odor.

Section 4. Fire and Explosion Data

Flash Point: 37 °F/2.8 °C, CC	**Autoignition Temperature:** 860 °F/460 °C	**LEL:** 5.6% v/v	**UEL:** 12.8% v/v

Extinguishing Media: Use dry chemical, CO_2, halon, water spray, or standard foam. Water may be ineffective unless used to blanket the fire.
Unusual Fire or Explosion Hazards: This material's vapors are a dangerous fire hazard and moderate explosion hazard when exposed to any heat or ignition source or oxidizer.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit. Vapors may travel to heat or ignition sources and flash back. Stay upwind and out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: This material is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: This material is incompatible with alkalies, nitrogen tetraoxide, difluoromethylene, strong oxidizers, and dihypofluorite. When in contact with copper or copper alloys or by reaction with potassium hydroxide, explosive chloroacetylene may be released.
Conditions to Avoid: Addition of hot liquid to cold 1,2-dichloroethylene may cause sudden emission of vapor that could flash back to an ignition source.
Hazardous Products of Decomposition: Thermal oxidative decomposition of 1,2-dichloroethylene can produce highly toxic fumes of chlorine (Cl^-).

Section 6. Health Hazard Data

Carcinogenicity: Neither the NTP, IARC, nor OSHA lists 1,2-dichloroethylene as a carcinogen.

Summary of Risks: 1,2-Dichloroethylene's most important effect is its irritation of the central nervous system (CNS) and narcosis. This material is toxic by inhalation, ingestion, and skin contact. It is also irritating to the eyes. The trans-isomer at 2200 ppm causes nausea, vertigo, and burning of the eyes. The trans-isomer is twice as potent as the cis-isomer. If renal effects occur, they are transient.

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

Target Organs: Central nervous system, eyes, respiratory system.

Primary Entry Routes: Inhalation, ingestion, skin and eye contact.

Acute Effects: Inhalation of 1,2-dichloroethylene causes narcosis, respiratory tract irritation, nausea, vomiting, tremor, weakness, central nervous depression, and epigastric (the abdomen's upper midregion) cramps. Contact with the liquid causes eye and skin (on prolonged contact) irritation. Ingestion causes slight depression to deep narcosis.

Chronic Effects: None reported.

FIRST AID

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

Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed. Have trained personnel administer 100% oxygen, preferably with humidification.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

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

Physician's Note: Intravenous injections of calcium gluconate may relieve cramps and vomiting. Treat central nervous system effects symptomatically.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a 1,2-dichloroethylene spill control and countermeasure plan (SCCP).* Notify safety personnel, remove all heat and ignition sources, evacuate hazard area, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Absorb small spills on paper towels. After evaporating the 1,2-dichloroethylene from these paper towels in a fume hood, burn the paper in a suitable location away from combustible material. Collect and atomize large quantities in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. 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)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per RCRA, Sec. 3001, 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)

† Listed as 1,2-*trans*-dichloroethylene.

Section 8. Special Protection Data

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

Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

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

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. 1,2-dichloroethylene attacks some forms of plastics, rubber, and coatings.

Ventilation: Provide general and local explosion-proof 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.[103]

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

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

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

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and oxidizing materials. Outside or detached storage is preferred. If stored inside, place containers in a standard flammable liquids storage cabinet or room. Protect containers from physical damage.

Engineering Controls: 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. 1,2-dichloroethylene is a dangerous fire hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement questionnaires which emphasize detecting a history of chronic respiratory disease.

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

MSDS Collection **References:** 7, 26, 38, 73, 84, 85, 87, 88, 100, 101, 103, 109, 126, 127, 136, 137

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

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 385
Ethylbenzene

Issued: 8/78 Revision: B, 9/92

Section 1. Material Identification

Ethylbenzene ($C_6H_5C_2H_5$) 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 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, acetophenone, ethyl anthraquinone, propyl oxide, and α-methylbenzol alcohol.
Other Designations: CAS No. 100-41-4, ethylbenzol, EB, phenylethane, NCI-C56393.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 3
S 2*
K 4
* Skin absorption

NFP

HMIS
H 2†
F 3
R 0
PPE - S
† Chron effect

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/m^3)
15-min STEL: 125 ppm (545 mg/m^3)
Action Level: 50 ppm (217 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH REL
TWA: 100 ppm (435 mg/m^3)
STEL: 125 ppm (545 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 125 ppm (545 mg/m^3)

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category 1: local irritants
Peak Exposure Limit: 200 ppm, 5 min momentary value, max of 8/shift
Danger of cutaneous absorption

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 100 ppm/8 hr caused eye effec sleep, and respiratory changes.
Human, lymphocyte: 1 mmol/L induced sister chromatic exchange.
Rat, oral, LD_{50}: 3500 mg/kg; toxic effects not yet review
Rat (female), inhalation, TC_{Lo}: 1000 ppm/7 hr/day, 5 da wk, for 3 wk prior to mating and daily for 19 days of ge tion produced pups with high incidence of extra ribs.(17

* 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 (-95 °C)
Surface Tension: 31.5 dyne/cm
Ionization 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 165.38 °F (74.1 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0768 lb/ft^3 or 1.2298 kg

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 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 sprea fire. **Unusual Fire or Explosion Hazards:** Burning rate = 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 ma produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-dem 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 ar use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Withdraw immediately if you hear rising sou 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. Hazar 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 acrid smoke and irritating fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list EB as a carcinogen. **Summary of Risks:** Occupational exposure to EB al 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. 56 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%), phenyl-glyoxylic acid (25%), and methylphenylcarbinol/1-phenyl ethanol (5%). Concurrent exposure to xylene and ethylbenzene causes slower excre of EB metabolites. Based on the rat LD_{50}, one manufacturer gives 3 to 4 oz. as the lethal dose for a 100 lb person.

Continue on next p

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 Organs:** Eyes, 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/cm^2/hr. Immersion of hand in solutions of 112 & 156 mg/L for 1 hr absorbed 118 & 215.7 µg/cm^2/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 flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. 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 spread over a large area of the lung tissue.

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

Note to Physicians: BEI = mandelic acid in urine (1.5 g/g of creatinine), sample at end of shift at workweeks 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 hrs to wks, 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 bioconcentrate in fish. Evidence points to slow biodegradation in groundwater. In air, it reacts with photochemically produced hydroxyl radicals with a half-life of hrs to 2 days. Additional amounts may be removed by rain. **Ecotoxicity Values:** Shrimp (*Mysidopsis bahia*), LC_{50} = 87.6 mg/L/96 hr; sheepshead minnow (*Cyprinodon variegatus*) LC_{50} = 275 mg/L/96 hr; fathead minnow (*Pimephales promelas*) LC_{50} = 42.3 mg/L/96 hr in hard water & 48.5 mg/L/96 hr in softwater. **Disposal:** A candidate for rotary kiln incineration at 1508 to 2912°F (820 to 1600°C), liquid injection incineration at 1202 to 2912°F (650 to 1600°C), and fluidized bed incineration at 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 261.21): 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)]

OSHA Designations

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to 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 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 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: 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 into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean 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 detatched 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 1, Group D electrical 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 cleanup. **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

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

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60 L

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

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

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

Material Safety Data Sheets Collection:

Sheet No. 311
Methyl Chloroform

Issued: 11/75 Revision: F, 3/92

Section 1. Material Identification

Methyl Chloroform ($C_2H_3Cl_3$) Description: Derived by catalytic addition of hydrogen chloride to 1,1-dichloroethylene or by re-fluxing chlorine monoxide with carbon tetrachloride and chloroethane. Available in technical and solvent grades which differ only in the amount of stabilizer added to prevent metal parts corrosion. Used as a solvent for oils, waxes, tars, cleaning precision instruments, and pesticides; as a component of inks and drain cleaners; in degreasing metals, and textile processing. In recent years, methyl chloroform (TCE) has found widespread use as a substitute for carbon tetrachloride.

R	1	Genlu
I	2	
S	2*	2 1
K	1	—

HMI
H
F
R
PPG
* Sec

Other Designations: CAS No. 71-55-6, α-trichloroethane; Inhibisol; 1,1,1-trichloroethane; Strobane; TCE.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: TCE is a skin, eye, and respiratory tract irritant and can become narcotic with an anesthetic effect at high concentrations.

* Data on skin absorption via methyl chloroform is conflicting.(133) Some studies show definite absorption where others don't.

Section 2. Ingredients and Occupational Exposure Limits

Methyl chloroform, ca 92 to 97%*

1990 OSHA PELs
8-hr TWA: 350 ppm (1900 mg/m³)
15-min STEL: 450 ppm (2450 mg/m³)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
15-min Ceiling: 350 ppm (1900 mg/m³)

1991-92 ACGIH TLVs
TWA: 350 ppm (1910 mg/m³)
STEL: 450 ppm (2460 mg/m³)

1990 DFG (Germany) MAKs
TWA: 200 ppm (1080 mg/m³)
Half-life: 2 hr to shift length
Peak Exposure Limit: 1000 ppm/30 min (average value)/2 per shift

1985-86 Toxicity Data†
Human, oral, TD_{Lo}: 670 mg/kg produced diarrhea, nausea, and vomiting
Human, inhalation, LC_{Lo}: 27 g/m³/10 min; toxic effects not yet reviewed
Man, eye: 450 ppm/8 hr produced irritation
Rat, inhalation, TC_{Lo}: 2100 ppm/24 hr for 14 days prior to mating and from 1 to 20 days of pregnancy produced specific developmental abnormalities of the musculoskelatal system

* Methyl chloroform usually contains inhibitors (3 to 8%) to prevent corrosion of aluminum and some other metals. Typical inhibitors are nitromethane, butylene oxide, secondary butyl alcohols, ketones, and glycol diesters.
† See NIOSH, *RTECS* (KJ2975000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 165 °F (75 °C)
Freezing Point: -22 °F (-30 °C)
Vapor Pressure: 100 mm Hg at 68 °F (20 °C)
Vapor Density (air = 1): 4.55
Corrosivity: Readily corrodes aluminum and its alloys
Refraction Index: 1.43765 at 69.8 °F (21 °C)
Viscosity: 0.858 cP at 68 °F (20 °C)
Molecular Weight: 133.42
Density: 1.3376 at 68/39.8 °F (20/4 °C)
Water Solubility: Insoluble
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, carbon tetrachloride, and carbon disulfide
% in Saturated Air: 16.7% at 77 °F (25 °C)
Relative Evaporation Rate (butyl acetate = 1): 12.8

Appearance and Odor: Colorless liquid with a sweetish, chloroform-like odor. The odor threshold is 44 ppm.

Section 4. Fire and Explosion Data

Flash Point: None (in conventional CC tests)	Autoignition Temperature: 932 °F (500 °C)	LEL: 7% v/v	UEL: 16% v/v

Extinguishing Media: *Noncombustible liquid* whose *vapor* burns in the presence of excess oxygen or a strong ignition source. For small fires, use dry chemical or carbon dioxide (CO_2). For large fires use fog or regular foam. If these materials are unavailable, a water spray may be used but be aware that water reacts slowly with methyl chloroform to release hydrochloric acid.
Unusual Fire or Explosion Hazards: Vapors are heavier than air and may travel to a strong ignition source and flash back. Air/vapor mixtures may explode when heated. Container may explode in heat of fire. Exposure to open flames or arc welding can produce hydrogen chloride and phosgene.
Special Fire-fighting Procedures: TCE's burning rate is 2.9 mm/min. Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides limited protection. Wear clothing specifically recommended by the manufacturer for use in fires involving methyl chloroform. Apply cooling water to container sides until after fire is extinguished. Stay away from ends of tanks. Isolate area for 1/2 mile if fire involves tank truck, or rail car. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: TCE is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization can occur in contact with aluminum trichloride.
Chemical Incompatibilities: TCE is incompatible with sodium hydroxide, nitrogen tetroxide, oxygen (liquid or gas), strong oxidizers, and chemically active metals like aluminum, zinc, and magnesium powders; reacts violently with caustics to form dichloroacetylene; reacts slowly with water to form hydrochloric acid; forms shock sensitive mixtures with potassium; and polymerizes in contact with aluminum trichloride.
Conditions to Avoid: Exposure to moisture, strong ignition sources, and arc-welding units, and contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition (temperatures >500 °F, contact with hot metals, or under UV rays) of methyl chloroform can produce carbon dioxide (CO_2) and toxic dichloroacetylene, hydrogen chloride, and phosgene gases.

Section 6. Health Hazard Data

Carcinogenicity: The IARC (Class 3, inadequate evidence),(164) NTP,(142) and OSHA(164) do not list methyl chloroform as a carcinogen.
Summary of Risks: Methyl chloroform is considered one of the least toxic of the liquid chlorinated hydrocarbons. It is irritating to eyes, skin, and respiratory tract. Although low in systemic toxicity, TCE is an anesthetic capable of causing death at high concentrations (>15,000 ppm), generally in poorly ventilated, enclosed areas. Quick and complete recovery is observed after prompt removal of unconscious persons from area of exposure. Like many other solvents, TCE sensitizes the heart to epinephrine (blood pressure-raising hormone) and may induce cardiac arrhythmia and arrest.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eyes, central nervous (CNS) and cardiovascular (CVS) systems.

Continue on next p

Section 6. Health Hazard Data, *continued*

Primary Entry Routes: Inhalation, skin contact.
Acute Effects: TCE defats the skin causing irritation, redness, dryness, and scaling. Contact with eyes produces irritation and mild conjunctivitis. Vapor inhalation can cause headache, dizziness, equilibrium disturbances, and in high concentrations may lead to CNS depression, unconsciousness, and coma. During a 60-min exposure period these effects are observed: 100 ppm is the observed odor threshold, at 500 ppm there is obvious odor and decreased reaction time, 1000 ppm causes slight equilibrium loss, at 5000 ppm there is definite incoordination, and 20,000 ppm produces surgical strength anesthesia with possible death. Mild liver and kidney dysfunction may occur after CNS depression recovery. Although unlikely, if ingestion occurs, symptoms include nausea, vomiting, diarrhea, and possible esophageal burns. The acute lethal human dose is ~500 to 5000 mg/kg.
Chronic Effects: None reported.
FIRST AID
Eyes: Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* allow victim to rub or keep eyes tightly shut. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. 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.
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 they advise otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. When deciding whether to induce vomiting, carefully consider amount ingested, time since ingestion, and availability of medical help. If large amounts are recently ingested (absorption into the body is not yet likely to have occurred), and medical help or transportation to a medical facility is not readily available, induce vomiting. Otherwise, vomiting is not recommended since aspiration of vomitus can produce chemical pneumonitis.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Do not use adrenaline or sympathomimetic amines in treatment because of the increased cardiac sensitivity involved.

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. If possible without risk, shut off leak. Cleanup personnel should wear fully encapsulating vapor-protective clothing. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material. Using nonsparking tools, place in suitable containers for disposal or reclamation. For large spills, dike far ahead of liquid spill for later disposal or reclamation. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Transport: In water, methyl chloroform's half-life is hours to weeks depending on wind and mixing conditions. It is very persistent in groundwater. On land it volatilizes due to its high vapor pressure and leaches extensively. When released to the atmosphere, methyl chloroform can be transported long distances and returned to earth via rain. It is slowly degraded by reaction with hydroxyl radicals and has a half-life of 6 months to 25 years. The Natural Resources Defenses Council reported recently that TCE depletes ozone.
Ecotoxicity Values: *Pimephales promelas* (fathead minnow), LC_{50}: 52.8 mg/L/96 hr; *Poecilia reticulata* (guppy), LC_{50}: 133 ppm/7 day.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U226
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 1000 lb (454 kg) [* per RCRA, Sec. 3001, CWA, Sec. 307(a), and CAA, Sec. 112]
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 splash-proof, protective chemical safety goggles or faceshields, 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 emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.
Other: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent repeated or prolonged skin contact. Viton and butyl rubber [with breakthrough times (BTs) of >8 hr and 4 to 7.9 hr, respectively] are recommended materials for protective gear. *Do not use* neoprene, polyvinyl chloride (PVC), natural rubber, or polyethylene because these materials have a BT of <1 hr.
Ventilation: Provide general and local exhaust (in some cases, explosion-proof) ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in cool, dry, well-ventilated (use pressure-vacuum ventilation) area away from ignition sources, arc-welding operations, and incompatibles (Sec. 5). Regularly monitor inhibitor levels. *Do not* store in aluminum containers or use pressure-spraying equipment when methyl chloroform is involved.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. To prevent static sparks, electrically ground and bond all equipment used in methyl chloroform manufacturing, use, storage, transfer, and shipping.
Administrative Controls: Consider preplacement and periodic medical exams of exposed workers that emphasize CNS, CVS, liver and skin.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: 1,1,1-Trichloroethane
DOT Hazard Class: ORM-A
ID No.: UN2831
DOT Label: None
DOT Packaging Exceptions: 173.505
DOT Packaging Requirements: 173.605

IMO Shipping Name: 1,1,1-Trichloroethane
IMO Hazard Class: 6.1
ID No.: UN2831
IMO Label: St. Andrews Cross
IMDG Packaging Group: III

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 148, 153, 159, 162, 163, 164
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD; **Edited by:** JR Stuart, MS

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:
Sheet No. 313
Perchloroethylene
Issued: 11/78 Revision: E, 9/92

Section 1. Material Identification

Perchloroethylene (C_2Cl_4) Description: By chlorination of hydrocarbons and pyrolysis of the carbon tetrachloride that is formed, or by catalytic oxidation of 1,1,2,2-tetrachloroethane. Used in dry cleaning and textile processing, metal degreasing, insulating fluid and cooling gas in electrical transformers, production of adhesives, aerosols, paints, and coatings; as a chemical intermediate, a solvent for various applications, extractant for pharmaceuticals, a pesticide intermediate, and an antihelminthic (parasitic worm removal) agent in veterinary medicine.
Other Designations: CAS No. 127-18-4, Ankilostin, carbon dichloride, Didakene, ethylene tetrachloride, Perchlor, Perclene, Perk, Tetracap, tetrachloroethylene.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Perchloroethylene is a central nervous system depressant, causes liver and kidney damage (from acute or chronic exposures), and is considered an IARC Class 2B carcinogen (animal sufficient evidence, human inadequate data).

R 1
I 3
S 2*
K 0
* Skin absorption

NFPA


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

Section 2. Ingredients and Occupational Exposure Limits

Perchloroethylene, < 99%. Impurities include a small amount of amine or phenolic stabilizers.

1991 OSHA PEL
8-hr TWA: 25 ppm (170 mg/m³)

1990 IDLH Level
500 ppm

1990 NIOSH REL
NIOSH-X Carcinogen
Limit of Quantitation: 0.4 ppm

1992-93 ACGIH TLVs
TWA: 50 ppm (339 mg/m³)
STEL: 200 ppm (1357 mg/m³)

1990 DFG (Germany) MAK
TWA: 50 ppm (345 mg/m³)
Category II: substances with systemic effects
Half-life: < 2 hr
Peak Exposure Limit: 100 ppm, 30 min average value, 4/shift

1985-86 Toxicity Data*
Man, inhalation, TC_{Lo}: 280 ppm/2 hr caused conjunctival irritation and anesthesia.
Human, lung: 100 mg/L caused unscheduled DNA synthesis.
Rat, oral, LD_{50}: 3005 mg/kg; caused somnolence, tremor, and ataxia.
Rat, inhalation, TC_{Lo}: 200 ppm/6 hr given intermittently over 2 years produced leukemia and testicular tumors.
Rabbit, eye: 162 mg caused mild irritation.
Rabbit, skin: 810 mg/24 hr caused severe irritation.

* See NIOSH, *RTECS* (KX3850000), for additional irritation, mutation, reproductive, tumorigenic, & toxicity data.

Section 3. Physical Data

Boiling Point: 250 °F (121.2 °C)
Freezing Point: -8 °F (-23.35 °C)
Vapor Pressure: 13 mm Hg at 68 °F (20 °C)
Surface Tension: 31.74 dyne/cm at 68 °F (20 °C)
Viscosity: 0.84 cP at 77 °F (25 °C)
Refraction Index: 1.50534 at 68 °F (20 °C)
Molecular Weight: 165.82

Density: 1.6311 at 59 °F (15/4 °C)
Water Solubility: 0.02% at 77 °F (25 °C)
Other Solubilities: Miscible with alcohol, ether, benzene, chloroform, and oils.
Odor Threshold: 47 to 71 ppm (poor warning properties since olfactory fatigue is probable)
Evaporation Rate: 0.15 gal/ft²/day at 77 °F (25 °C)
Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.081 lb/ft³ or 1.296 kg/m³

Appearance and Odor: Colorless liquid with an ether-like odor.

Section 4. Fire and Explosion Data

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

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2). For large fires, use water spray, fog, or regular foam.
Unusual Fire or Explosion Hazards: Vapors are heavier than air and collect in low-lying areas.
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. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Perchloroethylene is stable up to 932 °F (500 °C) in the absence of catalysts, moisture, and oxygen but deteriorates rapidly in warm, moist climates. It is slowly decomposed by light. Amine or phenolic stabilizers are usually added. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Slowly (faster in presence of water) corrodes aluminum, iron, and zinc. It is incompatible with chemically active metals (i.e., barium, beryllium, and lithium (explodes with lithium shavings), strong oxidizers, sodium hydroxide, caustic soda, potash, and nitric acid. Perchloroethylene forms an explosive mixture with dinitrogen tetraoxide and reacts with activated charcoal at 392 °F (200 °C) to yield hexachloroethane and hexachlorobenzene. **Conditions to Avoid:** Contact with moisture and incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of perchloroethylene can produce carbon dioxide and toxic chlorine, hydrogen chloride, and phosgene gas (also produced by contact with UV light).

Section 6. Health Hazard Data

Carcinogenicity: Perchloroethylene is listed as a carcinogen by The IARC (Group 2B, animal sufficient evidence, human inadequate data),(164) NTP (Class 2, reasonably anticipated as a carcinogen, with limited human evidence and sufficient animal evidence),(169) NIOSH (Class-X, carcinogen defined with no further explanation),(164) and DFG (MAK-B, justifiably suspected of having carcinogenic potential)(164). There is some controversy regarding human carcinogenicity because even though there is an increased number of cancers of the skin, colon, lung, urogenital tract, and lympho-sarcomas; the dry cleaning workers studied were also exposed to other chemicals. **Summary of Risks:** Perchloroethylene is stored in the fatty tissue and slowly metabolized with the loss of chlorine. The half-life of its urinary metabolite (trichloroacetic acid) is 144 hours. Perchloroethylene exerts the majority of its toxicity on the central nervous system causing symptoms ranging from light-headedness and slight 'inebriation' to unconsciousness. Liver damage is possible after severe acute or minor long-term exposure. It has a synergistic effect with toluene.

Continue on next page

Section 6. Health Hazard Data, *continued*

Medical Conditions Aggravated by Long-Term Exposure: Nervous, liver, kidney, or skin disorders. **Target Organs:** Liver, kidney, eyes, upper respiratory tract, skin, and central nervous system. **Primary Entry Routes:** Inhalation and skin and eye contact. **Acute Effects:** Exposure to high levels can cause liver damage which may take several weeks to develop. Vapor exposure can cause slight smarting of the eyes and throat (in high concentrations). In human studies, exposure to 2000 ppm/5 min caused mild CNS depression; 600 ppm/10 min caused numbness around the mouth, dizziness, and incoordination; 100 ppm/7 hr caused mild eye, nose, and throat irritation, flushing of the face and neck, headache, somnolence, and slurred speech. Skin contact may produce dermatitis because of perchloroethylene's defatting action (more common after repeated exposure). Direct eye contact causes tearing and burning but no permanent damage. Ingestion is rare but can cause irritation of the lips, mouth and gastrointestinal tract, irregular heartbeat, nausea & vomiting, diarrhea (possibly blood stained), drowsiness, unconsciousness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Prolonged exposure can cause impaired memory, extremity (hands, feet) weakness, peripheral neuropathies, impaired vision, muscle cramps, liver damage (fatty degeneration, necrosis, yellow jaundice, and dark urine) and kidney damage (oliguric uremia, conjestion and granular swelling).

FIRST AID ***Rescuers must not enter areas with potentially high perchloroethylene levels without a self-contained breathing apparatus.*** Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. 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. *Never administer adrenalin!* **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, then induce vomiting. Be sure victim's head is positioned to avoid aspiration of vomitus into the lungs. **Note to Physicians:** Monitor level of consciousness, EEG (abnormalaties may indicate chronic toxicity), blood enzyme levels (for 2 to 3 wk after exposure), EKG, adequacy of respirations & oxygenation, and liver and kidney function. *BEIs:* C_2Cl_4 in expired air (10 ppm), sample prior to last shift of work week; C_2Cl_4 in blood (1 mg/L), sample prior to last shift of work week; trichloroacetic acid in urine (7 mg/L), sample at end of workweek.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources (although noncombustible, it forms toxic vapors from thermal decomposition). For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of spill and await reclamation or disposal. Report any release in excess of 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, perchloroethylene evaporates and some leaches to groundwater. It may absorb slightly to soils with heavy organic matter. Biodegradation may be important in anaerobic soils. In water, it is subject to rapid volatilization with an estimated half-life from <1 day to several weeks. In air, it exists mainly in the vapor-phase and is subject to photooxidation with a half-life of 30 minutes to 2 months. **Ecotoxicity Values:** Guppy (*Poecilia reticulata*), LC_{50} = 18 ppm/7 days; fathead minnow (*Pimephales promelas*), LC_{50} = 18.4 mg/L/96 hr, flow through bioassay. **Disposal:** Consider recovery by distillation. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) or fluidized bed incineration at 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. U210
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per CWA Sec. 307 (a)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

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

Section 8. Special Protection Data

Goggles: Wear a faceshield (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a supplied-air respirator or SCBA with a full facepiece operated in pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a 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 butyl rubber, Neoprene, or Viton to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from sunlight, and incompatibles. Do not store sludge from vapor degreasers in tightly-sealed containers and keep outside until disposal is arranged. **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. Check stabilizer levels frequently and ventilation equipment (air velocity, static pressure, air valve) at least every 3 months. Install an air dryer in ventlines to storage tanks to prevent moisture from rusting and weakening the tank and contaminating or discoloring its contents. Purge all tanks before entering for repairs or cleanup. Build a dike around storage tanks capable of containing all the liquid. Ground tanks to prevent static electricity. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize liver, kidney, and nervous system function, and the skin. Alcoholism may be a predisposing factor.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Tetrachloroethylene
DOT Hazard Class: 6.1
ID No.: UN1897
DOT Packing Group: III
DOT Label: Keep away from food
Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
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: 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** W Silverman, MD

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:
Sheet No. 317
Toluene
Issued: 8/79 Revision: E, 9/92 Errata: 2/9

Section 1. Material Identification

Toluene ($C_6H_5CH_3$) Description: Derived from petroleum i.e., dehydrogenation of cycloparaffin 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, acetyl celluloses, cellulose paints and varnishes; a diluent for photogravure inks, raw material for organic synthesis (benzoyl & benzilidene chlorides, saccharine, TNT, toluene diisocyanate, and many dyestuffs), in aviation and high octane automobile gasoline, as a nonclinical thermometer liquid and suspension solution for navigational instruments.

R 1 NF
I 3
S 2*
K 3
* Skin absorption

Other Designations: CAS No. 108-88-3, Methacide, methylbenzene, methylbenzol, phenylmethane, toluol, Tolu-sol.

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

HMIS
H 2- Ch. eff
F 3
R 0
PPE-Sec.

Cautions: Toluene is an eye, skin, and respiratory tract irritant becoming narcotic at high centrations. 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

Toluene, < 100%; may contain a small amount of benzene (~ 1%), xylene, and nonaromatic hydrocarbons.

1991 OSHA PELs
8-hr TWA: 100 ppm (375 mg/m^3)
15-min STEL: 150 ppm (560 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH RELs
TWA: 100 ppm (375 mg/m^3)
STEL: 150 ppm (560 mg/m^3)

1992-93 ACGIH TLV (Skin)
TWA: 50 ppm (188 mg/m^3)

1990 DFG (Germany) MAK*
TWA: 100 ppm (380 mg/m^3)
Half-life: 2 hr to end of shift
Category II: Substances with systemic effects
Peak Exposure Limit: 500 ppm, 30 min average value, 2/shift

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: 100 ppm caused hallucinatic and changes in motor activity and changes in psychophysiological tests.
Human, oral, LD_{Lo}: 50 mg/kg; toxic effects not yet reviewed
Human, eye: 300 ppm caused irritation.
Rat, oral, LD_{50}: 5000 mg/kg
Rat, liver: 30 µmol/L caused DNA damage.

* Available information suggests damage to the developing fetus is probable.
†See NIOSH, *RTECS* (XS5250000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 232 °F (110.6 °C)
Melting Point: -139 °F (-95 °C)
Molecular Weight: 92.15
Density: 0.866 at 68 °F (20/4 °C)
Surface Tension: 29 dyne/cm at 68 °F (20 °C)
Viscosity: 0.59 cP at 68 °F (20 °C)
Refraction Index: 1.4967 at 20 °C/D

Water Solubility: Very slightly soluble, 0.6 mg/L at 68 °F (20 °C)
Other Solubilities: Soluble in acetone, alcohol, ether, benzene, chloroform, glacial acetic acid, petroleum ether, and carbon disulfide.
Vapor Pressure: 22 mm Hg at 68 °F (20 °C); 36.7 mm Hg at 86 °F (30 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0797 lb/ft^3 or 1.2755 kg/r
Odor Threshold (range of all referenced values): 0.021 to 69 ppm

Appearance and Odor: Colorless liquid with a sickly sweet odor.

Section 4. Fire and Explosion Data

Flash Point: 40 °F (4.4 °C) CC	Autoignition Temperature: 896 °F (480 °C)	LEL: 1.27% v/v	UEL: 7.0% v/v

Extinguishing Media: Toluene is a Class 1B flammable liquid. To fight fire, use dry chemical carbon dioxide, or 'alcohol-resistant' foam. Wat spray may be ineffective as toluene floats on water and may actually spread fire. **Unusual Fire or Explosion Hazards:** Concentrated vapors ar heavier than air and may travel to an ignition source and flash back. Container may explode in heat of fire. Toluenes' burning rate = 5.7 mm/mi 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 area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from fire and let burn. Withdraw immediately if you hear a rising sound fr venting safety device or notice any tank discoloration due to fire because a BLEVE (boiling liquid expanding vapor explosion) may be immine Do not release runoff from fire control methods 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't occur. **Chemical Incompatibilities:** Strong oxidizers, concentrated nitric acid, nitric acid + sulfuric acid, dinitrogen tetro silver perchlorate, bromine trifluoride, tetranitromethane, and 1,3-dichloro-5,5-dimethyl-2,4-imidazolididione. **Conditions to Avoid:** Contact w heat, ignition sources, or incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of toluene can produce car dioxide, and acrid, irritating smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list toluene as a carcinogen. **Summary of Risks:** Toluene is irritating to the e 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 urin The remainder is metabolized to *o*-cresol and excreted or exhaled unchanged. Toluene metabolism is inhibited by alcohol ingestion and is syner tic with benzene, asphalt fumes, or chlorinated hydrocarbons (i.e. perchloroethylene). Toluene is readily absorbed through the skin at 14 to 23 r cm^2/hr. Toluene is absorbed quicker during exercise than at rest and appears to be retained longer in obese versus thin victims; presumably due lipid solubility. There is inconsistent data on toluene's ability to damage bone marrow; chronic poisoning has resulted in anemia and leucopenia biopsy showing bone marrow hypo-plasia. These reports are few and some authorities argue that the effects may have been due to benzene con nants. Chronic inhalation during pregnancy has been associated with teratogenic effects on the fetus including microcephaly, CNS dysfunction attentional deficits, developmental delay + language impairment, growth retardation, and physical defects including a small midface, short palp fissures, with deep-set eyes, low-set ears, flat nasal bridge with a small nose, micrognathia, and blunt fingertips. There is some evidence that to causes an autoimmune illness in which the body produces antibodies that cause inflammation of its own kidney.

Continue on ne

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Alcoholism and CNS, kidney, skin, or liver disease. **Target Organs:** 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, parasthesis, 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 (cerebellar ataxia and cognitive dysfunction), liver enlargement, and kidney dystrophy (wasting away). Symptoms usually appear at workdays end, worsen at weeks end and decrease or disappear over the weekend. **FIRST AID** **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center 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/g 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, and stay upwind. Cleanup personnel protect against inhalation and skin/eye contact. Use water spray to cool and disperse vapors but it may not prevent ignition in closed spaces. Cellosolve, hycar 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. Dike 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 use mechanical dredges/lifts to remove immobilized masses of pollutants and precipitates. Toluene can undergo fluidized bed incineration at 842 to 1796 °F (450 to 980 °C), rotary kiln incineration at 1508 to 2912 °F (820 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, LC_{50} = 17 mg/L/24 hr; shrimp (*Crangonfracis coron*), LC_{50} = 4.3 ppm/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 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 photochemically produced 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

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U220

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

OSHA Designations

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

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. **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 < 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 facepiece, or any air-purifying respirator with a full facepiece 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.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove 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 liquids 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. **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:** Adopt controls for confined spaces (29 CFR 1910.146) if entering areas of unknown toluene levels (holes, 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)

DOT Shipping Name: Toluene	**Packaging Authorizations**	**Quantity Limitations**	**Vessel Stowage Requirements**
DOT Hazard Class: 3	**a) Exceptions:** 150	**a) Passenger Aircraft or Railcar:** 5L	**Vessel Stowage:** B
ID No.: UN1294	**b) Non-bulk Packaging:** 202	b) Cargo Aircraft Only: 60L	**Other:** --
DOT Packing Group: II	**c) Bulk Packaging:** 242		
DOT Label: Flammable Liquid			
Special Provisions (172.102): T1			

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 140, 148, 153, 159, 163, 164, 167, 169, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, CIH, MPH; **Medical Review:** AC Darlington, MD, MPH

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 312
Trichloroethylene

Issued: 7/79 Revision: F, 9/92

Section 1. Material Identification

Trichloroethylene (C_2HCl_3) Description: Derived by treating tetrachloroethane with lime or other alkali in the presence of water, or by thermal decomposition of tetrachloroethane followed by steam distillation. Stabilizers such as epichlorohydrin, isobutanol, carbon tetrachloride, chloroform, benzene, or pentanol-2-triethanolamine are then added. Used as a degreasing solvent in electronics and dry cleaning, a chemical intermediate, a refrigerant and heat-exchange liquid, and a diluent in paint and adhesives; in oil, fat, and wax extraction and in aerospace operations (flushing liquid oxygen). Formerly used as a fumigant (food) and anesthetic (replaced due to its hazardous decomposition in closed-circuit apparatus).

R 1
I 2
S 2*
K 3
* Skin absorption

NFPA
2
2 0
-

HMIS
H 2+
F 2
R 0
PPE‡
† Chron. Effec:
‡ Sec. 8

Other Designations: CAS No. 79-01-6; acetylene trichloride; Algylen; Anamenth; Benzinol; Cecolene; Chlorylen; Dow-Tri; ethylene trichloride; Germalgene; Narcogen; Triasol; trichloroethene; TCE; 1,1,3-trichloroethylene.

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

Cautions: TCE is irritating and toxic to the central nervous system (CNS). Inhalation of high concentrations have lead to death due to ventricular fibrillation. Chronic exposure may lead to heart, liver, and kidney damage. The liquid is absorbed through the skin. Although it has a relatively low flash point, TCE burns with difficulty.

Section 2. Ingredients and Occupational Exposure Limits

Trichloroethylene, < 100% [contains stabilizers (Sec. 1)].

1991 OSHA PELs
8-hr TWA: 50 ppm (270 mg/m³)
15-min STEL: 200 ppm (1080 mg/m³)

1990 IDLH Level
1000 ppm

1990 NIOSH REL
10-hr TWA: 25 ppm (~135 mg/m³)

1992-93 ACGIH TLVs
TWA: 50 ppm (269 mg/m³)
STEL: 200 ppm (1070 mg/m³)

1990 DFG (Germany) MAK
Ceiling: 50 ppm (270 mg/m³)
Category II: Substances with systemic effects
Half-life: 2 hr to shift length
Peak Exposure Limit: 250 ppm, 30 min average value; 2 peaks/shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 160 ppm/83 min caused hallucinations and distorted perceptions.
Human, lymphocyte: 5 mL/L caused DNA inhibition.
Rabbit, skin: 500 mg/24 hr caused severe irritation.
Rabbit, eye: 20 mg/24 hr caused moderate irritation.
Mouse, oral, TD_{Lo}: 455 mg/kg administered intermittently for 78 weeks produced liver tumors.

* See NIOSH, *RTECS* (KX4550000), for additional irritation, mutation, reproductive, tumorigenic and toxicity data.

Section 3. Physical Data

Boiling Point: 189 °F (87 °C)
Freezing Point: -121 °F (-85 °C)
Viscosity: 0.0055 Poise at 77 °F (25 °C)
Molecular Weight: 131.38
Density: 1.4649 at 20/4 °C
Refraction Index: 1.477 at 68 °F (20 °C/D)
Odor Threshold: 82 to 108 ppm (*not an effective warning*)

Vapor Pressure: 58 mm Hg at 68 °F (20 °C); 100 mm Hg at 32 °F (0 °C)
Saturated Vapor Density (Air = 0.075 lbs/ft³; 1.2 kg/m³): 0.0956 lbs/ft³; 1.53 kg/m³
Water Solubility: Very slightly soluble; 0.1% at 77 °F (25 °C)
Other Solubilities: Highly soluble in organic solvents (alcohol, acetone, ether, carbon tetrachloride, & chloroform) and lipids.
Surface Tension: 29.3 dyne/cm

Appearance and Odor: Clear, colorless (sometimes dyed blue), mobile liquid with a sweet chloroform odor.

Section 4. Fire and Explosion Data

Flash Point: 90 °F (32 °C) CC | **Autoignition Temperature:** 788 °F (420 °C) | **LEL:** 8% (25 °C); 12.5% (100 °C) | **UEL:** 10% (25 °C); 90% (100 °C)

Extinguishing Media: A Class 1C Flammable Liquid. Although it has a flash point of 90 °F, TCE burns with difficulty. 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:** Vapor/air mixtures may explode when ignited. Container may explode in heat of fire. **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 provides only limited protection against TCE. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: TCE slowly decomposes in the presence of light and moisture to form corrosive hydrochloric acid. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include alkalis (sodium hydroxide), chemically active metals (aluminum, beryllium, lithium, magnesium, sodium, potassium, and titanium), epoxides, and oxidants (nitrogen tetraoxide, perchloric acid). Contact with 1-chloro-2,3-epoxy propan or the mono and di 2,3-epoxypropyl ethers of 1,4-butanediol + 2,2-bis-4(2',3'-epoxypropoxy)-phenylpropane can, in the presence of catalytic quantities of halide ions, cause dehydrochlorination of TCE to explosive dichloroacetylene. **Conditions to Avoid:** Exposure to light, moisture, ignition sources, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of TCE (above 300 °C) or exposure to ultraviolet light can produce carbon dioxide (CO_2) and toxic dichloro acetylene (explosive), chlorine, hydrogen chloride, and phosgene gas.

Section 6. Health Hazard Data

Carcinogenicity: The following agencies have rated TCE's carcinogenicity: IARC (Class 3, limited animal evidence & insufficient human data), Germany MAK (Class B, justifiably suspected of having carcinogenic potential), & NIOSH (Class X, carcinogen defined with no further categorization). **Summary of Risks:** TCE vapor is irritating to the eyes, nose, and respiratory tract and inhalation of high concentrations can lead to severe CNS effects such as unconsciousness, ventricular arrythmias, and death due to cardiac arrest. Mild liver dysfunction was also seen at levels high enough to produce CNS effects. Contact with the liquid is irritating to the skin and can lead to dermatitis by defatting the skin. Chronic toxicity is observed in the victims increasing intolerance to alcohol characterized by 'degreasers flush', a transient redness of the face, trunk, and arms. The euphoric effect of TCE has led to craving, and habitual sniffing of its vapors.

Continue on next page

Section 6. Health Hazard Data, *Continued*

TCE crosses the placental barrier and thus exposes the fetus (any effects are yet unknown). There are increased reports of menstrual disorders in women workers and decreased libido in males at exposures high enough to cause CNS effects. TCE is eliminated unchanged in expired air and as metabolites (trichloroacetic acid & trichloroethanol) in blood and urine. **Medical Conditions Aggravated by Long-Term Exposure:** Disorders of the nervous system, skin, heart, liver, and kidney. **Target Organs:** Respiratory, central & peripheral nervous, and cardiovascular (heart) systems, liver, kidney, and skin. **Primary Entry Routes:** Inhalation, skin and eye contact, and ingestion (rarely). **Acute Effects:** Vapor inhalation can cause eye, nose, and throat irritation, nausea, blurred vision, overexcitement, headache, drunkenness, memory loss, irregular heartbeat (resulting in sudden death), unconsciousness, and death due to cardiac failure. Skin contact with the liquid can cause dryness and cracking and prolonged exposure (generally if the victim is unconscious) can cause blistering. Eye contact can cause irritation and watering, with corneal epithelium injury in some cases. Ingestion of the liquid can cause lip, mouth, and gastrointestinal irritation, irregular heartbeat, nausea and vomiting, diarrhea (possibly blood-stained), drowsiness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Effects may persist for several weeks or months after repeated exposure. Symptoms include giddiness, irritability, headache, digestive disturbances, mental confusion, intolerance to alcohol (degreasers flush), altered color perception, loss or impairment of sense of smell, double vision, and peripheral nervous system function impairment including persistent neuritis, temporary loss of sense of touch, and paralysis of the fingers from direct contact with TCE liquid.

FIRST AID **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Do not give milk, as its fat content (TCE is lipid soluble) may inhance gastrointestinal absorption of TCE. **Note to Physicians:** TCE elimination seems to be triphasic with half lives at 20 min, 3 hr, and 30 hr. Some success is seen in treating patients with propranolol, atropine, and disulfiram. Monitor urine and blood (lethal level = 3 to 110 µg/mL) metabolites. BEI = 100 mg/g creatinine (trichloroacetic acid) in urine, *sample at end of workweek.* BEI = 4 mg/L (trichloroethanol) in blood, *sample at end of shift at end of the workweek.* These tests are not 100% accurate indicators of exposure; monitor TCE in expired air as a confirmatory test.

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. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container for later disposal. For large spills, flush to containment area where density stratification will form a bottom TCE layer which can be pumped and containerized. Report any release in excess of 1000 lbs. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Bluegill sunfish, LC_{50} = 44,700 µg/L/96 hr; fathead minnow (*Pimephales promelas*), LC_{50} = 40.7 mg/L/96 hr. **Environmental Degradation:** In air, TCE is photooxidized with a half-life of 5 days and reported to form phosgene, dichloroacetyl chloride, and formyl chloride. In water it evaporates rapidly in minutes to hours. TCE rapidly evaporates and may leach since it does not absorb to sediment. **Soil Absorption/Mobility:** TCE has a Log K_{oc} of 2, indicating high soil mobility. **Disposal:** Waste TCE can be poured on dry sand and allowed to vaporize in isolated location, purified by distillation, or returned to supplier. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) with an acid scrubber to remove halo acids. 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): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33 & 261.31): No. U228 & F002 (*spent solvent*)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per RCRA, Sec. 3001, CWA Sec. 311 (b)(4), & CWA Sec. 307 (a)]

OSHA Designations

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

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles (cup-type or rubber framed, equipped with impact-resistant glass), 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. At any detectable concentration, wear a SCBA with a full facepiece operated in pressure demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a 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 from Viton or Neoprene to prevent skin contact. *Do not* use natural rubber or polyvinyl chloride (PVC). **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene 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 steel drums, in a cool, dry, well-ventilated area away from sunlight, heat, ignition sources, and incompatibles (Sec. 5). Store large quantities in galvanized iron, black iron, or steel containers; small amounts in dark (amber) colored glass bottles. **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. Design processes so that the operator is not directly exposed to the solvent or its vapor. Do not use open electric heaters, high-temperature processes, arc-welding or open flames in TCE atmospheres. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on skin, respiratory, cardiac, central and peripheral nervous systems, and liver and kidney function. Employ air and biological monitoring (BEIs). Instruct employees on safe handling of TCE.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Trichloroethylene
DOT Hazard Class: 6.1
ID No.: UN1710
DOT Packing Group: III
DOT Label: Keep Away From Food
DOT Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60L
b) Cargo Aircraft Only: 220L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** AC Darlington, MD

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:
Sheet No. 382
Vinyl Chloride
Issued: 7/78 Revision: C, 9/92

Section 1. Material Identification

Vinyl Chloride (C_2H_3Cl) Description: Derived from ethylene dichloride and alcoholic potassium, by reaction of acetylene and hydrogen chloride (as gas or liquids), or by oxychlorination where ethylene reacts with hydrochloric acid and oxygen. Inhibitors such as butyl catechol, hydroquinone, or phenol are added to prevent polymerization. Used in the plastics industry for the production of polyvinyl chloride resins, in organic synthesis and formerly as a refrigerant, extraction solvent, and propellant (banned in 1974 because of its carcinogenic activity).

Other Designations: CAS No. 75-01-4, chloroethylene, chloroethene, ethylene monochloride, Trovidur, VC, VCM.

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

Cautions: Vinyl chloride is a confirmed human carcinogen. Vapor inhalation leads to central nervous system (CNS) depression. The liquid can cause frostbite. It is a flammable gas at room temperature and polymerizes on exposure to air or sunlight. Avoid exposure to VC through engineering controls and wearing PPE

NFI: R 2, I 4, S 4, K 4

HMIS: H 3*, F 4, R 2, PPE - Sec. 8
* Chronic effe

Section 2. Ingredients and Occupational Exposure Limits

Vinyl Chloride, ca 98 to 99%. Impurities include water, acetaldehyde, hydrogen chloride, hydrogen peroxide, methyl chloride, butane, 1,3-butadiene, chlorophene, diacetylene, vinyl acetylene, and propine.

1991 OSHA PELs
8-hr TWA: 1 ppm
Ceiling: 5 ppm; OSHA-X

1990 NIOSH REL
NIOSH-X

1992-93 ACGIH TLV
TWA: 5 ppm (13 mg/m^3)
TLV-A1

1990 DFG (Germany) TRK*
Existing Installations: 3 ppm
MAK-A1

1985-86 Toxicity Data†
Man, inhalation, TC_{Lo}: Intermittent exposure to 200 ppm for 14 y caused liver tumors.
Man, inhalation, TC_{Lo}: 30 mg/m^3/5 yr caused spermatogenesis.
Human, inhalation, TC: Continuous exposure to 300 mg/m^3 for a undetermined number of weeks caused blood tumors.
Rat, oral, LD_{50}: 500 mg/kg; toxic effects not yet reviewed

* TRK (technical exposure limit) is used in place of MAK when a material is a carcinogen. Unlike an MAK below which no adverse effects are expected, the TR is a limit set below which adverse effects may still occur. This is based on the theory that 1 molecule of a carcinogenic substance may still produce a tumor. The TRK is set to allow for an acceptable risk (for example, 1 tumor in 1 million persons may be an acceptable risk).
† See NIOSH, *RTECS* (KU9625000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 7 °F (-13.9 °C)
Freezing Point: -245 °F (-159.7 °C)
Molecular Weight: 62.5
Specific Gravity: 0.9106 at 68 °F (20 °C)
Ionization Potential: 9.99 eV
Refraction Index: 1.370 at 20 °C/D
Surface Tension: 23.1 dyne/cm at -4 °F (-20 °C)
Odor Threshold: 2000 to 5000 ppm*
Vapor Density (Air = 1): 2.155

Water Solubility: Slightly soluble, 0.1% at 77 °F (25 °C)
Other Solubilities: alcohol, benzene, carbon tetrachloride, ether, hydrocarbon and oil
Vapor Pressure: 2530 mm Hg at 68 °F (20 °C), 400 mm Hg at -18.4 °F (-28 °C)
Critical Temperature: 304.7 °F (151.5 °C)
Critical Pressure: 56.8 atm
Viscosity: 0.01072 cP at 68 °F (20 °C), *gas*; 0.28 cP at -4 °F (-20 °C), *liquid*
Appearance and Odor: A gas at room temperature. Usually found as a compressed/cooled liquid. The colorless liquid forms a vapor with a pleasant ethereal odor.

*The actual vapor concentration that can be detected by humans has not been adequately determined and varies from one individual to another, from impurities, and probably from exposure duration. The odor threshold is not an accurate warning of exposure.

Section 4. Fire and Explosion Data

Flash Point: -108.4 °F (-78 °C) OC	Autoignition Temperature: 882 °F (472 °C)	LEL: 3.6% v/v	UEL: 33% v/v

Extinguishing Media: For small fires, use dry chemical or carbon dioxide. For large fires, use water spray, fog, or regular foam. **Unusual Fire or Explosion Hazards:** Large fires can be practically inextinguishable. Vapors may travel to an ignition source and flash back. VC may polymerize in cylinders or tank cars and explode in heat of fire. Vapors pose an explosion hazard indoors, outdoors, and in sewers. VC decomposes in fire to hydrogen chloride, carbon monoxide, carbon dioxide, and phosgene. Burning rate = 4.3 mm/min. **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. Stop gas leak if possible. Let tank, tank car, or tank truck burn unless leak can be stopped. 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/Polymerization: Long term exposure to air may result in formation of peroxides which initiates explosive polymerization of the chloric VC can polymerize on exposure to light or in presence of a catalyst. **Chemical Incompatibilities:** VC can explode on contact with oxide of nitrogen, may liberate hydrogen chloride on exposure to strong alkalies, and is incompatible with copper, oxidizers, aluminum, and peroxides. In the presence of moisture, VC attacks iron and steel. **Conditions to Avoid:** Exposure to sunlight, air, heat, and incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of vinyl chloride can produce carbon oxides, and chloride gas.

Section 6. Health Hazard Data

Carcinogenicity: Vinyl chloride is listed as a carcinogen by the IARC (Class 1, *sufficient human evidence*),(164) NTP (Class 1, *sufficient human* evidence),(169) NIOSH (Class X, *carcinogen defined without further categorization*),(163) ACGIH (TLV-A1, *confirmed human carcinogen*),(163) DFG (MAK-A1, *capable of inducing malignant tumors in humans*),(163) and OSHA (Class X, *carcinogen defined without further categorization*).(164) Liver tumors (angiosarcomas) are confirmed from VC exposure. Other tumors of the CNS, respiratory system, blood, and lymphatic system have occurred from exposure to the polyvinyl chloride manufacture process but VC itself may not be the causative agent. Summary of Risks: Vapor inhalation causes varying degrees of CNS depression with noticeable anesthetic effects at levels of 1% (10,000 ppm). Studies have shown loss of libido and sperm in men exposed to VC and in Russian studies, 77% of exposed women experienced ovarian dysfunction, benign uterine growths, and prolapsed genital organs. However, no teratogenic effects have been seen in offspring of exposed workers.

Continue on next p

Section 6. Health Hazard Data, *continued*

It appears that metabolism is necessary before many of VC's toxic effects occur. Some vinyl chloride is exhaled unchanged but most is metabolized to chloroacetaldehyde. Skin absorption may occur if liquid is confined on skin but absorbed amount would be small. It is possible that the phenol inhibitor may be absorbed as well. The compressed liquid can cause frostbite. Vapors are severely irritating to the eyes. Chronic exposure can cause cancer and a triad of syndromes known as *vinyl chloride disease*. **Medical Conditions Aggravated by Long-Term Exposure:** Liver, cardiac, pulmonary, and connective tissue disorders. **Target Organs:** Liver, CNS, respiratory and lymphatic systems, bone, and connective tissue of the skin. **Primary Entry Routes:** Inhalation, skin/eye contact. **Acute Effects:** CNS effects include fatigue, headache, vertigo, ataxia, euphoria, visual disturbances, dulling of auditory cues, numbness and tingling in the extremities, narcosis, unconsciousness, and death due to respiratory failure. Respiratory problems include dyspnea, asthma, and pneumonoconiosis. **Chronic Effects:** Repeated exposure has lead to liver cancer; confirmed because of the otherwise rarity of its type (angiosarcoma). Tumors in other organs have occurred in the polyvinyl chloride industry but agents other than VC may be responsible; authorities are still debating this issue. A triad of other effects are associated with VC exposure. Acro-osteolysis is associated with hand cleaning of polymerization vessels and characterized by dissolution of bone in the hands, especially when associated with resorption. Raynaud's Phenomenon is a vascular disorder marked by recurrent spasm of the capillaries and especially those of the fingers and toes on exposure to cold. This is usually accompanied by pain and in severe cases may progress to local gangrene. Sclerodermatous skin changes (affecting the dorsal hands and distal forearms) are seen and described as a slowly progressive disease marked by deposition of fibrous connective tissue in the skin. The skin becomes thickened and raised nodules appear. Arthralgias (pain in one or more joints) and blood changes with decreased platelet number and capillary abnormalities may also occur.
FIRST AID Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. For frostbite, immerse affected area in 107.6 °F (42 °C) water until completely rewarmed. *Do not* use dry heat. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Unlikely! VC is a gas above 7 °F (-14°C). **Note to Physicians:** Endotracheal intubation may be required if significant CNS or respiratory depression occur. Diagnostic test: thiodiglycolic acid in urine (normally < 2 mg/g creatinine).

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. If possible without risk, stop gas flow. Shut off ignition sources. Report any release > 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** VC reacts with hydroxyl radicals in the trophosphere with a half-life of 1.2 days. The half-life = a few hr in photochemical smog. Reaction products in the air include chloroacetaldehyde, hydrogen chloride, chloroethylene, epoxide, formaldehyde, formyl chloride, formic acid, and carbon monoxide. In soil, VC rapidly volatilizes. What does not evaporate will be highly mobile and may leach into groundwater. In water, VC is not expected to hydrolyze, bioconcentrate, or absorb to sediment. It will rapidly volatilize with an estimated half-life of 0.805 hr for evaporation from a river 1 meter deep with a current of 3 meter/sec and a wind velocity of 3 meter/sec. In waters containing photosensitizers such as humic acid, photodegradation will be rapid. **Soil Absorption/Mobility:** From an estimated solubility of 2,700 ppm, a Koc of 56 is established for VC which indicates high soil mobility and potential to leach into groundwater. **Disposal:** Dilute any waste compressed liquid to a 1% solution and remove phenol inhibitor as sodium. Pour onto vermiculite, sodium bicarbonate, or a sand & soda ash mixture (90/10). Add slaked lime if fluoride is present. Mix in paper boxes, place in incinerator, cover with scrap wood and paper, and ignite with excelsior train. Another method is to dissolve waste in a flammable solvent and spray in incinerator firebox equipped with an afterburner and alkali scrubber. 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. U043
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1 lb (0.454 kg) [* per CWA, Sec. 307 (a); CAA, Sec. 112, & RCRA, Sec. 3001]

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. According to NIOSH[148], for any detectable concentration use a SCBA or supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode. See 29 CFR 1910.1017 for detailed OSHA respirator recommendations. 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 made of Viton or chlorinated polyethylene to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL's (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate work clothes from street clothes, launder before reuse 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 in clearly labeled containers. Outside or detached storage is preferred. Large amounts should be stored in steel containers under pressure. Keep separate from incompatibles (Sec. 5). Venting, under pressure should be safety relief. At atm, venting should be pressure vacuum. Regularly monitor inhibitor levels. To avoid static sparks, electrically ground and bond all equipment used with VC. Avoid open flames, spark formation and electric discharges around VC. **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. Install Class 1, Group D electrical equipment. **Administrative Controls:** Inform VC exposed personnel of hazards associated with its use. Preplacement and periodic medical exams of workers exposed above the action level is mandatory under OSHA 29 CFR (1910.1017). Monitor for liver cancer, scleroderma, pneumonitis, clotting abnormalities, and acro-osteolysis.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Vinyl Chloride
DOT Hazard Class: 2.1
ID No.: UN1086
DOT Packing Group: --
DOT Label: Flammable Gas
Special Provisions (172.102): B44

Packaging Authorizations
a) **Exceptions:** 173.306
b) **Non-bulk Packaging:** 173.304
c) Bulk Packaging: 173.314 & 173.315

Quantity Limitations
a) **Passenger Aircraft or Railcar:** Forbidden
b) **Cargo Aircraft Only:** 150 kg

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

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 175
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MPH, MD

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)*

Issued: 11/80 Revision: E, 9/92 Errata: 12/94

Section 1. Material Identification

45

Xylene (Mixed Isomers) (C_8H_{10}) Description: The commercial product is a blend of the three isomers [*ortho*-(*o*-), *meta*-(*m*-), *para*-(*p*-)] 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 microscope technique; as a solvent for Canada balsam microscopy; as a fuel component; in aviation gasoline, protective coatings, sterilizing catgut, hydrogen peroxide, perfumes, insect repellants, pharmaceuticals, 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.

Other Designations: CAS No. 1330-20-7 [95-47-6; 108-38-3; 106-42-3 (*o*-, *m*-, *p*-isomers)], dimethylbenzene, methyltoluene, NCI-C55232, Violet 3, xylol.

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

R 1
I 2
S 2
K 3

NFPA

HMIS
H 2†
F 3
R 0
PPE ‡
† Chron Effect
‡ Sec. 8

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 *o*-xylene, *p*-xylene, and ethylbenzene; and smal quantities of toluene. Unpurified xylene may contain pseudocumene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m^3)
15-min STEL: 150 ppm (655 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 100 ppm (435 mg/m^3)
STEL: 150 ppm (655 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 150 ppm (651 mg/m^3)
BEI (Biological Exposure Index): Methylhippuric acids in urine at end of shift: 1.5 g/g creatinine

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category II: Substances with systemic effects
Half-life: < 2 hr
Peak Exposure: 200 ppm, 30 min, average value, 4 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 200 ppm produced olfaction effects, conjunctiva irritation, and other changes involving the lungs, thorax, or respiration.
Man, inhalation, LC_{Lo}: 10000 ppm/6 hr; toxic effects not yet reviewed.
Human, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted.
Rat, oral, LD_{50}: 4300 mg/kg; toxic effect not yet reviewed.
Rat, inhalation, LC_{50}: 5000 ppm/4 hr; toxic effects not yet reviewed.

* See NIOSH, *RTECS* (XE2100000), 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 (138.5 °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)
Saturated Vapor Density (Air = 1.2 kg/m^3): 1.23 kg/m^3, 0.077 lbs/ft^3

Appearance and Odor: Clear, sweet-smelling liquid.

* Materials with wider and narrower boiling ranges are commercially available.

Molecular Weight: 106.16
Specific Gravity: 0.864 at 20 °C/4 °C
Water Solubility: Practically insoluble
Other Solubilities: Miscible with absolute alcohol, ether, and many other organic liquids.
Octanol/Water Partition Coefficient: logKow = 3.12-3.20
Odor Threshold: 1 ppm
Viscosity: <32.6 SUS

Section 4. Fire and Explosion Data

Flash Point: 63 to 77 °F (17 to 25 °C) CC | **Autoignition Temperature:** 982 °F (527 °C) (*m*-) | **LEL:** 1.1 (*m*-, *p*-); 0.9 (*o*-) | **UEL:** 7.0 (*m*-, *p*-); 6.7 (*o*

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO_2), water spray or regular foam. For large fires, use water spray, fog or regular foam. Water may be ineffective. Use water spray to cool fire-exposed containers. **Unusual Fire or Explosion Hazards:** Xylene vapors or liquid (which floats on water) 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 present a vapor explosion hazard indoors, outdoors, or in sewers. Accumulated static electricity may occur from vapor or liquid 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 fc massive cargo fires. If impossible, withdraw from area and let fire burn. Withdraw immediately in case of any tank discoloration or rising sound fron 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-imidazolidindione (dichlorohydrantoin). 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,[164] NTP,[169] and OSHA[164] 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. 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, xylenes have been virtually benzene-free and blood dyscrasias have not been associated with xylenes. Chronic exposure to high concentrations of xylene in animal studies have demonstrated mild reversible decrease in red and white cell counts as well as increases in platelet counts.

Continue on next pc

Section 6. Health Hazard Data, *continued*

Menstrual 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, skin absorption (slight), eye contact, ingestion. **Acute Effects:** Inhalation of high xylene concentrations may cause dizziness; nausea, vomiting, and abdominal pain; eye, nose, and throat irritation; respiratory tract irritation leading to pulmonary edema (fluid in lung); 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 exposure to 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 *Emergency personnel should protect against exposure.* **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Carefully dispose of contaminated clothing as it may pose a fire hazard. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. Monitor exposed person for respiratory distress. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, *do not induce vomiting!* If spontaneous vomiting should occur, keep exposed person's head below the hips to prevent aspiration (breathing liquid xylene into the lungs). *Aspiration of a few millimeters of xylene can cause chemical pneumonitis, pulmonary edema, and hemorrhage.* **Note to Physicians:** Hippuric acid or the ether glucuronide of *ortho*-toluic acid may be useful in diagnosis of *meta-*, *para-* and *ortho*-xylene exposure, respectively. Consider gastric lavage if a large quantity of xylene was ingested. Proceed gastric lavage with protection of the airway from aspiration; consider endotracheal intubation with inflated cuff.

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. Cleanup 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 to contain. Do not allow xylene to enter a confined space such as sewers or drains. On land, dike to contain or divert to impermeable holding area. Apply water spray to control flammable vapor and remove material with pumps or vacuum equipment. On water, contain material with natural barriers, booms, or weirs; apply universal gelling agent; and use suction hoses to remove spilled material. Report any release in excess of 1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** Little bioconcentration is expected. Biological oxygen demand 5 (after 5 days at 20 °C): 0.64 (no stated isomer). **Ecotoxicity values:** LD_{50}, Goldfish, 13 mg/L/24 hr, conditions of bioassay not specified, no specific isomer. **Environmental Degradation:** In the atmosphere, xylenes degrade by reacting with photochemically produced hydroxyl radicals with a half-life ranging from 1-1.7 hr. in the summer to 10-18 hr in winter or a typical loss of 67-86% 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 groundwater. **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

SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U239, F003 (spent solvent)
Listed as a CERCLA 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]

OSHA Designations

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations >1000 ppm, use any chemical cartridge respirator with organic vapor cartridges; any powered, air-purifying respirator with organic vapor cartridges; any supplied-air respirator; or any self-contained breathing apparatus. 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 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 contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean 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 clearly labelled, tightly closed, containers in a cool, well-ventilated place, away from strong oxidizing materials and heat and ignition sources. During transferring operations, electrically ground and bond metal containers. **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. Use hermetically sealed equipment, transfer xylene in enclosed systems, avoid processes associated with open evaporating 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.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Xylenes
DOT Hazard Class: 3
ID No.: UN1307
DOT Packing Group: II
DOT Label: Flammable Liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Nonbulk Packaging : 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 5L
b) Cargo Aircraft Only: 60L

Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: –

***MSDS Collection* References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 176, 180.
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD

APPENDIX E

AIR MONITORING FORM
DAILY INSTRUMENT CALIBRATION CHECK FORM
NOISE MONITORING FORM

AIR MONITORING FORM

Project Name:

Project Number:

Contaminants:

Date	Time	Ionization Detector Reading		Explosimeter Reading		Detector Tube Readings (ppm)	Location	Purpose	Initials
		FID	PID	%LEL	$\%O_2$				

DAILY INSTRUMENT CALIBRATION CHECK FORM

Project Name_____ Instrument_____

Job Number_____ ID #_____

DATE	INSTRUMENT	BATTERY CHECK OK?	ZERO ADJUST OK?	CALIBRATION GAS (PPM)	READING (PPM)	CALIBRATED BY:	COMMENTS

NOISE MONITORING FORM

Project Name:

Project Number:

Noise: Equipment Used: (Type/Model)*

Date	Task*	Location/Employee	Noise Reading dB(A)	Initials

*Pre-calibrate noise monitor prior to conducting noise survey.

APPENDIX F

EXCAVATION/TRENCHING SAFETY PROCEDURES
TRENCH SAFETY DAILY FIELD REPORT
SOILS CLASSIFICATION CHECKLIST
SOILS ANALYSIS CHECKLIST
EXCAVATION/TRENCHING - UNDERGROUND UTILITIES
UNDERGROUND UTILITY CONTACT PREVENTION AND MANAGEMENT PLAN
EXCAVATION/TRENCHING - USTs
UST REMOVALS

ATTENTION:

THE TRENCH SAFETY DAILY FIELD REPORT FORM
MUST BE COMPLETED AT LEAST DAILY DURING EXCAVATION/TRENCHING OPERATIONS
AND MORE FREQUENTLY IF CONDITIONS CHANGE.

EXCAVATION/TRENCHING SAFETY PROCEDURES

Evaluation: Conducted by Competent Person 29 CFR 1926.

Two soil classifications must be completed to determine sloping/shoring requirements. Conduct daily inspections of all open excavations prior to entry.

Egress: Excavation areas 4 feet (1.22 meters) or more deep

Ladders must be spaced no more than 25 feet (7.62 meters) apart so that a person in the trench is always within 25 feet (7.62 meters) of a ladder for egress.

Shoring: Excavation areas 5 feet (1.52 meters) or more deep

Excavations must be sloped or shored if personnel will be entering the excavation. Soil classification may be done only by a competent person using both a visual and manual test.

WARNING: One soil classification may not be enough. Outside disturbances during excavation may change even the best classification.
Inspect the soil after any condition change.

Storage: All excavations

Spoils and heavy equipment must be stored a minimum of 2 feet (0.61 meters) from the edge of the excavation.
Store spoils on the downhill side.

Maximum Allowable Slopes

Soil or Rock Type	Maximum allowable slopes (H:V)[1] for excavations less than 20 feet (6.10 meters) deep[2]
Stable Rock[3]	Vertical (90°)
Type A - highly cohesive soil	3/4:1 (53°)
Type B - cohesive soil with some sand	1:1 (45°)
Type C - loose, wet, or sandy soil	1½:1 (34°)

Notes:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.

2. Sloping or benching for excavations greater than 20 feet (6.10 meters) deep shall be designed by a registered professional engineer.

3. A short-term maximum allowable slope of ½ H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 meters) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 meters) in depth shall be 3/4 H:1V (53°)

TRENCH SAFETY DAILY FIELD REPORT

DATE:_____

Project Name:_____
Project Manager:_____
Weather Conditions:

I hereby attest that the following conditions existed and that the following items were checked or reviewed during this inspection.

INSPECTION ITEM	YES	NO	NA
All open trenches were inspected.			
Were any tension cracks observed along top of any slopes?			
Was any water seepage noted on trench walls or trench bottom?			
Was bracing system installed in accordance with design?			
Type shoring being used_____.			
Is shoring secure?			
Was there evidence of shrinkage cracks in trench walls?			
Was there any evidence of caving since the last field inspection?			
Trench box(s) certified with tabulated data?			
Traffic in area adequately away from trenching operations with barricades			
Surface encumbrances and other hazards in area accounted for?			
Protective measures taken for standing water in trench.			
All site personnel wearing reflective vest.			
Atmospheric testing conducted in trenched < 4 feet deep.			
Vibrations from equipment or traffic too close to trenching operation?			

Observations:_____

Competent Person signature_____

Soils Analysis Checklist

This checklist must be completed when soil analysis is conducted to determine the excavation soil type. A separate analysis must be performed on each layer of soil excavation walls. Additional soil analysis must also be performed for the excavation (trench) when it stretches over a distance where soil type may change.

Name:_____ Date:_____ Time:_____

Competent person:_____

Where was the sample taken from?_____

Excavation: Depth_____ Width_____ Length_____

SOIL CLASSIFICATION - VISUAL TEST				
ITEM	TEST PROTOCOL	YES	NO	COMMENTS/ACTIONS
1	**Soil Particle Type** Fine Grained/Cohesive Course Grained(Sand or Gravel)			
2	**Excavation Water Conditions** Dry Surface Water Present Submerged Water Present			
3	**Soil Condition** Undisturbed Disturbed Layered Soil Dipping into Excavation Excavation Exposed to Vibrations Cracked/Fissures/Spalling Observed			
4	**Additional Excavation Hazards** Surface Encumbrances(If YES - What Type) Hazardous Atmosphere in Excavation (If YES - List Source and Conditions)			

SOIL ANALYSIS - MANUAL TEST		
RESULTS	THUMB TEST	Check here if conducted
	Type A - Soil identified by thumb with great degree of effort	
	Type B - Soil identified by thumb with some degree of effort	
	Type C - Soil identified by thumb with little degree or no effort	
RESULTS	PENETROMETER OR SHEARVANE Circle which used	Write in brand/model
	Type A - Soil with unconfined compressive strength of 1.5 tons per square foot (tsf) or greater	
	Type B - Soil with unconfined compressive strength > 0.5 to 1.5 tsf	
	Type C - Soil with unconfined compressive strength < 0.5 tsf or soil that is submerged or exposed to water	

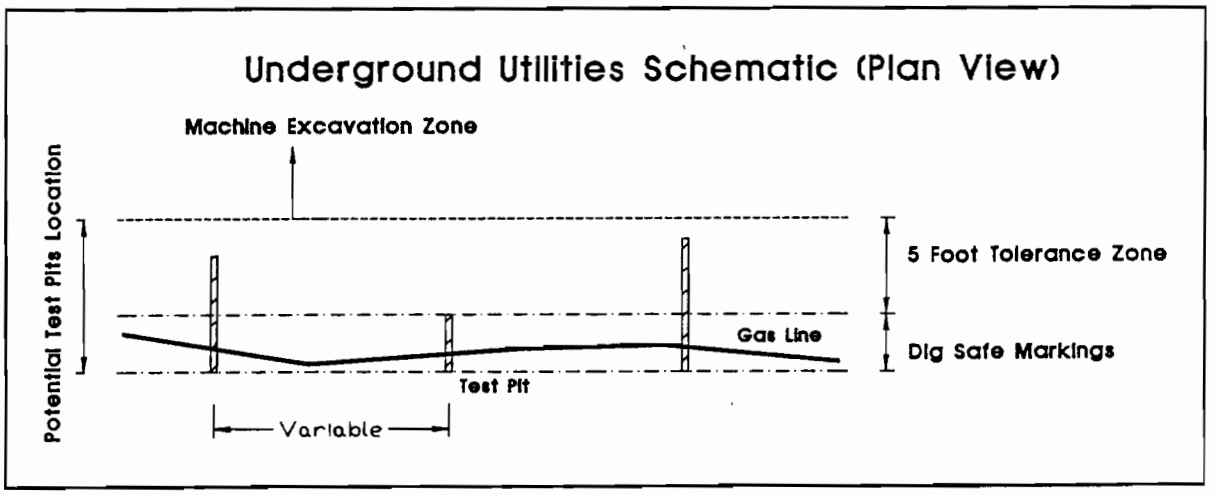
Soil Classification		
Type A	Type B	Type C

Selection of Protective System (Appendix F)	
PROTECTIVE SYSTEM	Sloping Specify angle_____ _____ Timber shoring _____ Aluminum hydraulic shoring _____ Trench Shield Max Depth in this soil _____

Note: Although OSHA will accept the above tests in most cases, some states do not - check your state safety requirements for trenching regulations.

EXCAVATION/TRENCHING - UNDERGROUND UTILITIES

Documentation:
Contact the local utility service (Digsafe, Misutility...), and document permit number A company utility representative in questionable areas, elaborate trenching projects tight/tricky areas or whenever drilling adjacent to a building or structure Contact the property owner and/or town building department for plans
Physical Location:
Use a metal detector to aid in the identification of obstructions Observe utility markers, vent pipes, catch basins, newly paved areas, etc.
Safety Procedures:
Machine excavate five feet from any underground utility, tank, or utility marker Hand dig in utility "**five-foot** tolerance zone" until the service is exposed Utilize test pits to establish and QC markers for sensitive utility locations
General Notes:
Comply with local and state codes and regulations Utilize experienced and trained equipment operators Use appropriate subcontractors and applicable insurance riders Hand dig per customer mandate



UTILITY MARK-OUT RECORD SHEET

Facility:_____ Location:_____

Fluor Daniel GTI Representative:_____ Date Called:_____

County of Work:_____ Township of Work:_____

Contact Miss Dig to have subgrade utilities marked. The nearest intersecting street for this site is: _____. We need the entire site area marked since we do not know exactly where we will be drilling/excavating. The site needs to be marked by:_____

List which utilities they will have marked. Confirmation Number:_____

List other known utilities in the area that they do not mark:_____

Contact other known utilities not contracted by Miss Dig to have them mark the site.

MAJOR UTILITIES MARKED BY COLOR CODE

ELECTRIC - RED **OTHER CONTACTS:**

GAS - YELLOW

COMMUNICATIONS/CABLE - ORANGE

WATER - BLUE

SEWER - GREEN

IMPORTANT NOTE: ALL UNDERGROUND UTILITIES MAY NOT BE LOCATED BY MISS DIG.

UNDERGROUND UTILITY CONTACT PREVENTION AND MANAGEMENT PLAN

Check Off When Completed

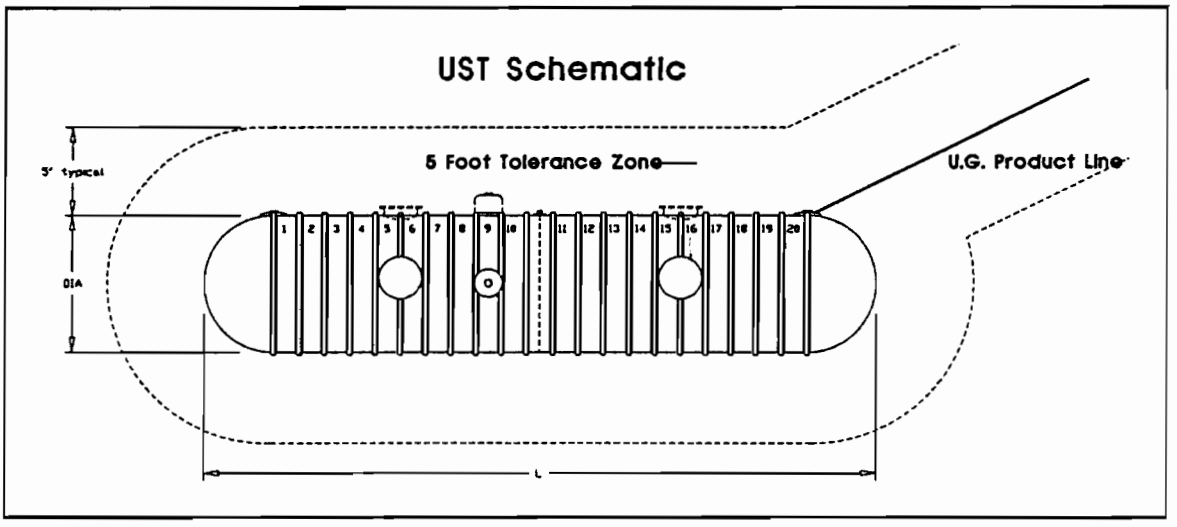
STEPS	TASK DESCRIPTION	RESPONSIBLE EMPLOYEE
STEP 1	Obtain site blueprints from client, if available, to show buried utility/conduits.	PM
	If site blueprints are unavailable **other methods should be employed to identify subsurface conduits in the field. Examples include privately contracted utility locators such as SM&P, a hand-held utility location device, field observations (cut pavement, signs and overhead lights, water, electric, and gas meters, etc.), and customer personnel with knowledge of conduit locations. No one tool should be relied upon. Instead, as many tools as practicable should be employed to insure that all known/suspect conduits have been identified.**	PM and/or field personnel
	Mark out any proposed digging locations with white survey paint.	
STEP 2	Contact underground utility locating service (before you dig). Give proposed drilling dates, location, etc. **Documented notification of the proper underground notification service at a minimum of 48 or 72 hours prior to the scheduled site work.* (Check with the state for notification requirements).**	PM Assistant for contacting "miss dig" and/or field personnel
	If possible, arrange site visit with client, facilities maintenance manager, or other site knowledgeable person to verify, utility and drilling/excavation locations.	PM
	Regarding subcontractors: at a minimum, excavation subcontractors will be required to supply sufficient labor to complete all requested installation tasks.	PM
STEP 3	**The HASP will be amended to include emergency telephone numbers for all utility companies identified during the notification process.**	Office safety coordinator updates HASP with PM approval.

STEPS	TASK DESCRIPTION	RESPONSIBLE EMPLOYEE
STEP 4	On the day that on-site activities are scheduled to begin, **at the first tailgate safety meeting, the locations of all known/suspect utilities (subgrade and overhead) will be reviewed with all personnel in the field (Fluor Daniel GTI and subcontractors).**	PM and/or field personnel
	Make sure that all underground utility locator markings are visible for each noted utility, etc. Note any discrepancies. Visually inspect for undocumented trenches, laterals, etc. that may be visible as discolored areas, patched pavement, and not marked accordingly.	PM and/or field personnel
STEP 5	Pre-screen each drilling/digging location by hand augering and/or post hole digger to a depth of at least 3 to 5 feet using a 3-inch OD minimum clam-shell style post hole digger and/or hand auger. Inspect excavation periodically with flashlight to check for visual obstructions. Discontinue immediately upon encountering any substantial resistance to hand auger and/or post hole digger.	Subcontractors to conduct hand augering and/or post hole digging under Fluor Daniel GTI oversight.
STEP 6	**During excavation/trenching activities, barricades and cones with flags will be used to mark the 10-foot distance from a located conduit. This will serve as a reminder of the conduit's presence and to alert the Fluor Daniel GTI supervisor that it is time to pay close attention to excavation/trenching activities.**	Field personnel

UNDERGROUND UTILITY CONTACT PREVENTION AND MANAGEMENT PLAN (continued)

STEPS	TASK DESCRIPTION	RESPONSIBLE EMPLOYEE
STEP 7 ENCOUNTER	In the unlikely event that a subsurface utility/conduit is encountered, immediately halt all drilling/digging operations and secure the area. Try to determine the source (i.e., gas line, water line, etc.) and contact the emergency numbers for that utility. Contact the PM immediately. Take all safety precautions to insure that all flames, etc. are extinguished, and all personnel are kept away from the area. Monitor for LEL, O_2, PID, and any other substances that may be present as appropriate for that utility encounter (i.e., gas line).	Fluor Daniel GTI field personnel secures area and contacts PM immediately.
	The PIR is filled out by field personnel and submitted to the PM.	PM contacts client, etc., to discuss appropriate actions. Fluor Daniel GTI field personnel contacts local emergency officials as necessary (i.e., fire, police, EPA, public works, etc.). PM submits PIR to appropriate Fluor Daniel GTI management and prepares follow-up report.

EXCAVATION/TRENCHING - UST
Documentation:
Refer to existing UST plans for potential location. Contact property owners for potential location. Contact local Fire or Building Department for information.
Physical Location Characteristics: Cross-check to existing documentation, if available
Determine tank capacity (from tank chart, owner, delivery records). Determine tank opening locations and spacing. Determine tank diameter (from tank chart, inventory records or gauge stick). Determine if tank is fiberglass or steel; single walled or double walled Refer to available UST vendor info charts on standard USTs for dimensions and tank opening locations.
Safety Procedures:
Empty tank of flammable liquids prior to excavation activities. Inert tank of flammable vapors and eliminate ignition sources (if practical). Drill no closer than five feet from suspected tank location or other nearby underground utilities.
General Notes:
Concrete pad on top of the USTs is sized to overhang the footprint of the tanks by 1 to 2 feet in each direction. Beware of exceptions. When possible, have the owner/client mark the locations for drilling and accept responsibility for potential mishaps in writing. Redundant information cross-checking to reduce oversight errors Visual inspection of augured or excavated materials for pre-gravel, etc., indicative of UST backfill/bedding.



UST REMOVALS*		
Minimum Action	**Site Set-Up**	**Precautions**
1. Ignition sources must be eliminated 2. Designate a **no smoking** zone or area. 3. Use pneumatic/nonsparking tools when appropriate. 4. Define the work area with barricades and hazard tape. 5. Contact local underground utility locating service: Check location of all utilities including water and sewer. 6. Wear Level D PPE: hard hat, safety glasses, steel-toed and shank boots, and traffic vest. Upgrade to modified Level D when possibility of contact to skin or work uniform can occur. Upgrade to Level C when air monitoring reveals action levels have been exceeded. This applies to all on-site personnel including subcontractors. 7. Perform air monitoring with an oxygen/combustimeter and an organic vapor analyzer at frequent intervals.	1. Ground vacuum truck. 2. Park vacuum truck downwind of excavation. 3. Vent vacuum truck vapors at least 12 feet from the ground surface; refer to the American Petroleum Institute (API) recommendations for greater clearance requirements. 4. Inert the tank with dry ice (1½ lbs. dry ice per 100 gallons tank capacity) or nitrogen. 5. Wear Level B PPE when cleaning tank interiors when indicated by HSR.	1. Verify tank inerting has been accomplished by measuring oxygen to be less than 8%. 2. Monitor LEL and organic vapors frequently in areas around tanks during removal process. **Note: LEL measurements taken in oxygen deficient atmospheres (e.g., in inerted tanks) will not be accurate.** 3. Check local/state requirements for tank removal/disposal regulations. 4. Assist subcontractor in performing tasks according to the HASP. 5. Notify the PM **immediately** when a sub-contractor will not follow site specific safety protocols. The PM must inform the client.
* Refer to Fluor Daniel GTI's UST Safety Training Manual for detailed information.		

APPENDIX G

CSE HAZARD ANALYSIS FORM
SITE-SPECIFIC CONFINED SPACES
CSE PERMIT
CONFINED SPACE PERSONNEL REQUIREMENTS

Fluor Daniel GTI, Inc.
CSE
Hazard Analysis Form

Site Name:_____

Site Address:_____

_____

CSE Name/Number:_____

CSE Definition: Vault Tank/Vessel
Pit Other_____

CSE Dimensions:

Length =_____

Width =_____

Depth =_____

Sketch:

Tasks/Activity/Reasons for Entry:

Well Gauging
Bailing Product
Pump Maintenance
Well Sampling
Product Recovery
_____

Potential hazards within space:

Oxygen Deficiency
Combustible Vapors
Toxic Vapors
Engulfment
No Hazards

Other CSE Hazards:

Greater than 5' deep
Difficult access/egress
Energy/isolation*
Prone to flooding
Slippery surface
Hot surfaces (i.e., pipes)

*Check here if LO/TO must be performed inside confined space.

FOR USE BY AUTHORIZED CSE SUPERVISOR
CSE Classification

Class I_____

Class II_____

Class III_____

Requirements:

Completed by:_____ Date_____

Reviewed by:_____ Date_____

SITE-SPECIFIC CONFINED SPACES

Site work may require personnel to enter confined spaces. **No Fluor Daniel GTI employee or subcontractor shall enter an area identified as a confined space without using the CSE procedures described in this appendix and completing the site specific entry procedures presented in the CSE Permit.** The purpose of the CSE procedure is to protect employees from potentially hazardous environments and to facilitate immediate rescue in an emergency situation. A CSE Permit must be posted at the entrance to each confined space.

CONFINED SPACES
Definition
A confined space has limited or restricted means of entry or exit, is large enough for an employee to enter and perform assigned work, and is not designed for continuous occupancy by the employee.
Examples
These spaces may include, but are not limited to, underground vaults, tanks, storage bins, pits and diked areas, vessels, and silos.
Characteristics
A permit-required confined space is one that meets the definition of a confined space and has one or more of these characteristics: Contains or has the potential to contain a hazardous atmosphere, Contains a material that has the potential for engulfing an entrant, Has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section, and/or Contains any other recognized serious safety or health hazards.
Protocol for CSE
Personnel trained to conduct CSE procedures. Perform the appropriate air monitoring activity at various depths in the space prior to entry. Monitor for: (1) oxygen level, (2) flammable vapors, and (3) toxic vapors. Ventilate the atmosphere in the space so that entry may be made safe without respiratory protection. If this is not feasible, appropriate respiratory protection must be worn by authorized entrants and attendants. Wear appropriate respiratory protection when ventilation alone can not achieve acceptable atmospheric levels of oxygen or flammable or toxic vapors. Have appropriate retrieval equipment worn by employees in the event of a mishap.

SITE-SPECIFIC CONFINED SPACES			
Location	Permit Required (Y or N)	Buddy Required (Y or N)	Specific Entry Procedures

CSE PERMIT

This permit must be completed prior to entering any confined space and is **ONLY VALID FOR THE DATE AND TIME INDICATED ON THIS FORM.** All procedural requirements contained in Fluor Daniel GTI Health and Safety Policy and Procedure No. 11 must be followed. In the event a confined space emergency situation develops and rescue is required, notify the following appropriate emergency services:

Ambulance:_____ Fire:_____ Police:_____

Purpose of entry:_____ Location of confined space:_____

Date:_____ Authorized duration:_____ Expires on:_____

Atmospheric Hazards: [ ] Oxygen Deficiency [ ] Flammable [ ] Toxic [ ] Other_____ [ ] Other_____

Physical Hazards: [ ] Mechanical [ ] Electrical [ ] Chemical [ ] Engulfment [ ] Other_____

PRE-ENTRY REQUIREMENTS

Yes	N/A		Yes	N/A	
[ ]	[ ]	Entry area is free of debris and objects	[ ]	[ ]	Non-sparking tools used
[ ]	[ ]	Warning barriers and signs are in place	[ ]	[ ]	Low voltage (less than 25v) lighting used
[ ]	[ ]	Atmospheric monitoring conducted	[ ]	[ ]	Electrical equipment rated for explosive atmospheres
[ ]	[ ]	All hazardous lines have been isolated	[ ]	[ ]	No compressed gas cylinders in the confined space
[ ]	[ ]	Hot work permit attached	[ ]	[ ]	Host employer and/or contractors notified
[ ]	[ ]	All energy sources have been locked out/tagged out	[ ]	[ ]	Entry and emergency procedures have been reviewed
[ ]	[ ]	The confined space has been drained and flushed	[ ]	[ ]	All personnel have been trained (classroom/exercise)
[ ]	[ ]	Forced air or exhaust ventilation is provided	[ ]	[ ]	All personnel have been informed of potential hazards
[ ]	[ ]	Electrical equipment is properly grounded	[ ]	[ ]	Attendant stationed at entrance and property inspected
[ ]	[ ]	Ground fault circuit interrupters (GFCI) provided accessible	[ ]	[ ]	Rescue equipment on location and readily

PROTECTIVE EQUIPMENT

Yes	No		Yes	No		Yes	No	
[ ]	[ ]	Hard Hat	[ ]	[ ]	Protective clothing	[ ]	[ ]	Communications Equipment
[ ]	[ ]	Eye/Face Protect.	[ ]	[ ]	Hearing protection	[ ]	[ ]	Ventilation to Provide Fresh Air
[ ]	[ ]	Boots	[ ]	[ ]	Retrieval Device/Tripod	[ ]	[ ]	Respirator (type)_____
[ ]	[ ]	Gloves	[ ]	[ ]	Harness and Lifeline	[ ]	[ ]	Other_____

Atmosphere Test(s) to be taken*	Yes	No	Acceptable Entry Conditions	Time	Time	Time	Time	Time	Time	Time	Time	Time	Time	Time
			Allowable Limits	Enter Air Monitoring Findings Below										
Oxygen			19.5% - 22.0%											
Combustible Gas			Below 10% LEL											
PID/FID														
Carbon Monoxide			0-15 PPM											
Hydrogen Sulfide			0-5 PPM											
Hydrogen Cyanide			0-2 PPM											
Sulfur Dioxide			0-1 PPM											
Ammonia			0-10 PPM											
Benzene			0-0.5 PPM											
Other														

SUPERVISOR APPROVAL: I certify that all necessary precautions have been taken to make this confined space safe for entering and conducting the work during the prescribed time(s) as well as emergency response procedures.

Print Name_____ Sign Name _____ Date_____

Entry Supervisor_____ Permit Prepared by_____

Atmosphere Tester_____ Attendant_____

ENTRANT ACKNOWLEDGMENT: I HAVE BEEN PROPERLY INSTRUCTED FOR SAFE ENTRY INTO THIS CONFINED SPACE AND UNDERSTAND MY DUTIES AND EMERGENCY PROCEDURES

Print Entrant Name	Sign Entrant Name	Employee or S.S. No	Date	Time

*An evaluation should be performed to consider all potential air contaminants which could be present and represent a hazard.

ENTRANT INSTRUCTIONS

All personnel who enter confined spaces must be thoroughly familiar with the following duties for entrants as listed below. Your primary responsibilities include:

Understand the hazards of the confined space to be entered and the physical effects of those hazards.
Continuously monitor the atmosphere inside of the confined space with a calibrated, direct reading, air monitoring instrument.
Evacuate the confined space:

- If atmospheric hazards exceed the action level,
- If a hazardous condition is identified inside of the confined space, and
- Whenever attendant signals entrants to evacuate.

Read and understand the rescue procedures.
If PPE is required, the entrant must be properly trained on the use of the equipment prior to entry. PPE must be in good working condition.

ATTENDANT INSTRUCTIONS

You should be thoroughly familiar with the following duties when you assume the responsibility of attendant for a person or persons inside a confined space. Your primary responsibilities are the following:

Focus on the safety of the personnel inside.
Understand the hazards of the confined space to be entered and the physical effects of those hazards.
Maintain the conditions and requirements listed on entry permit.
Evacuate the space if you observe any condition which you consider hazardous.
Read and understand the rescue procedures. Get help if an emergency situation develops. never enter the confined space in an emergency unless you are trained and equipped with the proper equipment for confined space rescue operations (i.e., self contained breathing apparatus, safety harness, life line) and are relieved by another attendant.
Keep an accurate count of all personnel inside of the confined space at all times.
Do not leave the entrance to the confined space while any personnel are still inside unless you are properly relieved. These instructions must be passes onto your relief.
If you have any questions regarding the job, check with your supervisor or a health and safety professional.

ENTRY SUPERVISOR'S INSTRUCTIONS

You should be thoroughly familiar with the following details to quality as the Entry Supervisor for a permit-required CSE procedure.

Requirements for confined space entrant and attendant instructions.
Knowledge of the hazards that may be faced during entry, including information in the mode, signs and symptoms and consequences of exposure.
Ability to verify that the appropriate entries have been made on the permit, and that all tests specified by the permit have been conducted and that all procedures and equipment specified by the permit are in place before endorsing the permit and allowing entry to begin.
Procedures to terminate the entry permit when the CSE operations have been complete or when a condition exists that is not allowed under entry permit requirements.
Ability to verify that rescue services are available and that the means of summoning them are operable.
Procedures to remove unauthorized individuals who enter or who attempt to enter the permit space during entry operations.
Ability to take responsibility for the confined space when entry is transferred to other personnel.
Ability to determine that entry operations are still consistent with the terms of the CSE permit and that the prescribed intervals regardless of changes in entry personnel.

APPENDIX H

HOT WORK PERMIT
HOT WORK JSA

HOT WORK PERMIT

Project Name_____ Job #_____

Hot Work Task Description:_____

Workers/Welders Conducting Hot Work_____

(PERMIT MUST BE COMPLETED IN ITS ENTIRETY AND POSTED BEFORE HOT WORK BEGINS)

Action Item	Yes	No	NA
Has client representative been notified of intended hot work?			
Hazardous materials involved? Name:_____			
Will hot work impact the general public, customers or operations employees?			
Will the intended hot work need to be coordinated with other contractors who may be working on the site to make them aware of any hazards and the scope of work to be performed?			
Have hazardous energy sources been identified, isolated, and locked out - tagged out before the start of the project?			
Will hot work be conducted within a confined space?			
All testing equipment (i.e., CGI, oxygen meter, etc.) and fire fighting equipment (i.e., extinguisher, etc.) have been checked to ensure proper operation and calibration before the start of this project?			
Does task require a designated fire watch (**30 minutes after work**)?			
Flammable and combustible materials within 35 feet have been cleared or shielded.			
All fuel sources have been identified and protected (USTs, ASTs, sewers, piping).			
The area has been restricted with proper barriers and signs.			
The area has been tested to be certain that atmosphere is 0% LEL before starting hot work.			
Flame sensitive areas and equipment (including cylinders and gas delivery lines) exposed to slag, heat, and sparks are protected by flame a resistant blanket, shield, or removed from the area?			
Escape routes have been identified before starting work?			
Is ventilation equipment needed? Type needed:_____			

THE FOLLOWING PROTECTIVE EQUIPMENT WILL BE REQUIRED (PLEASE CHECK):

	Yes	No		Yes	No
Welding Goggles/Shield___ Tint			Hearing Protection		
Safety Boots			Head Protection		
Leather Gloves			Safety Harness		
Supplied Air Respirator			Welding Leathers - Top		
APR ___ Cartridge			Welding Leathers - Bottom		

Cold Cut Only Method Required:_____ Hot Cut Method Allowed:_____

APPROVALS:

_____ _____

Fluor Daniel GTI Site Manager or Site Safety Officer Date

Name of Employee Performing Hot Work_____ Fire Watch Representative_____

Hot Work/JSA Welding/Torch Cutting	
Job Hazards	**Safeguards/Precautions**
1. Unsafe act Untrained worker	a. Require qualified operators only. b. Provide training per 29 CFR 1910.1200. c. Provide proper PPE. d. Inspect area prior to welding/cutting. e. Use permit system. f. Use fire watch for 30 minutes following termination of work.
2. Welder's flash to eye	a. Use filter lens based on actual hazard or welding technique in accordance with the American Welding Society Laws shade selector chart. b. Provide warning signals, barricades or similar means to protect other workers, general public. c. Provide screens or barriers to protect other workers, general public.
3. Radiation burns, skin burns, heat burns	a. Helmet with proper filter lens. b. Gauntlet gloves, leather apron. c. Cotton shirt, long sleeves, buttoned at sleeves and collar. d. Cotton cuffless pants. e. Steel toe boots, 6-inch minimum height. f. Hearing/ear cover protection as appropriate. g. Work zone definition - see 2(a) and (b) above.
4. Faulty equipment	a. Use equipment that is in good working condition. b. Inspect valves, regulators, and hoses prior to use. c. Preventive maintenance performed per manufacturer specifications.
5. Toxic fumes and gases	a. Provide source ventilation. b. Provide respiratory protection, selected based on hazard. c. Rope off area, define work area with cones, caution tape or similar (see 2(a) and (b) above).
6. Adjacent flammable/ combustible materials	a. Move combustibles at least 50 feet from work area. b. If they cannot be moved consider protection by metal guards or flame proof curtain. c. Openings in walls, floors or ducts should be covered if within 35 feet of work area. d. Assure facility sprinklers are in working condition and will not be taken out of service. e. Suitable fire extinguishing equipment shall be readily available at the work area. f. Designate a reliable means of contacting the Fire Department in the event of an emergency.

Hot Work/JSA Welding/Torch Cutting	
Job Hazards	**Safeguards/Precautions**
7. Flammable/combustible vapors	a. If in an environment classified as a hazardous location then define specific tasks using JSA technique. b. Provide equipment per classification (i.e., explosion proof, etc.) c. Post sign: DANGER - NO SMOKING, MATCHES OR OPEN LIGHTS. d. Ensure person is assigned as fire watch and fully charged extinguisher is present.
8. CSE	a. Follow CSE procedures. b. Use CSE permit. c. Define specific JSA techniques for that work. d. Exercise caution when using inertion to address O_2 deficiency. e. Exercise caution when using O_2/acetylene fuel mix, address O_2 enrichment from cylinder leak.
9. Unsecured compressed gas cylinders, cylinder handling	a. Store cylinders upright. b. Secure against stationary object. c. Cylinders in excess of 40 pounds in weight must be moved using wheeled cart or motorized truck. d. Lifting cylinders > 40 pounds in weight is prohibited. e. Compatible storage practices = separate O_2 cylinders from flammable combustible gases. f. Use tags on cylinders to mark full, in use or empty. g. Remove protective cap using hand method or use cylinder "cap wrench". Do not jam screwdriver or wrench in cap slots to loosen.
10. Unsafe practice during inactivity	a. Provide protective cap when cylinders are not in use. b. Valves or gas cylinders shall be closed and line pressure relieved. c. Power source of electric welding equipment shall be disconnected.
11. Improper flow of gases, gas mixing, pressure in gas lines	a. Label cylinders per 29 CFR 1910.1200. b. Color code hoses (green = O_2; red = fuel gases; black = inert gas or air hoses). c. Install "flash back" arresters for fuel mixing welding. d. Use acetylene at 15 pounds per square inch (psi) or less.
12. Improper ignition of oxygen/fuel torch	a. Use "spark lighter" to ignite. b. Don't use cigarette, match or lighter for ignition.
13. Static electricity	a. Provide and use grounding clamp for electric area welding equipment.

APPENDIX I

HEAT/COLD STRESS PROCEDURES

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Static Electricity	1. Do not create static discharge in flammable atmospheres. 2. Electrically bond and ground pumps transfer vessels, tanks, drums, bailers and probes, when moving liquids. 3. Electrically bond and ground vacuum trucks and the tanks they are emptying. 4. Do not splash fill containers with flammable liquids.
Drilling/Boring Operations	1. Driller and helper must be present during all active operations. 2. Driller helper and other site personnel must know location of emergency shut off switch. 3. Ensure jewelry is removed, loose clothing is buttoned and loose PPE is secured close to the body to avoid getting caught in moving parts. 4. Unauthorized personnel must be kept clear of drilling rig. 5. Area of drilling operation must be cordoned off/barricaded. 6. When hazardous conditions are deemed present, operation must be shut down. 7. Do not allow drillers to climb to mast while it is erected. 8. Pipe, drill rods, casing, augers, and similar drilling tools should be orderly stacked on racks or sills to prevent spreading, rolling or sliding. 9. Work areas, platforms, and walkways should be kept free of materials, debris, and obstructions such as ice, grease or oil that could cause a surface to become slick or otherwise hazardous. 10. Shut down drill rig to make repairs or adjustments to drill rigor to lubricate fittings. Release all pressure on the hydraulic systems, the drilling fluid system, and the air pressure systems of the drill rig prior to performing maintenance. 11. For start-up, all gear boxes must be in neutral, all hoist levels are disengaged, all hydraulic levers are in the correct non-actuating positions and the cathead rope is not on the cathead before starting a drill rig engine. 12. Do not drive the drill rig from hole to hole with the mast in the raised position. Before raising the mast, check for overhead obstructions. 13. If it is necessary to drill within an enclosed area, make certain that exhaust fumes are conducted out of the area. 14. Clean mud and grease from your boots before mounting a drill platform. Watch for slippery ground when dismounting from the platform. 15. Should the rope "grab" the cathead it could become tangled in the drum. Release the rope and sound an appropriate alarm for all personnel to rapidly back away and stay clear. 16. Always maintain a minimum clearance of 18 inches between the operating hand and the cathead drum when driving samplers, casing or other tools with the cathead and rope method. 17. Use a long handle shovel to move auger cuttings away from the auger.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Reacting to Drill Rig Contacting Electricity	1. Under most circumstances, the operator and other personnel on the seat of the vehicle should remain seated and not leave the vehicle. Do not move or touch any part of the vehicle. 2. If it is determined that the drill rig should be vacated, then all personnel should jump clear as far as possible from the rig. Do not step off, and do not hang on to the vehicle when jumping clear. 3. If ON THE GROUND, STAY FAR AWAY FROM THE VEHICLE AND THE DRILL RIG, DO NOT LET OTHERS GET NEAR THE VEHICLE AND THE DRILL RIG AND SEEK ASSISTANCE FROM LOCAL EMERGENCY PERSONNEL. 4. When the victim is completely clear of the electrical source and is unconscious and a heart beat cannot be detected, begin CPR immediately.
Off-Road Movement of Drill Rig	1. Before moving a drill rig, walk the route of travel, inspecting for depressions, stumps, gullies, ruts, and similar obstacles. 2. Check the complete drive train of a carrier at last weekly. 3. Discharge all passengers before moving a drill rig on rough or hilly terrain. 4. Engage the front axle for 4x4, 6x6, etc. when traveling off highway on hilly terrain. 5. Use caution when traveling side-hill. 6. Cross obstacles such as logs and erosion channels or ditches squarely. 7. Use a spotter when lateral or overhead clearance is close. 8. After drill rig has been moved to a new spot, set the brake and/or locks. When grades are steep, block the wheels.
Safety During Rotary and Core Drilling	1. Check water swivels and hoisting plugs for frozen bearings prior to use. 2. The capacities of hoist and sheaves should be checked against the anticipated weight to the drill rod string plus other expected hoisting loads. 3. Only the operator of the drill rig should brake or set a manual chuck so that rotation of the chuck will not occur prior to removing the wrench from the chuck. 4. Drill rods should not be braked during lowering into the hole with drill rod check jaws. 5. Do not lower drill rods into the hole using pipe wrenches. 6. Do not use your hands to catch a falling rod in the hole. 7. In the event of a plugged bit or other circulation problem, the high pressure in the piping and hose between the pump and the obstruction should be relieved or bled before braking the first tool joint. 8. Do not use your hands to clean drilling fluids from rods. 9. Secure the ends of drill rod sections for safe vertical storage or lay the rods down.

Table 5. Potential Hazards and Control (continued)

Potential Hazard	Control
Well Installation, Well Development, Well Gauging, Well Bailing, Soil/Ground-water Sampling	1. Wear appropriate PPE to avoid skin, eye, and inhalation contact with contaminated groundwater and/or soil. 2. Stand upwind when conducting tasks and minimize possible inhalation exposure; especially when first opening monitoring wells. 3. Conduct air monitoring to determine level of respiratory protection. 4. Utilize engineering controls such as portable venturi air movers to draw away or blow away chemical vapors.
Rapid Response	1. Ensure emergency response activities have been completed prior to beginning rapid response field activities. 2. Conduct hazard assessment of project site and communicate findings through a "Daily Tailgate Safety Meeting" to all Fluor Daniel GTI employees and subcontractors prior to beginning rapid response field activities. 3. Communicate applicable Fluor Daniel GTI health and safety programs to other contractors on site that may be impacted and coordinate field activities with them.
Welding, Cutting, Brazing (not currently anticipated for this project)	1. Conduct fire safety evaluation. 2. Complete Hot Work Permit (Appendix H). 3. Ensure flammable materials are protected from hot work, sources of ignition. 4. Ensure fire watch/fire extinguisher is on standby by hot work location.
Cleaning Equipment	1. Wear appropriate PPE to avoid skin and eye contact with isopropyl alcohol, alconox, or other cleaning materials. 2. Stand upwind to minimize any potential inhalation exposure. 3. Dispose of spent cleaning solutions and rinses accordingly.
First aid kit, blood borne pathogen kit, emergency eye wash/shower station, fire extinguisher and absorbent pads will be located on-site either in the decontamination zone, or in the Fluor Daniel GTI company vehicle.	

3.0 AIR MONITORING AND NOISE MONITORING

3.1 Air Monitoring

Air monitoring must be performed on all sites in accordance with Fluor Daniel GTI practices. Organic vapor and/or concentrations are monitored in the field with a FID or PID with an 11.7 eV lamp. Flammable vapor and/or gas are monitored with an oxygen/combustimeter (O_2/LEL) real-time instrument. Airborne dust/particulate concentrations are measured with a real-time aerosol monitor (using a scattered light photometric sensing cell) when there are visible signs of airborne dust. Detector tube grab sampling is conducted for benzene, vinyl chloride and perchloroethylene when results of non-specific real-time monitor action levels are reached, or when their presence is suspected. Both area and personal air monitoring readings should be taken to characterize site activities. Air monitoring results must be documented on the Air Monitoring Form (Appendix E).

ATTENTION:

SITE PERSONNEL ASSIGNED RESPONSIBILITY TO CONDUCT AIR MONITORING MUST HAVE BEEN TRAINED IN AIR MONITORING EQUIPMENT OPERATION AND CALIBRATION PRIOR TO ITS USE.

Calibration and maintenance of air monitoring equipment must follow manufacture specifications and documented. Recalibration and adjustment of air monitoring equipment must be completed when site conditions and equipment operation reveal the need. Record all air monitoring equipment calibration and adjustment information on form in Appendix E.

Air monitoring action levels (Table 7) have been developed by the Fluor Daniel GTI HSM, to indicate the chemical concentrations in the breathing zone that require an upgrade in level of PPE. Action levels are typically set at either one-half the OSHA Permissible Exposure Limit (PEL), National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limits (REL), or the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV). Rationale for establishing action levels is based upon the data available that characterizes contaminants of concern in soil or water. Calculation for estimating action levels is then completed using the principles of Henry's Law (volatiles in water), fugacity (volatiles in soil), and proportionality (particulates in soil). When analytical data is not available, a qualitative assessment is conducted based on knowing the contaminants of concern and then setting action levels based on the compound(s) with the lowest OSHA PEL, NIOSH REL or ACGIH TLV, and following an air monitoring schedule that will minimize any potential for over exposure.

All workers on-site must have been properly fitted with PPE (i.e., respirators) and have been trained in their use (i.e., donning and doffing). Air monitoring measurements will be taken in the breathing zone of the worker most likely to have the highest exposure. Transient peaks will not automatically trigger action. Action will be taken when levels are consistently exceeded in a 5-minute period. Similarly, if chemical odors are detected that are a nuisance, bothersome, or irritating, an upgrade in respiratory

protection can provide an extra level of comfort or protection when conducting site activities. Guidelines for frequency of air monitoring are presented in Table 6. Job tasks that require air monitoring, the applicable action levels that apply for those tasks, and the frequency of air monitoring are described in Table 6 and Table 7 respectively.

Engineering controls such as the venturi air mover (supplied by compressed air) to exhaust or dilute solvent vapors emanating from monitoring wells or when conducting intrusive activities can be utilized as a means to downgrade PPE requirements (Level B to C, Level C to D).

Table 6. Air Monitoring Frequency Guidelines

Conduct periodic monitoring when:

1. It is possible that an immediately dangerous to life or health (IDLH) condition or a flammable atmosphere has developed, or

2. There is an indication that exposures may have risen over established action levels, permissible exposure limits or published exposure levels since the last monitoring. Look for a possible rise in exposures associated with these situations:

   - ☐ **Change in site area** - work begins on a different section of the site.
   - ☐ **Change in contaminants** - handling contaminants other than those first identified.
   - ☐ **Visible signs of particulate exposure from intrusive activities such as drilling/boring and excavation.**
   - ☐ **Perceptible chemical odors or symptoms of exposure.**
   - ☐ **Change in on-site activity** - one operation ends and another begins.
   - ☐ **Handling leaking drums or containers.**
   - ☐ **Working with obvious liquid contamination** (e.g., a spill or lagoon).

Conduct air monitoring when the possibility of volatilization exists (such as with a new monitoring well or a well containing known product).

Table 7. Air Monitoring Action Levels

Instrument*	Function	Measurement	Action
FID or PID (11.7 eV lamp) - Measures Total Organic Vapors			
	Conduct air monitoring for volatile organic compounds during activities where contaminated media are present.	0 - 1 ppm	Level D/Modified Level D required. Check for benzene and vinyl chloride with detector tubes. Upgrade to Level C if either compound is present above 0.5 ppm.
		>1 -25 ppm	Level D/Modified Level D required. Check also for perchloroethylene with detector tube. If benzene, vinyl chloride is present above 0.5 ppm and/or PCE >12.5 ppm, upgrade to Level C.
		>25 to 100 ppm	Upgrade to Level C.
		>100 ppm	Stop work required. Leave work area, contact PM and HSR for guidance and possible upgrade to Level B (with approval from HSR).
Benzene, Vinyl Chloride and Perchloroethylene Detector Tubes			
	Conduct grab sampling for benzene, vinyl chloride and perchloroethylene when sustained PID/FID readings are detected in the breathing zone above the action levels specified in the above table.	> 0.5 to 25 ppm	If benzene and vinyl chloride present at these levels, Level C is required; otherwise Level D or Modified Level D required.
		>12.5 - 25 ppm	If PCE present at these levels, Level C required.
		>25 ppm	If benzene, vinyl chloride or PCE present above this level, Level B required with approval from HSR. Employees must be trained in the use of Level B PPE.
Dust/Particulate Monitor			
	Conduct air monitoring for dust particulate when sustained (> 5 minute) levels of visible dust are generated and engineering controls such as wet methods are ineffective.	0 - 2.5 mg/M^3	Level D/Modified Level D required.
		2.5 - 50 mg/M^3	Upgrade to Level C.
		>50 mg/M^3	Stop work. Contact PM and HSR for guidance.

Table 7. Air Monitoring Action Levels (continued)

Instrument*	Function	Measurement	Action
Oxygen/Combustimeter (O_2/LEL)	Measures oxygen level (O_2) and lower explosive limit (LEL)		
Conduct air monitoring for O_2/LEL when conditions exist where flammable vapors/gases and/or oxygen deficiency or enrichment can occur. A decreased O_2 reading of 0.1% (e.g., 20.9% to 20.8%) actually represents a change in the total air envelope of approximately 0.5% or 5,000 ppm. This represents little hazard if the displacing gas is inert; if the displacing gas is toxic/flammable/reactive, such a concentration represents a real hazard. Verify reasons for O_2 depletion by conducting air monitoring with instruments that can measure suspected contaminants (PID/FID) or that can confirm presence of contaminants (detector tubes or chemical specific real-time air monitors).		O_2 = 20.9 %	Acceptable
		O_2 >19.5 - 20.8%	Verify reasons for O_2 depletion with appropriate air monitoring instrumentation before work continues. Utilize appropriate engineering controls/PPE once atmospheric contaminants have been verified.
		O_2 >20.9 % - 22 %	Verify reasons for O_2 enrichment before entering area. Utilize appropriate engineering controls/PPE to control O_2 enriched atmosphere.
		O_2 >22 %	Leave area immediately; this atmosphere is extremely flammable. Notify PM or HSR for guidance.
		O_2 <19.5%	Leave area immediately; this atmosphere is oxygen deficient. Verify reasons for O_2 depletion with appropriate air monitoring instrumentation before work continues. Utilize appropriate engineering controls/PPE once atmospheric contaminants have been verified.
		LEL <10%	Acceptable conditions. Continue normal activity.
		LEL >10%	Leave area immediately. Contact PM or HSR for guidance on venting and other safety measures.
*Note: Instruments must be calibrated according to manufacturer's recommendations.			

Table 8. Hazard Summary

AIR MONITORING SUMMARY			
Job Task	Level PPE	Instrument	Frequency
Drilling/ Boring/Soil Sampling/ Hand Augering	Modified Level D (See Table 11)	PID[1] or FID[2], O_2/LEL[3], DT[4], DM[5]	Start up of work, then 15 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded.
Well Installation	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT, DM	Start up of work, then 15 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded.
Monitoring Well Bailing/ Gauging/ Sampling	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT	Start up of work, then 15 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded.
Soil Gas Survey/Well Surveying	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT	Start up of work, then 15 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded.
Surface water Sampling	Modified Level D (See Table 11)	PID or FID, O_2/LEL, DT	Start up of work, then 15 minutes to continuously based on sampling results and sample location. Continuously if action level is exceeded.

[1] PID, Photoionization Detector
[2] FID, Flame Ionization Detector
[3] O_2/LEL, Oxygen Level and Combustible Gas Meter
[4] DT, Benzene Detector Tube
[5] DM, Dust/ Particulate Monitor

Note: "Start up of work at each new task location" means to monitor the air quality at each new operation on the site. The breathing zone is the area inside a 1-foot radius around the head.

3.2 Noise Monitoring

Noise monitoring must be performed in accordance with Fluor Daniel GTI practices. Noise levels are monitored in the field with either a Type I or Type II Sound Level Meter (SLM). Noise dosemeter readings can also be obtained to determine the percent (%) noise dose. Noise levels and % dose measured are then compared to limits listed in OSHA standard 29 CFR 1910.95, Hearing Conservation.

Action levels listed in Table 9 will trigger upgrade in PPE to include appropriate hearing protectors (muffs or plugs) or initiate possible noise control engineering. Noise monitoring equipment must be calibrated prior to use each shift and checked at the end of the shift to determine accuracy. Noise readings must be recorded on data form in Appendix E, Noise Monitoring Form.

Selection of hearing protection must match the employees needs and the ability to attenuate noise below 90 dB(A). Each hearing protection device (muff or plugs) has a Noise Reduction Rating (NRR) assigned by the U.S. Environmental Protection Agency (EPA). To calculate the hearing protector's effectiveness use the following formula:

Noise Reading dB(A) - (NRR - 7dB) < 90 dB(A)

Table 9. Noise Monitoring

Instrument	Measurement	Action
Type I or Type II SLM - Calibrate Before Use		
	>80 dB(A) ⊐ 85 dB(A)	Hearing protection recommended. Limit work duration to 8-hour shifts.
	>85 dB(A) ⊐ 90 dB(A)	Hearing protection required. Limit work duration to 8-hour shifts.
	>90 dB(A) ⊐ 115 dB(A)	Hearing protection required. Investigate use of engineering controls. Limit work duration to 8-hour shifts.
	> 115 dB(A)	Stop work. Contact HSR and PM.

4.0 CSE PROCEDURES

In the event site work may require personnel to enter confined spaces, **No Fluor Daniel GTI employee or subcontractor shall enter an area identified as a confined space without using the CSE procedures described in Appendix G and the site-specific entry procedures presented in Appendix G.** The purpose of the CSE procedure is to protect employees from potentially hazardous environments and to facilitate immediate rescue in an emergency situation. A CSE Permit must be posted at the entrance to each confined space. No permit-required confined spaces are identified for this project, however, if the scope of work changes Appendix G must be reviewed and followed, and only personnel trained in confined space hazards may be utilized for such work. Emergency rescue services must also be prearranged.

5.0 CHEMICAL HAZARD CONTROL

5.1 Chemical Handling Procedures

Personnel must practice the chemical-specific handling procedures tabulated below.

Table 10. Chemical Handling Procedures

Chemical	Description	Procedures
Acids and Bases Acids: including hydrochloric, nitric, and sulfuric acids Bases: including sodium hydroxide	Extremely corrosive materials with a variety of uses.	☐ Wear gloves and eye-splash protection while using acid dispensed from a small dropper bottle during water sampling. ☐ Wear a full-face, air-purifying respirator equipped with combination cartridges (organic vapor/acid gas) as well as Tyvek® coveralls and nitrile and/or nitrile butyl rubber (NBR) gloves for large volume applications. ☐ Have an eye wash bottle or portable eye wash station on-site. ☐ Cap all drums after dispensing chemicals. ☐ Do not add anything into a virgin chemical drum, including unused product. ☐ Avoid mixing strong acids and bases. Consult HSR for task-specific evaluation. If mixing is absolutely necessary, do it slowly. Avoid vapors or fumes that are generated. ☐ When diluting acids, add the acid to water in small quantities and mix cautiously. ☐ When diluting bases, add water to the base in small quantities and mix cautiously.
Activated Carbon	Granular adsorbent medium used to remove residual hydrocarbons from water and/or air.	☐ Use respiratory protection when activated carbon creates a dusty environment. ☐ Avoid using Activated Carbon Filter Beds for Ketone Solvents - an exothermic reaction can develop over time and result in possible explosion. ☐ Contact HSR for task-specific evaluation.

5.2 PPE

Based upon the hazards that may be encountered during site activities, PPE as follows was selected. Only PPE that meets the following American National Standards Institute (ANSI) standards are to be worn.

☐ Eye protection - ANSI Z87.1-1989
☐ Head protection - ANSI Z89.1-1986
☐ Foot protection - ANSI Z41-1991

Employees must maintain proficiency in the use and care of PPE that is to be worn. Typically this is covered during formal and informal refresher training sessions presented by Fluor Daniel GTI.

Level D is the minimum acceptable level of protection for this project site. Upgrade to Modified

Level D occurs when the possibility of contact to the skin or work uniform can occur from contaminated media. Upgrade to Level C will occur when results of air monitoring reveals action levels have been exceeded. Upgrade to Level B occurs when results of air monitoring reveals action levels have been exceeded, and site personnel meet training requirements. Wear hearing protection when in areas where high noise levels are generated.

Table 11. PPE

Level	Requirements
Level D	☐ Work uniform ☐ Steel-toed boots ☐ Approved safety glasses or goggles ☐ Hard hat ☐ Fluorescent vest, when vehicular traffic is on or adjacent to the site ☐ Nitrile gloves for water sampling handling
Modified Level D	**One or more of the following:** ☐ Chemical resistance (acid or solvent) boot covers ☐ PE-coated Tyvek® suit, NBR outer and nitrile inner gloves if skin contact with contaminants is possible. ☐ Hearing protection (muffs and/or plugs).
Level C	☐ Level D and Modified Level D ☐ Cooling vests and/or Thermal Protection ☐ NIOSH/MSHA-approved full-face respirator with organic vapor/acid gas high efficiency particulate air-purifying (HEPA) cartridges.
Level B	☐ Level D and Modified Level D ☐ Cooling vests or Thermal Protection ☐ NIOSH/MSHA approved full face positive pressure demand supplied air respirator, either airline or self contained.
Prior to use, all equipment must be inspected to ensure proper working condition.	

5.3 Site Control: Work Zones

Work zones will be established in order to:

- ☐ Delineate high-traffic locations,
- ☐ Identify hazardous locations, and
- ☐ Contain contamination within the smallest area possible.

Employees entering the work zone must wear the proper PPE for that area. Work and support zones will be established based on ambient air monitoring data, necessary security measures, and site-specific conditions. Work zones will be identified as either Hot Zone (HZ)/Exclusion Zone (EZ); Decontamination Zone (DZ)/Contamination Reduction Zone (CRZ); or Clean Zone (CZ)/Support Zone (SZ).

The following PPE requirements apply for Work Zones:

- HZs/EZs requires Level B or C PPE
- DZs/CRZs require Level D or C PPE
- SZs/CZs require Level D or Modified Level D PPE

Specific work zones for this project have been identified and shown on the site map in Appendix I.

Listed are general guidelines for delineation of work zones. CRZs will be developed for decontamination procedures listed in Section 4.5.

1. The HZ/EZ is identified to include a 10 foot radius around the Geoprobe which will be demarcated with cones, barricades and/or caution tape depending on location to employees, general public, and high traffic areas. When performing sampling of monitoring wells, soil gas or surface water, the immediate area surrounding the sampler should be considered to be potentially contaminated with organic vapors.

2. The DZ/CRZ will be a corridor leading from the HZ/EZ, demarcated at its boundaries with barricades, cones, and/or caution tape depending on location to employees, general public, and high traffic areas.

3. Support areas are the areas outside the HZ/EZ and DZ/CRZ in which soils or ambient air are not impacted by environmental contaminants from the site.

Table 12. Site Security and Work Zone Definition

WORKING IN STREET OR ROADWAY
☐ Wear traffic vest and hardhat when vehicle hazard exists.
☐ Use cones, flag-mounted cones, caution tape and/or barricades.
☐ Use vehicle strobe light and block area with truck.
☐ Develop traffic patternization plan for high traffic situations: • use flag person, • use flashing arrow sign, • use "MEN WORKING" signs liberally, • obtain lane closing permits, and • engage police details.
WORKING AT EXCAVATION/TRENCHING SITES
☐ "Competent person" is required per OSHA 29 CFR 1926 Subpart P.
☐ Safety guard open excavations by restricting unauthorized access.
☐ Highlight work area using prominent warning signs (cones, saw horses/barricades and signage) placed a minimum of 10' back from excavation opening.
☐ Maintain zone definition along perimeter with **continuous string** of yellow orange caution tape.
EXCAVATIONS LEFT UNATTENDED OR OVERNIGHT
Use one of the following methods to address these situations:
☐ Surround entire perimeter with plastic or cloth construction net fencing. Anchor fence to ground using steel posts driven into ground. Space out posts no greater than 8 feet apart. Fence height minimum 4-feet high. Fence material must be of a quality capable of withstanding a pressure of 200 pounds. Place fence a minimum of 10 feet back from excavation opening.
☐ Place 8-foot long barricades affixed with flashing lights end to end with 4-foot high construction net fence attached to barricades.
☐ Utilize temporary curbing or concrete "jersey" barriers affixed with flashing signal lights or other effective warning signs.

5.4 Decontamination Procedures

Operations conducted at this site have the potential to contaminate field equipment and PPE. To prevent the transfer of contamination to vehicles, administrative offices and personnel, the procedures presented in Table 13 must be followed. Specific decontamination requirements will be followed by utilizing the equipment for that purpose. Work uniforms and Level D PPE must not be brought to employee residences and left either on-site, at the office location, or in the company vehicle. Laundering of company uniforms must be by Fluor Daniel GTI approved laundering services and not done at employees residence.

Table 13. Decontamination Procedures

Item	Examples	Procedure
Field equipment	Bailers, interface probes, hand tools, drill augers, and miscellaneous sampling equipment	☐ Decontaminate with a solution of detergent and water; rinse with water prior to leaving the site. ☐ Protect from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.
Disposable PPE	Tyvek® suits, inner latex gloves, respirator cartridges	☐ Dispose of according to the requirements of the client and state and federal agencies. ☐ Change out respirator cartridges on a daily basis and dispose accordingly.
Nondisposable PPE	Respirators	☐ Wipe out respirator with disinfecting pad prior to donning. ☐ Decontaminate respirator on-site at the close of each day based upon extent of contamination. This procedure could include disassembling the respirator and cleaning, rinsing, sanitizing, and drying all parts with approved powders and solutions.
	Boots and gloves	☐ Decontaminate outside with a solution of detergent and water; rinse with water prior to leaving the site. ☐ Protect from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.

All water used in decontamination procedures should be stored in portable storage tanks until sufficient amount are stockpiled to facilitate disposal treatment. Disposable sampling and PPE will be place in plastic bags and temporarily stored in designated drums. These drums shall be disposed of according to regulatory guidelines, if necessary.

5.5 Example Decontamination Diagram

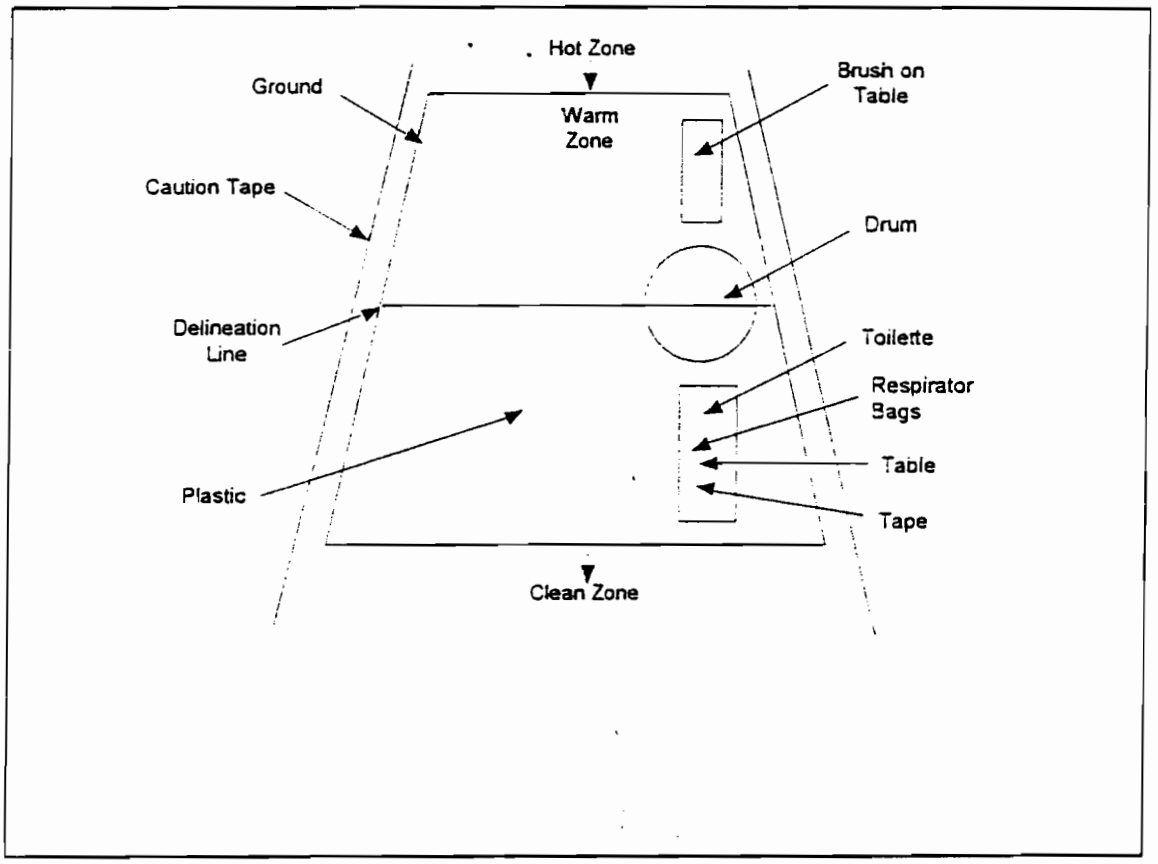
If Level C or Level B PPE is required, a CRZ will be constructed in a centralized common area with a travel path from the EZ demarcated with tall cones. The decontamination procedure for this project site is a two stage process.

STAGE 1

- ☐ Gross contamination removal with a brush.
- ☐ Remove outer boots and dispose in a drum.
- ☐ Remove Tyvek® suit and dispose in a drum.
- ☐ Remove outer gloves and dispose in a drum.
- ☐ Walk to Stage 2.

STAGE 2

- ☐ Remove respirator.
- ☐ Remove cartridge and dispose in a drum.
- ☐ Clean respirator and insert into a bag.
- ☐ Remove inner gloves and dispose.
- ☐ Wipe hands with a toilette and dispose.
- ☐ Walk out of decontamination area.



6.0 CONTINGENCY PLANS

Table 14 presents contingency plans for potential emergency situations. Ensure that the information in the contingency plans have been clearly communicated to all project personnel and those within the vicinity that may be affected, such as plant personnel and other contractors on site.

Table 14. Contingency Plans for Site Emergencies

Situation	Action
Evacuation	1. Immediately notify all on-site personnel of an emergency requiring evacuation. 2. Leave the dangerous area and report to a designated rally point. 3. Notify emergency medical service (EMS), as appropriate. 4. Account for all personnel. 5. Contact the PM and the HSR as soon as possible. 6. Maintain site security and control measures for community safety until emergency responders arrive.
Medical Emergency	1. Survey the situation: **Do not enter an area that may jeopardize your safety.** ☐ Establish the patient's level of consciousness. ☐ Call for help. ☐ Contact EMS and inform them of patient's condition. 2. Primary assessment (patient unconscious) ☐ Arousal ☐ Airway ☐ Breathing ☐ Circulation **Only trained personnel should perform CPR or First Aid - State you are medically trained** 3. Secondary assessment (patient conscious) ☐ Check for bleeding: Control with direct pressure. ☐ Do not move patient (unless location is not secure). ☐ Monitor vital signs. ☐ Provide First Aid to the level of your training. ☐ Contact the PM and HSR as soon as possible. ☐ Document the incident on Fluor Daniel GTI's PIR form.
Fire Emergency	1. **Evacuate the area.** 2. Notify the EMS. 3. Extinguish small fires with an all-purpose extinguisher. 4. Contact the PM and HSR. 5. Document the incident using the PIR form.

Situation	Action
Spill/ Release	Prevent problems by documenting the location of underground lines (e.g., product, sewer, telephone) before starting site work. If you drill through a line or tank or another leak occurs, document the spill/release in writing. Include dates, times, actions taken, agreements reached and names of people involved. In the event of a spill/release, follow this plan. 1. Wear appropriate PPE; stay upwind of the spill/release. 2. Turn off equipment and other sources of ignition. 3. Turn off pumps and shut valves to stop the flow/leak. 4. Plug the leak or collect drippings in a bucket, when possible. 5. Place sorbent pads to collect product, if possible. 6. Call Fire Department immediately if fire emergency develops. 7. Inform Fluor Daniel GTI PM about the situation. 8. Determine if the client wants to repair the damage of if the client will use an emergency repair contractor. 9. Based on agreements, contact emergency spill contractor for containment of free product. 10. Advise the client of spill discharge notification requirements and determine who will complete and submit forms. Do not submit or report to agencies without the client's consent. Document each interaction with the client and regulators and note, in writing; name, title authorizations, refusals, decisions, and commitments to actions. 11. Do not transport or approve transportation of contaminated soils or product until proper manifests have been completed and approve. Be aware that soils/product may meet criteria for hazardous waste. 12. Do not sign manifests as generator of wastes; contact the regional compliance manager to discuss waste transportation.
*Notifications - **a spill/release requires completion of a PIR and Class III notification.*** The PM must contact the client or generator. The generator is under obligation to report to the proper government agencies. If the spill extends into waterways, the Coast Guard and the National Response Center ([800] 424-8802) must be notified immediately by the client or with their permission. Evidence of petroleum or hazardous chemical releases must also be called into the NYSDEC immediately at 516-444-0354.	

6.1 Field Communications

Communications at the work site can be accomplished by verbal and/or non-verbal means to ensure contact with all Fluor Daniel GTI and subcontractors. Verbal communication can be impacted by the on-site background noise and while wearing respiratory protection. Table 15 lists the type of communication methods and equipment to use, depending on site conditions. Communication equipment must be checked daily to ensure proper operation and all project personnel must be initially briefed on the communication methods prior to starting work and reviewed in Daily Safety Tailgate Meetings as a reminder.

Table 15. Field Communication Methods

COMMUNICATION DEVICE	TYPE OF COMMUNICATIONS	SIGNAL
Telephone On-Site or Cellular Telephone	Emergency notification	Initiate phone call using applicable emergency numbers
Two-Way Radio	Emergency notification among site personnel	Initiate radio communication with Code Red message
Compressed Air Horn	Hailing site personnel for non-emergency	One long blast, one short blast
Compressed Air Horn	Hailing site personnel for emergency evacuation	Three long continuous blasts
Visual	Hailing site personnel for distress, need help	Arms waved in circle overhead
Visual	Hailing site personnel for emergency evacuation	Arms waved in criss-cross over head
Visual	Contaminated air/strong odor	Hands clutching throat
Visual	Break, lunch, end of day	Two hands together, break apart

7.0 MEDICAL MONITORING PROGRAM

Fluor Daniel GTI, under the oversight of the company's consulting physician, has developed a medical monitoring program to track the physical conditions of it's employees on a routine basis; starting with a baseline assessment, then periodic follow-up (annual or biennial) or specific project requirements based upon site contaminants or as assessment tool to aid in determining possible exposure.

7.1 Medical/Technical Advisors

Elayne Theriault, MD
Fluor Daniel GTI, CONSULTING PHYSICIAN (800) 229-3674 x 326

John Reinemann, CIH
Fluor Daniel GTI, Albany, NY (518) 783-1996

David Crowley, CSP, CET, CHMM
Fluor Daniel GTI, Norwood, MA (781) 769-7600

The specific duties of the medical/technical advisors include:

- recommending a suitable medical monitoring program for the site workers by the occupational health physician in conjunction with consultation of the above listed personnel,
- providing interpretation of medical monitoring requirements and technical guidance for developing project specific medical monitoring requirements, and
- advising worker exposure potential along with appropriate hazard reduction methods.

Table 16. Medical Monitoring Program

Module	Hst. Phys. W/Dipstick UA, Vision, Vital Signs	Spiro	Audio	EKG	Chest X-Ray	Bio Chem W/Diff	Shipping Fee	Substance Abuse Screen	Random Substance Abuse	Tetanus Diphtheria
BASELINE										
Regular	□	□	□	□	□	□	□	NL/BP		(10Y)
Regular/DOT	□	□	□	□	□	□	□	N/BP		(10Y)
ANNUAL/PERIODIC										
Regular	□	□	□	□	5Y	□	□	NL/BP	RT/RBP	(10Y)
Regular/DOT	□	□	□	□	5Y	□	□	N/BP	RT/RN/RB	(10Y)
BIENNIAL										
Regular	□	□	□	□	5Y	□	□	NL/BP	RT/RBP	(10Y)

□ >40 years of age or for medial indications (pre-approved by EMR)
X-ray film sent to EMR for International Labor Organization (ILO) reading
1Y - 5Y Yearly frequency
( ) If not done within
TP Fluor Daniel GTI ten panel drug screen
BP Breath pipe
N National Institution of Drug Abuse (NIDA) drug screen
NL NIDA-like drug screen
RT Random ten panel drug screen
RBP Random breath pipe
RB Random breathalyser

An EKG is required on a baseline exam. Thereafter, an EKG is performed annually for anyone over 40 years of age or for medical indications. A chest x-ray is required on a baseline exam, and then once every 5 years thereafter. A chest x-ray is also required upon termination (if it has been more than 1 year since the previous x-ray). Random drug screens and tetanus are variable components; therefore, they are not included in the total examination price. These variable components will only be billed at the time they are included in the exam.

Examination price is based on the utilization of the EMR medical facility network. Should Fluor Daniel GTI wish to choose the facilities at which some or all of the services are provided, it is agreed that Fluor Daniel GTI will pay any difference between these component prices and those charged by those facilities designated by the client. In the event an EMR medical facility increases fees substantially over those component prices, Fluor Daniel GTI has agreed to pay any reasonable difference or to change to an alternative EMR-qualified facility.

APPENDIX A

AGREEMENT AND ACKNOWLEDGEMENT FORM
HASP AMENDMENT SHEET
VISITOR/TRAINEE GUIDELINES
TRAINEE/OBSERVER AGREEMENT FORM

AGREEMENT AND ACKNOWLEDGEMENT SHEET

Fluor Daniel GTI personnel have the authority to stop field activities at this site if any activity is not performed in accordance with the requirements of the HASP. All Fluor Daniel GTI project personnel, subcontractor personnel, and visitors are required to sign the Agreement and Acknowledgement Sheet **prior** to conducting field activities at this site.

FLUOR DANIEL GTI
AGREEMENT AND ACKNOWLEDGEMENT STATEMENT

1. **I have read and fully understand the HASP and my responsibilities.**
2. **I agree to abide by the provisions of the HASP.**

Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date
Name	Signature
Company	Date

FLUOR DANIEL GTI, INC.

Project Name:

Project Number:

PM:

Location:

Changes in field activities or hazards:

Approved by:_____ _____
Project Manager Date

VISITOR/TRAINEE GUIDELINES

Fluor Daniel GTI is committed to providing a safe environment on all work sites for visitors, trainees, employees and/or passersby. In order to accomplish this, the following guidelines must be followed. **Infractions of the listed requirements agreement will be viewed as extremely serious and will be subject to discipline up to and including termination for either the trainee and/or supervisor.**

1. VISITORS

Any person not actively participating in the work at the site is regarded as a "visitor" and must follow Fluor Daniel GTI's visitor/trainee guidelines while on-site. Visitors must be accompanied by a representative at all times.

Visitors will attend and sign-off on a site orientation. The orientation will cover specific areas that visitors will not be allowed to access during certain work activity. Visitors are required to wear appropriate PPE on-site. Required PPE for visitors include:

closed toed shoes,
hard hat,
safety glasses with side shields, and
other as required by SHSO (i.e., gloves, hearing protection, Tyvek® suit, etc.)

2. TRAINEES

Trainees are employees of Fluor Daniel GTI who have not yet completed Fluor Daniel GTI's required safety training program. New hires and in-house company transfers will be considered trainees until safety training requirements are met.

Trainees will be informed of restrictions by their supervisor and must abide by them on-site.

Trainees will be permitted to visit Fluor Daniel GTI sites to obtain three days on the job (OJT) training as observers as long as the following conditions are met:

Trainees are supervised at all times while on-site.
Trainees do not perform work functions of any type while on-site unless under direct supervision.
Trainees do not handle any equipment, tools and/or supplies while on-site unless under direct supervision.
Trainees do not enter any hazardous or HZ or confined space areas while on-site unless under direct supervision.

Supervisors will be responsible for informing trainees of the above conditions and for ensuring that the conditions are met. Supervisors will also ensure that trainees will not be asked to violate the conditions listed above.

A Trainee/Observer Agreement Form must be signed by both the trainee and the supervisor and placed on file in the Regional Human Resources department.

TRAINEE/OBSERVER AGREEMENT FORM

The following section is to be filled out by trainee.

Agreement between:

_____ _____ and Fluor Daniel GTI.

Name (print/type) SS#

Because we have your safety in mind, you will be considered a trainee until all training criteria are met. This means you must complete all training requirements prior to performing work activities on-site.

Training requirements include:

Up to date medical clearance documentation, successful completion and documentation or 40-hour HAZWOPER.

Trainees also must attend an orientation of the HASP including specific training on hazards that there is a likelihood the worker would be exposed to.

Prior to a trainee becoming a worker, the trainee must successfully complete three days of OJT. This three day OJT must be performed under direct supervision of a qualified supervisor.

I agree to adhere to the above conditions in all instances while on-site as a trainee/observer.

_____ _____

Signature Date

This section is to be filled out by supervisor.
As supervisor to the above trainee, I agree to the above restrictions and agree not to request him/her to perform activities contrary to those restrictions.

_____ _____

Signature Date

APPENDIX B

PJR
INCIDENT REPORTING GUIDE

APPENDIX J

JSA

FLUOR DANIEL GTI
APPROACH TO
JSA

Fluor Daniel GTI follows along a traditional approach to worker health and safety by using job safety analysis (JSA) as a technique to identify hazards associated with certain job tasks. This technique is prepared in a fashion to meet requirements described job hazard analysis per the U.S. Army Corps. of Engineers (ACOE) Safety and Health and Requirements Manual EM-385-1-1 as well as other recognized groups like the National Safety Council (NSC).

The JSA library contains example sheets for potential hazards expected to be encountered while engaging in site specific tasks for this project. Additional JSA sheets can be added in the future as an amendment to the library to address any unexpected or unforeseeable hazards not yet identified, the Fluor Daniel GTI Health and Safety Policy and Procedure Manual or the described JSA's.

FLUOR DANIEL GTI

Job Safety Analysis Worksheet

INSTRUCTIONS

Record the operation/location for the job. Also record the person doing the JSA worksheet. A Job Safety Analysis (JSA) is a preventative tool that identifies the hazards and either eliminates or minimizes them before the job is performed. Use your JSA for hazard awareness and job clarification, during all aspects of training for new employees, and refresher training of experienced employees. The JSA can also be used as a tool for investigating accidents. JSA's should be performed on all existing and new jobs as well as those with a history of related disabling injuries or with an increased potential for causing disabling or fatal injuries. A JSA contains three parts: Job Steps, Job Hazards, and Safeguards/Precautions.

Job Steps	Job Hazards	Safeguards and Precautions
Jobs should be broken down into steps. A. Each step should accomplish some major task. B. Study the first procedure used to perform a task and determine the next logical step(s) to be taken. C. How does each action breakdown to form this task? D. Make sure all job steps are listed, even though some steps may not be done each time, they should still be listed and analyzed.	A. To complete a JSA effectively, the identification of all potential and existing hazards must be recorded. It is important to distinguish the difference between a hazard, an accident or an injury. B. Definitions: 1. **Hazard** - Is a potential danger. 2. **Accident** - Is an unexpected action that may result in an injury, loss or damage. 3. **Injury** - Is the result following an accident C. Identify **all hazards** associated with each step that could lead to an accident. 1. Examine each step in a way to find and identify: a. Hazards b. Safeguards or precautions c. Conditions & possibilities D. Don't overlook **obvious hazards**. a. Look at the entire environment. b. Locate any possible hazards that might exist. E. Make sure all **health hazards** are listed. (Including hazards that are not immediately harmful), i.e., exposure to chemical solvents, chemical dusts over a long period of time. F. List all **hazards** since they can lead to accidents, injuries and occupational illness.	A. By referring to the first two columns of this worksheet, determine what **safeguards** or **precautions** are desired to eliminate or reduce the hazards that could result in an accident, injury or occupational illness. B. Some desired safeguards that can be taken will include: a. Engineering the hazards out b. Personal protective equipment c. Job training d. Good ergonomic design (positioning the person in relationship to the machine or other elements in the environment. To reduce or eliminate stress or strain). C. List proposed safe operating procedures (S.O.P.'s)on this form along with the required or proposed personal protective equipment for each step of the job. D. Clearly state exactly what needs to be done to correct the hazards. Avoid general statements. E. State proposed **safeguards, precautions** or **procedures** for each hazard. F. If a specific hazard is a serious one, it should be corrected immediately. A JSA should be updated any time changes are made to the job.

FLUOR DANIEL GTI

JOB SAFETY ANALYSIS WORKSHEET

Operation/Location_____

Person Doing JSA_____ **Date**_____

Job Steps	Job Hazards	Safeguards and Precautions

Recently the Health and Safety Department has put a number of documents onto the Bulletin Board System (BBS) for everyone to have access to. The following are the bulletins that are currently available.

Rapid Response
Health and Safety Forms
Safety Alerts
JSA's

The bulletins above have many attachments that you can down load into your own files. Each bulletin has a cover page explaining what that specific bulletin is about. We encourage all employees to move up to the electronic age and explore the BBS!

Below are directions on how to access the BBS system and how to download files.

To enter the BBS system.

1. Log in to the network.

2. Either go to the directory containing the BBS programs (the Z:\ drive in this case) or set your DOS path to include that directory.

3. At the dos prompt type BBS and press enter. The main board for the bulletin board service appears. If does not appear, check with your system administrator.

4. Cursor to #13, Health and Safety. When it is highlighted, press ENTER.

5. Cursor to the bulletin that you want information on. When it is highlighted press ENTER.

6. A memo describing the bulletin will now be on your screen. After you have read through it press F10.

7. Cursor down to COPY ATTACHMENTS TO DOS FILES. When this is highlighted, press ENTER

8. Cursor to desired document and press ENTER

9. At DOS FILENAME, change the BBS directly to the directory that you want to copy the document into--MAKING SURE NOT TO DELETE THE FILE NAME ALREADY IN THE PATH. When you have completed the new path, press ENTER (Example: Z:\rrp.i is changed to A:\rrp.i)

10. The system will confirm that the file has been copied, bringing you back to the file list so you can repeat Step #9 until you have copied all desired documents.

LEAVING THE BBS

Leave the BBS by pressing the ESC key repeatedly. ESC closes the bulletin or board at which you are looking and returns to the previous board. From the main board, ESC leaves the BBS entirely.

You can also exit the BBS from anywhere by pressing CTRL-C (press C while pressing CTRL key).

JOB SAFETY ANALYSIS

DRILLING

JOB STEPS	JOB HAZARDS	SAFEGUARD & PRECAUTIONS
Drilling	Minor Injury/Cut from Sharp Objects	First Aid Kit
	Small Engine Fire	Fire Extinguisher on Site
	Drop Equipment on Foot	Steel Toe/Steel Shank Boots
	Frayed Wire Rope	Preventive Maintenance Check. Wire Rope Inspections (daily)
	Contaminated Soil/Flammables	No Smoking on Work Zone
	Adverse Weather Conditions: - lightening - high winds - driving rain	Monitor weather forecast. Shut down operations should severe weather conditions exist.
	Unstable placement; failure of stabilizing plates, jacks or out riggers rollover of drill rig	Choose level ground; Use adequate blocking materials; Engage emergency brake; When on wet or loose soil, consider guy wires to be attached to derrick for additional stability for rig.

JOB SAFETY ANALYSIS

DRILLING

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
Soil Boring/Drilling	1. Noise levels exceeding the OSHA PEL	1. earmuffs and/or ear plugs effectively reduce noise levels
	2. Fumes from drilling rig; vapors from suspect contaminants	2. a. review hazard information/MSDS for the contaminants suspected to be on-site and; b. perform required air monitoring; c. redirect exhaust fumes; if action levels are approached; d. reposition to upwind location. e. shut down drill rig if action levels are exceeded; f. no smoking in work zone.
	3. Overhead utilities	3. a. lower boom prior to moving drill rig; b. maintain 20' minimum distance; c. 10' distance if insulated or blanketed with cover or shroud. placed by utility firm representatives
	4. Underground pipelines and utility lines can be ruptured or damaged during active drilling operations	4. a. have a dig-safe search conducted; b. obtain as built plans or blueprints to identify underground utilities/obstacles; c. hand dig to 5' depth in questionable areas or suspect utilities.

JOB SAFETY ANALYSIS

DRILLING (continued)

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
Soil Borings/Drilling	5. Free or falling parts from the cat head may cause head injury	5. a. wear head protection; b. inspect wires, cables and ropes; c. do not raise/hoise objects or stack piping greater than 1 foot above the crown block heights.
	6. Moving parts such as augers on the rig may catch clothing	6. a. secure loose clothing; b. do not wear reflective vest; c. check "kill switch" daily; d. keep hands free from moving parts.
	7. High pressure hydraulic lines and air lines used on drill rigs are hazardous when they are in need of repair or improperly assembled.	7. All high pressure lines should have preventative maintenance check regularly
	8. Lack of rig stability, failure stabilizing plates (jacks or out riggers) or tilt from high winds -- tip over, roll over or collapse.	8. a. establish safe work zone; b. choose level ground; c. engage emergency brake.
	9. Unattended borehole, trip and fall hazard.	9. a. Cover or protect well head or borehole location to prevent equipment, personnel, visitors or animals from stepping or falling into the hole.

GROUNDWATER TECHNOLOGY, INC.

JOB SAFETY ANALYSIS WORKSHEET

Operation/Location: Storage of Non-hazardous waste (drill cuttings and well development water) drums generated from site assessment activities
Person Doing JSA: Drew Miller Date: 7/15/96

Job Steps	Job Hazards	Safeguards and Precautions
(1) Transportation of drum from work location to on-site storage location	(1) Physical injury	(1) Use appropriate PPE (company standard plus heavy gloves) (2) Identify location of drum storage area prior to transportation and make sure that there are no obstructions between work area and storage area (3) Make sure that drum lid is secured (4) Use proper lifting procedures and equipment, obtain additional personnel to assist, if necessary (5) If necessary, use additional personnel to control site traffic while drum is transported
(2) Drum Storage	(1) Physical Injury	(1) Make sure that drum is placed on flat, preferably hard, surface (2) Place drums so that there is at least three inches between the drum and the nearest object (wall, other drum, etc.) (3) If soil drums and well development drums are stored together, make sure that the water drums are accessible without having to move any soil drums.
	(2) Regulatory Compliance	(1) Make sure that drum is labeled according to Company and/or client protocols. Contact Project manager if instructed to label drums in a manner not consistent with the minimum company guidelines

C:\abmpm\h_&_s\drumjsa.tbl

JOB SAFETY ANALYSIS

GAUGE, BAIL & SAMPLE WELLS

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
Gauge,bail and sample water from monitoring wells	1. metal burr on well cap	1. wear NBR gloves
	2. toxic vapors	2. use PID/stay upwind
	3. explosive vapors	3. use LEL/ventilate
	4. static electricity	4. use grounding clip on IP
	5. muscle strain-back	5. proper posture crouch or squat, don't bend exercise and stretch use lumber support belt
	6. muscle strain-shoulder	6. use pump for large volume wells exercise and stretch, avoid over exertion, take breaks
	7. splashing liquid-eyes	7. wear PPE-splash goggles
	8. splashing liquid-skin	8. wear PPE-NBR gauntlet gloves
	9. contamination	9. proper zone set up, zone definition, etc.

JOB SAFETY ANALYSIS

BAIL FREE PRODUCT

TASK - JOB STEPS	JOB HAZARDS	CONTROL/SAFEGUARDS
Bail Free Product Liquid Phase Hydrocarbons (LPH)	1. toxic vapors	1. use PID/stay upwind
	2. explosive vapors	2. use LEL/ventilate
	3. static electricity	3. a. store bailed product in 5 gallon metal pail (DOT approved container) b. ground 5 gal. pail using bonding cable and grounding clip c. pour off into larger vessel (ie., 55 gallon drum) using bonding/grounding technique d. use dual action drum vent on 55 gallon drum when storing LPH for pressure relief valve purposes e. mark all container with pertinent warning signs and labels

JOB SAFETY ANALYSIS WORKSHEET

Operation/Location: UCC-RP Institute, WV

Person Doing JSA: J. Renemann Date: 10/6/98

JOB STEPS	JOB HAZARDS	SAFEGUARDS/PRECAUTIONS
Soil Boring	Noise levels exceeding the OSHa PEL of 90 dBA	Ear muffs and/or ear plugs effectively reduce noise levels
	Fumes from drill rig; vapors from suspect contaminants	Review the contaminants suspected to be on-site and perform required air monitoring. Shut down drill rig; re-direct exhaust fumes if action levels are exceeded; reposition to upwind location
	Overhead utilities	Lower boom prior to moving drill rig; Maintain 20' minimum distance; 10' distance if insulated or blanketed with cover or shroud
	Underground pipelines and utility lines can be ruptured or damaged during active drilling operations	Have a Dig-Safe search conducted; Obtain as-built plans or blueprints to identify underground utilities/obstacles; Hand dig to 5' depth in questionable area or suspect utilities
	Free or falling parts from the cat head may cause head injury	Near head protection; inspect wires, cables and ropes
	Moving parts such as augers on the rig may catch clothing	Secure loose clothing; do not wear reflective vest
	High pressure hydraulic lines and air lines used on drill rigs are hazardous when they are in need of repair or improperly assembled	All high pressure lines should have preventative maintenance check regularly

FLUOR DANIEL GTI

JOB SAFETY ANALYSIS WORKSHEET

Operation/Location Monitoring Well Installation

Person Doing JSA _____ Date _____

Job Steps	Job Hazards	Safeguards and Precautions
Job Set Up	Underground Utilities	Call digsafe before hand. Check markouts.
	Overhead Obstructions	Identify and avoid.
	Drill Rig Stabilization	Ensure that drill rig won't tip.
Drilling and Monitoring	Noise Levels	Appropriate ear protection. Alternate communication methods.
	Contaminant Exposure	Proper PPE and continuous monitoring. Upgrade if necessary. - - DECON Equipment
	Traffic	Define work area with cones and barriers
	Drill Rig - Moving Parts	Avoid loose clothing.
	Exhaust Fumes	Redirect fumes with hose.
	Carelessness	Safety meeting with drillers. Emergency plans, hospital directions. Slip, trip fall hazards - PPE gloves, glasses, hearing protection. No driving with mast up.

	Weather	Lightening - lower mast and shut down.
	Cuttings/Soil	Proper disposal. Monitor to determine. Properly label drums.
	Equipment Safety	Check all equipment (Inspection)
Drilling and Continuous Monitoring	Lifting	Sand, concrete, rods, drum handling. Back belts or engineering controls.
	Housekeeping	Keep area neat and clean.
	Inhalation Hazard	Concrete and sand.
	Communication - In Isolated Areas.	Have a phone on site or make nearest location known.
	Work Environment (Crime)	Don't work after dark. Stay in a group.
	Cumbersome Objects	Well screen/casing. Be aware of surroundings.

JOB SAFETY ANALYSIS

HAND AUGERING

JOB STEPS	JOB HAZARDS	SAFEGUARDS AND PRECAUTIONS
Hand Augering	1. Muscle Strain	1. a. Perform muscle/stretch exercises prior to initiating work. b. Use proper body mechanics, use firm footing and leverage, avoid awkward positions. c. Crouch/squat, bend at the knees. d. Wear grip gloves for firm dexterity while twisting hand auger.
	2. Toxic Vapors	2. a. Monitor air for a O_2/LEL and organic vapors, adhere to action levels in SSP, be alert and conscious of acute health affects of suspected contaminants. b. Contact the PM: - difficulty hand augering through soil strata; - upgrade to Level C (contact PM and H&S Rep.); - problems or emergency situation.

DTC8.HANDAUG.JSA

JOB SAFETY ANALYSIS

SITE SURVEY

JOB STEPS	JOB HAZARDS	SAFEGUARD AND PRECAUTIONS
Surveying	1. Slip, trip, fall.	1. Caution in moving around site, watch for uneven surfaces, holes, etc.
	2. Noise levels exceeding the OSHA PEL from adjacent field activities.	2. Earmuffs and/or ear plugs effectively reduce noise levels.
	3. Dust generated from adjacent field activities.	3. a. Monitor for ambient dust per SSP. b. Spray water mist as control. c. Upgrade to level C PPE as appropriate.

GSIH&S:SURVEY.JSA

JOB SAFETY ANALYSIS

METHANE HAZARD

JOB STEPS	JOB HAZARDS	SAFEGUARDS AND PRECAUTIONS
Intrusive Activities (drilling, excavating, trenching, digging, etc.)	1. Methane = Flammable Gas	1. a. Use O_2/LEL meter. b. Continuous monitoring. c. LEL readings < 10% = acceptable. d. LEL readings > 10% = evacuate.
	2. Employee Exposure to Methane Gas	2. If inhaled will cause dizziness, difficulty breathing and loss of consciousness. Move to fresh air, if breathing has stopped implement EMS.
	3. Asphyxiation by Methane	3. a. Asphyxiant by displacing oxygen. b. Monitor O_2 concentration continuously. c. O_2 readings 19.5 - 22% acceptable. d. O_2 readings <19.5% evacuate. e. O_2 readings >22% evacuate.

APPENDIX K

SITE MAPS

APPENDIX L

FLUOR DANIEL GTI FIELD INSPECTION FORM

GROUNDWATER TECHNOLOGY, INC.
OFFICE SAFETY CHECKLIST

Name:_____ Date:_____

Others:_____ Office:_____

PLEASE INDICATE ACCEPTABLE (A), UNACCEPTABLE (U), OR NOT APPLICABLE (NA)

HOUSEKEEPING		GENERAL	
Paper and waste properly disposed		Bulletin board neat and readable	
Waste baskets away from traffic area		Materials dated, changed frequently	
File drawers closed when not in use		OSHA poster prominently displayed	
Restrooms clean and sanitary		OSHA 200 log updated	
Elec. receptacles not overloaded		Safety awareness notices posted	
Elec. and phone cords away/secured		MSDS collection readily available	
Elec. outlet cover plates secured		Standing on chairs prohibited	

DOORS/EXITS/EGRESS		FIRST AID KITS	
Egress maps posted		Kit stored in prominent area	
Exits marked and clear for egress		MD approval letter enclosed in kit	
Emergency numbers at each phone		MD approved equipment available	
Fire extinguishers inspected annually		Stocked with latex gloves	
Fire extinguishers mounted on wall		Stocked with microshield	
Fire extinguishers marked with sign		Supplies replenished as needed	
Fire extinguishers easily accessible		Eyewash bottle station available	

FLOORS/AISLES/STAIRS		ACTION ITEMS/RESPONSIBILITY
Worn carpeting repaired		
Loose debris secured		
Floors slippery, oily or wet		
Aisles clear of obstructions		
Stairway well lighted		
Stairway has secure handrail		
Stairway clear and unblocked		

Copies to:_____ Signature:_____

GROUNDWATER TECHNOLOGY, INC.
WAREHOUSE SAFETY CHECKLIST

Name:_____ Date:_____

Others:_____ Office:_____

Please Indicate Acceptable (A), Unacceptable (U), or Not Applicable (NA)

GENERAL		CHEMICAL STORAGE	
Materials stored neatly, safely stacked		Transfer containers marked with labels	
Tools and equipment properly stored		Flammable liquids stored in safety cans	
Tools and equipment in safe working order (guards)		Flammables stored in approved containers	
"UNSAFE DO NOT USE" tags in stock		Compressed gas cylinders labeled\ secured	
Safety glasses worn when working		Hydrogen area marked with flammable sign	
Safety boots worn when working		Samples stored in designated refrigerator	
GFCI used with portable hand tools		Refrigerator marked "NO FOOD OR DRINK"	
Three prong extension cords used		Samples not handled by admin. staff	
Lockout/tagout used for maintenance		Spill kit for chemicals readily available	
Circuit breaker panel schedule completed		Splash goggles and gloves used with liquids	

DOORS/EXITS/EGRESS		FIRST AID KITS	
Egress maps posted		Kit stored in prominent area	
Exits marked and clear for egress		MD approval letter enclosed in kit	
Emergency numbers at each phone		MD approved equipment available	
Fire extinguishers inspected annually		Stocked with latex gloves	
Fire extinguishers mounted on wall		Stocked with microshield	
Fire extinguishers marked with sign		Supplies replenished as needed	
Fire extinguishers easily accessible		Eye wash bottle station available	

FLOORS/AISLES/STAIRS		VEHICLES	
Floors slippery, oily or wet		Tires have good tread	
No piling in traffic area		Windshield not broken or chipped	
Aisles clear of furniture and boxes		Fire Extinguisher available	
Stairway is well lit and has secure handrail		BBP\First Aid Kit/Eyewash available	
Stairway clear and unblocked		MSDS packet in truck	

EQUIPMENT			
Lifting equipment available (dollies)		Visitor equipment available	
Liftgates available (on trucks)		Ear Plugs available	
Reflective cones available (36" high)		Ear Muffs available	
Flags available for cones		LO/TO equipment available	
Traffic vests available		PPE bag inspected, stocked and clean	
Caution tape available		RPE cartridges available	
Drinking coolers available		PPE and RPE is properly stored in clean area	
Colormetric tube devices are available		GFCI's available	
Instruments (3 or 4 gas meters)		Safety glasses available	
Instruments are calibrated routinely		Splash goggles available	
MSDS inventory readily available		Faceshields available	

OTHER ITEMS			

COMMENTS/CORRECTIONS NEEDED

Copies to:_____ Signature:_____

GROUNDWATER TECHNOLOGY, INC.

HEALTH AND SAFETY SELF-AUDIT CHECKLIST

Name:_____ Date:_____ Site Location_____
Personnel on site:_____

PLEASE INDICATE AS ACCEPTABLE (A), UNACCEPTABLE (U), OR NOT APPLICABLE (NA)

A. PROTECTIVE EQUIPMENT

1. Hard hat ____
2. Safety glasses ____
3. Safety boots ____
4. Traffic vest ____
5. Respirator ____
6. Ear plugs/muffs ____

B. SITE SAFETY

1. SSP on site & available ____
2. SSP has map to hospital ____
3. Nearest phone identified ____
4. Tailgate meeting conducted ____
5. GFCI's used appropriately ____
6. Lockout/Tagout for elec. work ____

C. SITE CONTROL

1. Access to exclusion (hot) zone restricted & properly defined ____
2. Additional precautions taken in high traffic areas ____

D. VEHICLE INSPECTION

1. First aid kit ____
2. Fire extinguisher ____
3. MSDS package ____
4. Mirrors ____
5. Headlights/brakelights/signals ____
6. Housekeeping ____

E. AIR MONITORING

1. Vapor monitoring has been conducted per the SSP ____
2. Calibration and maintenance has been performed per mfg. ____
3. Confined space entry permit has been utilized as required ____

F. CONSTRUCTION SAFETY

1. Excavations >4' have ladders spaces every 25' ____
2. Excavations > 5' have been sloped or shored for entry ____
3. Soils have been stored back > 2' from the pit ____

COMMENTS/CORRECTIONS NEEDED:_____

_____

_____

_____cc: District Manager, Completed by:_____

_____
Project Manager

DTC5:CHECKLST.AUD

GROUNDWATER TECHNOLOGY, INC.

FIELD AUDIT REPORT

Performed By_____

Audit Date_____ Project Manager_____

Project Name_____ Project Number_____

Name	Site Activity
_____	_____
	_____
	_____
	_____
_____	_____
	_____
	_____
	_____
_____	_____
	_____
	_____
	_____
_____	_____
	_____
	_____
	_____

cc:

DC4:FIELDAUD.N91

GROUNDWATER TECHNOLOGY

GROUNDWATER TECHNOLOGY, INC.

Personal Protective Equipment

ITEM	YES	NO	N/A	YES	NO	N/A	YES	NO	N/A
Name									
Hard Hat									
Safety Glasses									
Safety Boots									
Traffic Vest									
Uniform or Coveralls									
Hearing Protection									

Site Safety Plan		**Yes**	**No**	**N/A**
1.	Site Specific SSP on site and available.	____	____	____
2.	All personnel on site have signed and acknowledged SSP.	____	____	____
3.	Site map is attached to SSP with hospital location indicated.	____	____	____

Vehicle Inspection

1.	Windshields free of "vision-impaired" cracks.	____	____	____
2.	Mirrors are in good working order.	____	____	____
3.	First Aid Kit is complete and available.	____	____	____
4.	Fire extinguisher is mounted in vehicle, ABC type 10 pound at a minimum.	____	____	____
5.	Vehicle MSDS Package in vehicle.	____	____	____
7.	Seat belt warning sign in vehicle.	____	____	____
8.	Eyewash available.	____	____	____

Respiratory Protective Equipment	Yes	No	N/A
1. Only GTI approved air purifying respirators are used.	____	____	____
2. Respirators are stored in a company provided safety equipment bag.	____	____	____
3. Supplies to clean respirators are available.	____	____	____
4. Respirators appear in good working condition.	____	____	____
5. GTI Facial Hair Policy is in force.	____	____	____
6. Personnel with corrective lenses have obtained a respirator spectacle kit.	____	____	____

Contamination Control			
1. Access to exclusion (hot) zone is restricted and clearly defined through the use of cone(s), caution tape or another similar barricade.	____	____	____
2. Good housekeeping enforced.	____	____	____

Toxic Vapor Monitoring			
1. Air monitoring for organic vapor concentrations has been conducted to assess worker protection and it is documented.	____	____	____
2. Instrumented calibration and maintenance is performed as recommended by the manufacturer and it is documented.	____	____	____
3. Organic vapor air monitoring instrument operating manual is readily available.	____	____	____
4. Confined space entry (CSE) permit is utilized as required.	____	____	____
5. Full body harness retrieval system (tripod) is utilized, for CSE work if appropriate.	____	____	____
6. The buddy system is in effect for CSE as required.			
7. Continuous air monitoring is performed for CSE.	____	____	____

Fire Prevention and Protection	Yes	No	N/A
1. Air monitoring for flammable concentrations has been conducted to assess worker protection and it is documented.	____	____	____
2. Instrument calibration and maintenance is performed as recommended by the manufacturer and it is documented.	____	____	____
3. Oxygen/combustible vapor air monitoring instrument operating manual is readily available.	____	____	____
4. Portable fire extinguishers are appropriate for the job, charged, deemed operable and have current annual inspection tag by a qualified licensed vendor.	____	____	____

Electrical Safety*

1. Electrical equipment is properly rated if used in hazardous areas.	____	____	____
2. Systems are properly grounded/bonded.	____	____	____
3. Extension cords have a 3 prong plug for grounding.	____	____	____
4. Extension cords and electrical cords are in good working condition.	____	____	____
5. A ground fault circuit interrupter (GFCI) is being used as required.	____	____	____
6. Lockout/Tagout is performed as required.	____	____	____

Comments/Notes:_____

_____

_____

_____

_____

_____

*consult with GTI Engineering for site specific evaluations.

Construction Safety	Yes	No	N/A
1. Excavation area has been sloped or shored at depths beyond 5 feet for personnel entry.	____	____	____
2. Excavation areas 4 feet or greater in depth have ladders spaced so there is no greater than 25 foot travel distance for egress.	____	____	____
3. Soils have been stored back greater than 2 feet from top of slope.	____	____	____
4. Forks or buckets are in the down position when equipment is not in use.	____	____	____
5. Construction vehicles and equipment display back alarms as required.	____	____	____
Ladder Safety			
1. Ladder rungs are sturdy and free of cracks or breaks.	____	____	____
2. Ladders have secure safety feet.	____	____	____
3. Ladders are pitched at a 4:1 ratio.	____	____	____
4. Ladders are secured at the top.	____	____	____
5. Ladders are not used for access to air stripper towers.	____	____	____
Chemical Safety			
1. All recovery vessels stored on a GTI site shall be marked with appropriate hazard warning label.	____	____	____
2. All sheds and/or temporary storage structures shall be marked with a 10 inch diamond placard indicating any hazardous contents contained within that structure.	____	____	____
3. Compressed gas cylinders are properly stored.	____	____	____
4. Incompatible chemicals are segregated.	____	____	____
5. MSDS' are available for all chemicals on site.	____	____	____
6. Manufacturers chemical containers and transfer containers are properly labeled.	____	____	____

APPENDIX M

DAILY TAILGATE SAFETY MEETING FORM

FLUOR DANIEL GTI
DAILY TAILGATE SAFETY MEETING

Project/Site:_____

Date:_____

Presented by:_____ Title:_____

Topic(s)/Information Reviewed:_____

_____

_____

_____

_____

Comments/Follow-up Actions:

_____

_____

_____

_____

Sign in:

NAME SIGNATURE COMPANY

_____

_____

_____

_____

_____

_____

Instructions:

Conduct a Daily Tailgate Safety Meeting prior to beginning each day's site activities.

Complete form and file with Site HASP.

Follow-up on any noted items and document resolution of any action items.

HEAT/COLD STRESS PROCEDURES

1.0 HEAT STRESS

Heat stress is a significant potential hazard associated with the work task performed and the type and degree of protective equipment used in hot weather environments. Local weather conditions may produce conditions which will require restricted work schedules in order to protect employees. Monitoring for heat stress will follow one of two protocols depending on whether impermeable clothing (tyvek, saranex, rain gear, etc.) or permeable clothing (cotton coveralls) is worn. This section will apply to both hazardous and non-hazardous waste workers at the site. The SHSO with direction from HSR will determine the environmental wet bulb globe temperature (WBGT) and physiological (heart rate [HR] and oral temperature [OR]) monitoring to be conducted for both types of workers.

1.1 Workers Wearing Permeable Clothing

The ACGIH have set TLVs for worker exposure to heat stress in which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. The TLVs assume that workers are acclimatized, fully clothed in permeable clothing with adequate water and salt intake, and capable of functioning effectively under the given working conditions without exceeding a deep body temperature (BT) of 100.4Fahrenheit (F). Measurement of the WBGT has been found to be the most adequately measurable environmental factor in which to correlate with the deep BT and other physiological responses to heat. The following table reviews the work/rest regimen to be followed by all permeably clothed workers based upon routinely measured WBGT.

Permissible Heat Exposure TLVs Applicable to Workers Wearing Permeable Clothing

Work/Rest Regimen	Workload		
	Light	Moderate	Heavy
Continuous work	86 (76)	80 (70)	77 (67)
75% work - 25% rest, each hour	87 (77)	82 (72)	78 (68)
50% work - 50% rest, each hour	89 (79)	85 (75)	82 (72)
25% work - 75% rest, each hour	90 (80)	88 (78)	86 (76)

Values are given in F WBGT.

Rest means minimal physical activity. Rest should be accomplished in the shade. Any activity requiring only minimal activity can be performed during rest period.

() Parentheses indicate the 10 degree adjustment for working in impermeable protective clothing.

1.2 Workers Wearing Impermeable Clothing

Workers who must wear impermeable clothing are held at a higher risk of suffering heat stress. Impermeable clothing impedes sweat evaporation, one of the body's major cooling mechanisms. It is the duty of each employer to alert or notify the SHSO if symptoms of heat stress occur to their respective site personnel. Physiological and environmental monitoring of personnel wearing an impermeable protective equipment ensemble will commence when the ambient temperature rises above 70F. Environmental monitoring will be conducted continuously for as long as the ambient temperature stays above 70F and physiological monitoring will be conducted immediately before and after each work period. Frequency of physiological monitoring will increase as the ambient temperature increases or if slow recovery rates are indicated. The break time must be sufficient to allow workers to recover from the effects of heat stress. This will be accomplished by measuring the recovery HR and OT. The break time duration will be determined using the following methodology and criteria:

Seat person being monitored,
Take OT, and
Measure pulse in the following sequence:

- Pulse #1: 30 seconds to 1 minute after sitting
- Pulse #2: 2½ to 3 minutes after sitting

An excessive heat stress condition exists when any of the following conditions exist:

1. Oral or ear temperature exceeds 99.5F
2. If pulse #2 is greater than 90 beats/minute
3. Pulse #1 is greater than 100 beats/minute

Worker cannot return to work until:

Oral or ear temperature is below 99.5F
Pulse rate is below 90 beats/minute
Recovery HR for workers with HRs over 90 beats per minute is less than 10 beats per minute less than the original HR

Adhering to the guidelines for heat stress prevention and monitoring will greatly minimize the possibility of the occurrence of heat stress. Site personnel must also be aware of the symptoms of heat-related disorders and be prepared to administer the appropriate treatments.

1.2.1 Prevention

A. Provide plenty of fluids. A 50 percent solution of fruit juice or similar solution in water, or plain water will be available. For workers performing work inside an EZ, fluid intake may occur in the CRZ. Workers must first perform a partial decontamination process which will include removal of gloves and washing of hands and face prior to consumption of fluids. The SHSO will monitor the partial decontamination and fluid consumption process to ensure that ingestion of site contaminants does not occur.
B. Work in pairs whenever conducting Level B activity or permit required CSE activity.

C. Provide cooling devices. Ice vests or on-site showers can be provided to reduce BT and/or cool protective clothing.

   The amount and type of undergarments worn will be left to the preference of each individual unless prone to heat stress, especially heat rash. In this case, the worker can wear "long john" cotton type underwear to keep skin off chemical resistant clothing.

D. Adjustment of the work schedule. When practicable, the most labor-intensive tasks should be carried out during the coolest part of the day.

E. Shaded or cooled rest areas. Shaded or cooled rest areas will be provided when site environmental and/or workers physiological responses warrant.

1.1.3 Heat Stress Monitoring

Physiological monitoring of personnel wearing an impermeable protective ensemble will be conducted at regular intervals at the beginning and conclusion of the work period. HR must be periodically measured for all site personnel when heat stress conditions (climate or wearing impermeable clothing). Additional physiological monitoring such as BT and body water temperature (BWT) monitoring can be measured for extreme temperatures and when impermeable clothing is worn.

A. HR must be measured by the radial pulse for 30 seconds as early as possible in the resting period and repeated approximately 3 minutes into rest period.

   The HR at the beginning of the rest period should not exceed 110 beats per minute. The HR also should not exceed 90 beats per minute after approximately 3 minutes of rest. If the HR does exceed the criteria, the next work period will be shortened by 33 percent, while the length of the rest period will remain the same. If the HR still exceeds the criteria at the beginning of the next rest period, the following work period will be shortened by 33 percent.

B. BT can be measured orally with a clinical or disposable thermometer, in accordance with manufacturer's instructions, as early as possible in the rest period (before drinking liquid). Oral or ear temperature at the beginning of the rest period should not exceed 99.5F. If it does, the next work period will be shortened by 33 percent while the length of the rest period will remain the same. However, if the OT exceeds 99.5F at the beginning of the next rest period, the following work period will be shortened by another 33 percent. A worker will not be permitted to wear a semi-permeable or impermeable protective ensemble when his/her BT exceed 99.5F.

C. Body water loss (BWL) due to perspiration can be measured by having the worker weigh him/her self at the beginning and end of each work day. Similar clothing should be worn at both weighing. BWL should not exceed 1.5 percent total body weight in a work day.

Suggested Frequency of Physiological Monitoring for Fit and Acclimated Workers[1]

Adjusted Temperature[2]	Normal Work Ensemble[3]	Impermeable Ensemble[4]
90F (32.2C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5-90F (30.8-32.2C)	After each 60 minutes of work	After each 30 minutes of work
82.5-87.5F (28.1-30.8C)	After each 90 minutes of work	After each 60 minutes of work
77.5-82.5F (25.3-28.1C)	After each 120 minutes of work	After each 90 minutes of work
72.5-77.5F (22.5-25.3C)	After each 150 minutes of work	After each 120 minutes of work

1 For work levels of 250 kilocalories per hour.
2 Calculate the adjusted air temperature (T_{adj}) using the following equation:
T_{adj} (F) = T_{adj} (F) + (13 x percent sunshine)
Measure the air temperature (T_{adj}) using a standard mercury-in-glass thermometer with the bulb shielded from radiant heat.
3 A normal work ensemble consists of cotton overalls with long sleeves and pants.
4 An impermeable work ensemble consists of impermeable coveralls with long sleeves and pants.

1.1.4 Recognition and Treatment

Any personnel who observes any of the following forms of heat stress either in themselves or in another worker, will report this information to his or her immediate supervisor or the SSHO.

A. Heat Rash (or prickly heat)

Cause: Continuous exposure to hot and humid air, aggravated by chafing clothing.

Symptoms: Eruption of red pimples around sweat ducts accompanied by intense itching and tingling.

Treatment: Remove sources of irritation and cool the skin with water or wet cloths.

B. Heat Cramps or Heat Prostration

Cause: Profuse perspiration accompanied by inadequate replenishment of body water and electrolytes.

Symptoms: Sudden development of pain and/or muscle spasms in the abdominal region.

Treatment: Remove the worker to the CRZ. Remove protective clothing. Decrease BT and allow a period of rest in a cool location.

C. Heat Exhaustion - **SERIOUS**

Cause: Overexertion in a hot environment and profuse perspiration accompanied by inadequate replenishment of body water and electrolytes.

Symptoms: Muscular weakness, staggering gait, nausea, dizziness, shallow breathing.

Treatment: Perform the following while simultaneously making arrangements for transport to a medical facility.

Remove the worker to the CRZ. Remove protective clothing. Lie the worker down on his or her back in a cool place, and raise the feet 6 to 12 inches. Keep warm, but loosen all clothing. If conscious, provide sips of a salt water solution consistency of one teaspoon salt in 12 ounces water. Transport the worker to a medical facility.

D. Heat Stroke - **EXTREMELY SERIOUS**

Cause: Same as heat exhaustion.

Symptoms: **No perspiration**, dry mouth, pain in the head, dizziness, nausea.

Treatment: Perform the following while making arrangements for transport to a medical facility.

Remove the worker to the CRZ. Remove protective clothing. Lie the worker down in a cool place and raise the head and shoulder slightly. **Cool without chilling**. Apply ice bags or cold wet cloth to the head. Sponge bare skin with cool water or rubbing alcohol. If possible, place the worker in a tub of cool water. Do not give stimulants. Transport to a medical facility.

HEAT STRESS MONITORING FORM

Project Name:_____

Project Number:_____

SHSO:_____

Date	Title	Ambient Temp	WBGT	Work/ Rest Regimen	Employee/ Location	Pulse Rate	Body Temp	Body Water Loss	Comments

2.0 COLD STRESS

If work on this project begins in the winter months, thermal injury due to cold exposure can become a problem for field personnel. Systemic cold exposure is referred to as hypothermia. Localized cold exposure is generally labeled frostbite.

A. Hypothermia: hypothermia is defined as a decrease in the patient core temperature below 96F. The BT is normally maintained by a combination of central (brain and spinal cord) and peripheral (skin and muscle) activity. Interferences with any of these mechanisms can result in hypothermia, even in the absence of what normally is considered a "cold" ambient temperature. Symptoms of hypothermia include: shivering, apathy, listlessness, sleepiness, and unconsciousness.

B. Frostbite: frostbite is both a general and medical term given to areas of local cold injury. Unlike systemic hypothermia, frostbite rarely occurs unless the ambient temperatures are less than freezing and usually less than 2F. Symptoms of frostbite are: a sudden blanching or whitening of the skin; the skin has a waxy or white appearance and is firm to the touch; tissues are cold, pale, and solid.

Prevention of cold related illness can be aided by educating workers on recognizing the symptoms of frostbite and hypothermia and by identifying and limiting known risk factors. The workers should be provided with enclosed, heated environments on or adjacent to the site, dry changes of clothing, and warm drinks.

To monitor the worker for cold related illnesses, start (oral) temperature recording at the job site:

At the field team leader's discretion when suspicion is based on changes in a worker's performance or mental status.
At a worker's request.
As screening measure, two times per shift, under unusually hazardous conditions (e.g., wind-chill less than 20F, or wind-chill less than 30F with precipitation).
As a screening measure whenever any one worker on the site develops hypothermia.

Workers developing moderate hypothermia (a core temperature of 92F) should not return to work for at least 48 hours.

Table 3. Progressive Clinical Symptoms of Hypothermia

Core Temperature (F)	Symptoms
99.6	Normal core body temperature
96.8	Metabolic rate increases
95.0	Maximum shivering
93.2	Victim conscious and responsive
91.4	Severe hypothermia
89.6 - 87.8	Consciousness clouded, blood pressure difficult to obtain, pupils dilated but react to light, shivering ceases
86.0 - 84.2	Progressive loss of consciousness, muscular rigidity increases, pulse and blood pressure difficult to get, respiratory rate decreases
78.8	Victim seldom conscious
64.4	Lowest accidental hypothermia victim to recover

In order to minimize the risk of the hazards of working in cold environments, workers will be trained and periodically reinforced in the recognition of the physiologic responses of the body to cold stress. In addition, the use of insulated work clothing, warm shelters and work/warming regimens may be used to minimize the potential hazards of cold stress. Also, special attention will be paid to equipment warm-up time and freeze protection for vessels, piping, equipment, tools, and walking/working surfaces. The current ACGIH TLVs for cold stress found in this appendix will be used as a guideline.