Utah
Underground Storage Tank (UST)
Remover
Recertification Guide

November 2008

INDEX

UST NOTIFICATION REQUIREMENTS

It is important to understand UST notification requirements to determine if an UST is regulated under the Utah UST Program. Of course, the DERR makes the final judgment to determine if an UST is regulated. UST removers should have a general understanding of which USTs are regulated. Owners and operators of non-regulated are not required to follow UST rules and regulations.

Regulated USTs include: (See 40 CFR 280.12 Definitions: "Underground storage tank")

- tank and connected piping that has at least 10% of its volume underground; and
- stores petroleum or certain hazardous substances. Ethylene Glycol (antifreeze) is a hazardous substance. A release from a hazardous substance UST must also be reported to RCRA and cleaned up according to RCRA standards.

Non-regulated USTs include (See 40 CFR 280.10 & 280.12)

- non-commercial farm or residential tanks of 1,100 gallons or less
- heating oil tanks for use on the premise
- tanks holding 110 gallons or less
- flow-through process tanks

Review federal regulations: 40 CFR 280

Subpart A 280.10 - 280.12 Program Scope ...
Subpart B 280.22, Notification requirements

Regulated USTs which are not registered, are not in compliance with UST rules are subject to penalties. **See: Utah UST Act 19-6-408.** When an UST remover submits a closure plan for a non-registered UST, the DERR will notify the UST owner or operator concerning registration and back fees.

Contents:

EPA Notification Form (7530- **1**)

EPA

United States
Environmental Protection Agency
Washington, DC 20460

Form Approved.
OMB No.2050-0068

Notification for Underground Storage Tanks

State Agency Name and Address:
UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY
DIVISION OF ENVIRONMENTAL RESPONSE AND REMEDIATION
168 NORTH 1950 WEST
SALT LAKE CITY, UTAH 84116

STATE USE ONLY

ID NUMBER:

DATE RECEIVED:

DATE ENTERED INTO COMPUTER:

DATA ENTRY CLERK INITIALS:

OWNER WAS CONTACTED TO CLARIFY RESPONSES, COMMENTS:

TYPE OF NOTIFICATION

☐ A. NEW FACILITY ☐ B. AMENDED ☐ C. CLOSURE

_____ Number of tanks at facility

_____ Number of continuation sheets attached

INSTRUCTIONS AND GENERAL INFORMATION

Please type or print in ink. Also, be sure you have signatures in ink for sections VIII and XI. Complete a notification form for each location containing underground storage tanks. If more than 5 tanks are owned at this location, you may photocopy pages 3 through 5 and use them for additional tanks.

The primary purpose of this notification program is to locate and evaluate underground storage tank systems (USTs) that store or have stored petroleum or hazardous substances. The information you provide will be based on reasonably available records, or in the absence of such records, your knowledge or recollection.

Federal law requires UST owners to use this notification form for all USTs storing regulated substances that are brought into use after May 8, 1986, or USTs in the ground as of May 8, 1986 that have stored regulated substances at any time since January 1, 1974. The information requested is required by Section 9002 of the Resource Conservation and Recovery Act (RCRA), as amended.

Who Must Notify? Section 9002 of RCRA, as amended, requires owners of USTs that store regulated substances (unless exempted) to notify designated State or local agencies of the existence of their USTs. "Owner" is defined as:

- In the case of an UST in use on November 8, 1984, or brought into use after that date, any person who owns an UST used for storage, use, or dispensing of regulated substances; or
- In the case of an UST in use before November 8, 1984, but no longer in use on that date, any person who owned the UST immediately before its discontinuation.

Also, if the State so requires, any facility that has made any changes to facility information or UST system status, must submit a notification form (only amended information needs to be included).

What USTs Are Included? An UST system is defined as any one or combination of tanks that (1) is used to contain an accumulation of regulated substances, and (2) whose volume (including connected underground piping) is 10% or more beneath the ground. Regulated USTs store petroleum or hazardous substances (see the following "What Substances Are Covered").

What Tanks Are Excluded From Notification?

- Tanks removed from the ground before May 8, 1986;
- Farm or residential tanks of 1,100 gallons or less capacity storing motor fuel for noncommercial purposes;
- Tanks storing heating oil for use on the premises where stored;
- Septic tanks;
- Pipeline facilities (including gathering lines) regulated under the Natural Gas Pipeline Safety Act of 1968, or the Hazardous Liquid Pipeline Safety Act of 1979, or which is an intrastate pipeline facility regulated under State laws;
- Surface impoundments, pits, ponds, or lagoons;
- Storm water or waste water collection systems;
- Flow-through process tanks;
- Liquid traps or associated gathering lines directly related to oil or gas production and gathering operations;
- Tanks on or above the floor of underground areas, such as basements or tunnels;
- Tanks with a capacity of 110 gallons or less.

What Substances Are Covered? The notification requirements apply to USTs containing petroleum or certain hazardous substances. Petroleum includes gasoline, used oil, diesel fuel, crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute). Hazardous substances are those found in Section 101 (14) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), with the exception of those substances regulated as hazardous waste under Subtitle C of RCRA.

Where To Notify? Send completed forms to:

STATE OF UTAH DIVISION OF ENVIRONMENTAL RESPONSE
168 NORTH 1950 WEST
PO BOX 144840
SALT LAKE CITY, UTAH 84114-4840

When To Notify? 1. Owners of USTs in use or that have been taken out of operation after January 1, 1974, but still in the ground, must notify by May 8, 1986. 2. Owners who bring USTs into use after May 8, 1986, must notify within 30 days of bringing the UST into use. 3. If the State requires notification of any amendments to facility, send information to State agency immediately.

Penalties: Any owner who knowingly fails to notify or submits false information shall be subject to a civil penalty not to exceed $11,000 for each tank for which notification is not given or for which false information is given.

I. OWNERSHIP OF UST(s)

Owner Name (Corporation, Individual, Public Agency, or Other Entity)

Street Address

County

City	State	Zip Code

Phone Number (Include Area Code)

II. LOCATION OF UST(s)

If required by State, give the geographic location of USTs by degrees, minutes, and seconds. Example: Latitude 42° 36' 12" N, Longitude 85° 24' 17" W

Latitude _______________ **Longitude** _______________

Facility Name or Company Site Identifier, as applicable

☐ If address is the same as in Section I, check the box and proceed to section III.
If address is different, enter address below:
Street Address

County

City	State	Zip Code

EPA Form 7530-1 (Rev. 11-98) Electronic and paper versions acceptable.
Previous editions may be used while supplies last.

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Environmental Protection Agency
Washington, DC 20460

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Notification for Underground Storage Tanks

III. TYPE OF OWNER

☐ Federal Government
☐ State Government
☐ Local Government
☐ Commercial
☐ Private

IV. INDIAN COUNTRY

USTs are located on land within an Indian Reservation or on trust lands outside reservation boundaries. ☐

USTs are owned by a Native American nation or tribe. ☐

Tribe or Nation where USTs are located:

V. TYPE OF FACILITY

☐ Gas Station
☐ Petroleum Distributor
☐ Air Taxi (Airline)
☐ Aircraft Owner
☐ Auto Dealership
☐ Railroad
☐ Federal - Non-Military
☐ Federal - Military
☐ Industrial
☐ Contractor
☐ Trucking/Transport
☐ Utilities
☐ Residential
☐ Farm
☐ Other (Explain) ______________________

VI. CONTACT PERSON IN CHARGE OF TANKS

Name:	Job Title:	Address:	Phone Number (Include Area Code):

VII. FINANCIAL RESPONSIBILITY

☐ I have met the financial responsibility requirements (in accordance with 40 CFR Subpart H) by using the following mechanisms:

Check All that Apply

☐ Self Insurance
☐ Commercial Insurance
☐ Risk Retention Group
☐ Local Government Financial Test
☐ Guarantee
☐ Surety Bond
☐ Letter of Credit
☐ Bond Rating Test
☐ State Funds
☐ Trust Fund
☐ Other Method (describe here)
____

VIII. CERTIFICATION (Read and sign after completing ALL SECTIONS of this notification form)

I certify under penalty of law that I have personally examined and am familiar with the information submitted in Sections I through XI of this notification form and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete.

Name and official title of owner or owner's authorized representative (Print)	Signature	Date Signed

Paperwork Reduction Act Notice

EPA estimates public reporting burden for this form to average 30 minutes per response including time for reviewing instructions, gathering and maintaining the data needed and completing and reviewing the form. Send comments regarding this burden estimate to Director, OP, Regulatory Information Division (2137), U.S. Environmental Protection Agency, 401 M Street, Washington D.C. 20460, marked "Attention Desk Officer for EPA." This form amends the previous notification form as printed in 40 CFR Part 280, Appendix I. Previous editions of this notification form may be used while supplies last.

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Environmental Protection Agency
Washington, DC 20460

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Notification for Underground Storage Tanks

IX. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for all tanks and piping at this location.)

Tank Identification Number	Tank No. ______	Tank No. ______	Tank No. ______	Tank No. ______	Tank No. ______
1. **Status of Tank** (check only one) Currently In Use	☐	☐	☐	☐	☐
Temporarily Closed	☐	☐	☐	☐	☐
Permanently Closed	☐	☐	☐	☐	☐
2. **Date of Installation** (month/year)					
3. **Estimated Total Capacity** (gallons)					
4. **Material of Construction** (check all that apply)					
Asphalt Coated or Bare Steel	☐	☐	☐	☐	☐
Cathodically Protected Steel	☐	☐	☐	☐	☐
Coated and Cathodically Protected Steel	☐	☐	☐	☐	☐
Composite (Steel Clad with Fiberglass)	☐	☐	☐	☐	☐
Fiberglass Reinforced Plastic	☐	☐	☐	☐	☐
Lined Interior	☐	☐	☐	☐	☐
Excavation Liner	☐	☐	☐	☐	☐
Double Walled	☐	☐	☐	☐	☐
Polyethylene Tank Jacket	☐	☐	☐	☐	☐
Concrete	☐	☐	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
If Other, please specify here	______ ______	______ ______	______ ______	______ ______	______ ______
Check box if tank has ever been repaired	☐	☐	☐	☐	☐
5. **Piping Material (check all that apply)** Bare Steel	☐	☐	☐	☐	☐
Galvanized Steel	☐	☐	☐	☐	☐
Fiberglass Reinforced Plastic	☐	☐	☐	☐	☐
Copper	☐	☐	☐	☐	☐
Cathodically Protected	☐	☐	☐	☐	☐
Double Walled	☐	☐	☐	☐	☐
Secondary Containment	☐	☐	☐	☐	☐
Unknown	☐	☐	☐	☐	☐
Other, please specify	______ ______	______ ______	______ ______	______ ______	______ ______
6. **Piping Type** "Safe" Suction (no valve at tank)	☐	☐	☐	☐	☐
(Check all that apply) "U.S." Suction (valve at tank)	☐	☐	☐	☐	☐
Pressure	☐	☐	☐	☐	☐
Gravity Feed	☐	☐	☐	☐	☐
Check box if piping has ever been repaired	☐	☐	☐	☐	☐

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Tank Identification Number	Tank No. ______	Tank No. ______	Tank No. ______	Tank No. ______	Tank No. ______
7. Substance Currently Stored (or last stored in the case of closed tanks) (Check all that apply) Gasoline	☐	☐	☐	☐	☐
Diesel	☐	☐	☐	☐	☐
Gasohol	☐	☐	☐	☐	☐
Kerosene	☐	☐	☐	☐	☐
Heating Oil	☐	☐	☐	☐	☐
Used Oil	☐	☐	☐	☐	☐
If Other, please specify here					
Hazardous Substance	☐	☐	☐	☐	☐
CERCLA name and/or CAS number					
Mixture of Substances	☐	☐	☐	☐	☐
Please specify here					

8. Release Detection *(check all that apply)*	TANK	PIPE	TANK	PIPE	TANK	PIPE	TANK	PIPE	TANK	PIPE
Manual tank gauging	☐		☐		☐		☐		☐	
Tank tightness testing	☐		☐		☐		☐		☐	
Inventory Control	☐		☐		☐		☐		☐	
Automatic tank gauging	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Vapor monitoring	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Groundwater monitoring	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Interstitial monitoring	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Automatic line leak detectors		☐		☐		☐		☐		☐
Line tightness testing		☐		☐		☐		☐		☐
No release detection required (such as some types of suction piping, emergency generator tanks or field constructed tanks)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other method allowed by implementing agency (such as SIR)	☐		☐		☐		☐		☐	
Please specify other method here										

9. Spill and Overfill Protection					
Overfill device installed	☐	☐	☐	☐	☐
Spill device installed	☐	☐	☐	☐	☐

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Notification for Underground Storage Tanks

Tank Identification Number	Tank No. ____	Tank No. ____	Tank No. ____	Tank No. ____	Tank No. ____

X. CLOSURE OR CHANGE IN SERVICE

1. **Closure or Change in Service**					
Estimated date the UST was last used for storing regulated substances (month/day/year)	____	____	____	____	____
Check box if this is a change in service	☐	☐	☐	☐	☐
2. **Tank Closure**					
Estimated date tank closed (month/day/year)	____	____	____	____	____
(check all that apply below)					
Tank was removed from ground	☐	☐	☐	☐	☐
Tank was closed in ground	☐	☐	☐	☐	☐
Tank filled with inert material	☐	☐	☐	☐	☐
Describe the inert fill material here	____	____	____	____	____
3. **Site Assessment**					
Check box if the site assessment was completed	☐	☐	☐	☐	☐
Check box if evidence of a leak was detected	☐	☐	☐	☐	☐

XI. CERTIFICATION OF INSTALLATION (COMPLETE FOR UST SYSTEMS INSTALLED AFTER DECEMBER 22, 1988)

Installer Of Tank And Piping Must Check All That Apply:

Installer certified by tank and piping manufacturers	☐	☐	☐	☐	☐
Installer certified or licensed by the implementing agency	☐	☐	☐	☐	☐
Installation inspected by a registered engineer	☐	☐	☐	☐	☐
Installation inspected and approved by implementing agency	☐	☐	☐	☐	☐
Manufacturer's installation checklists have been completed	☐	☐	☐	☐	☐
Another method allowed by State agency If so, please specify here	☐ ____	☐ ____	☐ ____	☐ ____	☐ ____

Signature of UST Installer Certifying Proper Installation of UST System

Name ____________________
Signature ____________________
Date ____________________
Position ____________________
Company ____________________

UST Permanent Closure

Certified UST Removers MUST know *every detail* of the Utah UST closure process.

Review: R311.204 Underground Storage Tanks: Closure and Remediation
Review: 40 CFR 280.70 Subpart G: Out-of-Service UST Systems and Closure

Review: UST Closure Letter and attached Closure Plan
Review: UST Closure Notice

UST Removers should have a basic understanding of samples taken at UST closure. **See: R311-205 Site Assessment Protocol.** Individuals taking samples at UST closures must be Utah certified Soil and Groundwater Samplers.

Note Closure of any portion of the tank system (tank, piping, dispensers) requires submittal, and approval of a Closure Plan. Environmental soil samples must be taken to determine the presence/absence of contamination.

Temporary Closure

Some tank owners/operators may want to close their tanks temporarily rather than permanently or convert their tanks to store an unregulated substance. UST Removers should know the requirements concerning temporary closure and change in service.

Maintaining Closure Records

UST regulations require owners/operators to maintain closure records for a minimum of 3 years after completion of permanent closure or change-in -service.

DERR recommends that the records of all closure-related activities, including site maps and photographs revealing the location of the tanks and piping, analytical results, sample collection sites, written reports on the site assessment, etc., be maintained indefinitely.

Contents:

Closure Plan Requirements

R311-204, Utah Administrative Code (U.A.C.), requires Underground Storage Tank (UST) owners/operators to submit a Closure Plan outlining the details of the UST closure to the Executive Secretary (UST), Utah Solid and Hazardous Waste Control Board.

1. The Owner(s)/Operator(s) (O/O) must submit to the Division of Environmental Response and Remediation (DERR) a completed "CLOSURE PLAN" which must be approved before commencing closure of the UST. A contractor may complete the closure plan, however the O/O is responsible for compliance with the UST rules and regulations.

2. For closure in-place or change in service, the Closure Plan must now be submitted and approved prior to completing the site assessment.

3. The approved Closure Plan is valid for one year from the approval date. If closure does not take place within one year the O/O must submit a new Closure Plan for approval.

4. The O/O must notify the Local Health and Fire Departments **and the DERR/UST** at least 72 hours prior to starting closure activities.

5. The certified UST remover and sampler performing the closure must have a current Utah certification and follow the approved Closure Plan. **Changes to an approved plan must be submitted in writing to the Executive Secretary and approved before closure.**

6. The O/O must have a copy of the approved Closure Plan on-site during closure activities.

7. The O/O must ensure the completion of a site assessment in accordance with 40CFR 280.72 and R311-205, U.A.C.. Indicate the proposed sample locations on the Facility Site Plat of the Closure Plan and complete the Sample Information Table. If contamination is encountered or suspected at locations other than the approved sample locations, additional samples must be collected at the location(s) where contamination is most likely to be present. If groundwater is encountered a soil sample must be collected, in the unsaturated zone, in addition to each groundwater sample.

8. The O/O must report suspected or confirmed contamination (any amount) to the Executive Secretary by reporting to the DERR/**Leaking Underground Storage Tanks (LUST) section** at (801)536-4100 within 24 hours of discovery.

9. The O/O must submit to the DERR a Closure Notice within 90 days after the tank closure. The Closure Notice should include:

a. A properly completed Closure Notice form signed by the owner and certified groundwater and soil sampler.

b. An updated Site Plat and a Sample Information Table with actual depths and locations of all samples, including depth of ground water.

c. Analytical results of samples

d. A Chain of Custody Form

10. The O/O must pay Registration and PST Fund fees for the assessment period in which the tank is closed and all other unpaid fees.

11. If contamination is suspected or confirmed during UST closure activities, or is based on analytical results, the O/O may receive a reporting and remediation schedule from the DERR/LUST section, outlining their obligation to characterize and possibly remediate the release. **Any person providing remedial assistance for a fee, including over-excavation (of more than 50 yd^3) and aeration, must be a Certified UST Consultant** (a list is available from the DERR). Expenses to be applied toward the Petroleum Storage Tank (PST) Fund deductible must meet the same test of reasonable, customary and legitimate as expenses submitted for reimbursement. For expenses above the $10,000 deductible to be eligible for reimbursement from the PST Fund, all work plans and budgets must be approved the State Project Manager before any work begins

Refer questions concerning the Closure Plan approval process to the DERR/UST section at (801) 536-4100.

Send the completed Closure Plan to:
State of Utah Department of Environmental Quality
Division of Environmental Response and Remediation UST Section
P.O. Box 144840
168 North 1950 West
Salt Lake City, Utah 84114-4840

UNDERGROUND STORAGE TANK CLOSURE PLAN **(rev. 1/05)** **FACILITY ID#** ________________

LHD USE ONLY
Date Received
Reviewer
Date LHD Approved
Date mailed to State

STATE USE ONLY
Date Received
Date Mailed to LHD
Date Received From LHD
Reviewer/Date Approved
Mgr. Review/Date

Closure Plan prepared at the request of the owner/operator (identified below) by			
of (company name)		Phone #	
Address	City	State	Zip

A Contractor may prepare this Closure Plan as the owner/operator's agent. In preparing the Closure Plan, the Contractor must act with the owner/operator's knowledge and approval. The owner/operator must sign the Closure Plan.

This Closure Plan is submitted in compliance with the requirements contained in 40 CFR 280 Subpart G and R311-204 (U.A.C.)

FACILITY INFORMATION

Tank Owner		Phone #	
☐ sole proprietorship	☐ partnership	☐ corporation	
Address	City	State	Zip
Facility Name			
Address	City	State	Zip
Contact person		Phone #	
Total number of regulated underground tanks at this site			
Total number of regulated underground tanks at this site to be closed			

Tank #						
Type (Steel,FRP,etc.)						
Date Installed						
Capacity						
Substance stored*						
Date last operated						
Removed/In Place/ Change in Service (CIS)?						

*Indicate the specific substance stored in each tank to be closed (regular, unleaded, diesel, waste oil, etc.)

For waste oil tanks: Have degreasing or other types of solvents been stored or mixed with the waste oil?

Yes (identify if known) ______________________________ No ☐ Not Known ☐

Analysis for lead or other contaminants may be required prior to disposal of contaminated soil or other material. (Check with your disposal facility.)

TANK REMOVER Name		Cert. # TR	Exp. Date
Company		Phone #	
Address	City	State	Zip
SOIL/GROUNDWATER SAMPLER Name		Cert. # GS	Exp. Date
Company		Phone #	
Address	City	State	Zip

Before the closure plan is submitted for approval, the local health and fire departments where the facility is located must be contacted. *If the facility is in Beaver, Carbon, Davis, Emery, Garfield, Grand, Iron, Kane, Salt Lake, San Juan, Wasatch, or Washington county contact DERR (UST) at (801)536-4100 instead of the local health district. <u>You still must contact the local fire department in these counties</u>.*

CONTACT LOCAL HEALTH DISTRICT: Name of Dist.			Date
Contact	Title	Phone#	
CONTACT LOCAL FIRE DEPT. Name of Dept.			Date
Contact	Title	Phone#	
DISPOSAL INFORMATION			
Tank(s) will be disposed at: Facility			
Address	City	State	Zip
Contact person		Phone#	
Product lines will either be: ☐ removed or ☐ cleaned, secured in place, and capped.			
Vent lines will either be: ☐ removed or ☐ cleaned and secured open.			
Piping will be disposed at: Facility			
Address	City	State	Zip
Contact person		Phone#	
Tank(s) will be **emptied** by: company		Phone#	
Tank(s) will be **cleaned** by: company		Phone#	
Contaminated water in the tank/rinsate will be disposed at: Facility			
Contact person		Phone#	
Tank(s) will be: ☐ purged or ☐ rendered inert by the following method:			
Residual sludges will be disposed at the following facility:			
Address	City	State	Zip
Contact person		Phone#	

FOR CLOSURE IN PLACE ONLY			
☐ Approval for in-place closure has been granted by the Local Fire Department.			
Fire Dept.	Phone#	Contact person	Date
☐ Approval for in-place closure has been granted by the Local Health Department.			
Health Dept.	Phone#	Contact person	Date
Substance to be used to fill tanks:			

SITE ASSESSMENT

A site assessment must be performed for all UST closures and change-in-service. Site assessments must be performed as outlined in 40 CFR 280.72 and R311-205 (U.A.C.). If contamination is suspected, additional samples must be collected at the location where contamination is most likely to be present. If groundwater is encountered, a soil sample must be collected, in the unsaturated zone, in addition to each groundwater sample. Soil and groundwater samples must be analyzed for the compounds shown in the following table, using appropriate lab methods.

Substance or Product Type	**Contaminant Compounds to be Analyzed for Each Substance or Product Type**	**ANALYTICAL METHODS[1]**
		Soil, Groundwater or Surface Water
Gasoline	Total Petroleum Hydrocarbons (<u>purgeable</u> TPH as gasoline range organics C_6 - C_{10})	EPA 8015B <u>or</u> EPA 8260B
	Benzene, Toluene, Ethyl benzene, Xylenes, Naphthalene, (BTEXN) and MTBE	EPA 8021B <u>or</u> EPA 8260B
Diesel	Total Petroleum Hydrocarbons (<u>extractable</u> TPH as diesel range organics $C_{10} – C_{28}$)	EPA 8015B
	Benzene, Toluene, Ethyl benzene, Xylenes, and Naphthalene (BTEXN)	EPA 8021B <u>or</u> EPA 8260B
Used Oil	Oil and Grease (O&G) or Total Recoverable Petroleum Hydrocarbons (TRPH)	EPA 1664A <u>or</u> EPA 1664A (SGT*)
	Benzene, Toluene, Ethyl benzene, Xylenes, Naphthalene (BTEXN) & MTBE; <u>and</u> Halogenated Volatile Organic Compounds (VOX)	EPA 8021B <u>or</u> EPA 8260B
New Oil	Oil and Grease (O&G) or Total Recoverable Petroleum Hydrocarbons (TRPH)	EPA 1664A <u>or</u> EPA 1664A (SGT*)
Other	Type of analyses will be based upon the substance or product stored, and as approved by the Executive Secretary (UST)	Method will be based upon the substance or product type
Unknown	Total Petroleum Hydrocarbons (<u>purgeable</u> TPH as gasoline range organics C_6 - C_{10})	EPA 8015B <u>or</u> EPA 8260B
	Total Petroleum Hydrocarbons (<u>extractable</u> TPH as diesel range organics $C_{10} – C_{28}$)	EPA 8015B
	Oil and Grease (O&G) or Total Recoverable Petroleum Hydrocarbons (TRPH)	EPA 1664A <u>or</u> EPA 1664A (SGT*)
	Benzene, Toluene, Ethyl benzene, Xylenes, and Naphthalene (BTEXN) and MTBE; <u>and</u> Halogenated Volatile Organic Compounds (VOX)	EPA 8021B <u>or</u> EPA 8260B

[1] The following modifications to these certified methods are considered acceptable by the Executive Secretary (UST):

- Dual column confirmation may not be required for TPH and BTEXN/MTBE analysis.
- A micro-extraction or scale-down technique may be used for aqueous samples, but <u>only</u> for the determination of extractable TPH as diesel range organics ($C_{10} – C_{28}$).
- Hexane may be used as an extraction solvent.
- *Silica Gel Treatment (SGT) may be used in the determination of Total Recoverable Petroleum Hydrocarbons.

NOTE: The sample preparation method and any modification(s) to a certified method must be reported by the laboratory.

CONTAMINATED MATERIALS MUST BE DISPOSED AT AN ACCEPTABLE FACILITY:

All materials generated from UST closures must be managed and disposed in a manner that does not place those materials in direct contact with the environment. On-site stockpiling of contaminated soils may be required prior to any soil management activities. *Any person providing remedial assistance for a fee, including aeration and over-excavation (of more than 50 yd^3), must be a Certified UST Consultant.*

Contaminated soils generated as part of tank removal are to be disposed at the following facility:

Address | City | State | Zip

Contact person | Phone

Complete the Facility Site Plat and Sample Information Table on pages 4 and 5 to provide site assessment information.

CONTAMINATION INFORMATION

If contamination at the facility is suspected or confirmed, the information must be reported to the Executive Secretary (UST) at (801) 536-4100 within 24 hours. The Division of Water Quality must be notified at (801) 538-6146 if Free Product is encountered or if surface water has been impacted. If contamination is confirmed, any person assisting in the remediation process for a fee must be a Certified UST Consultant.

SAMPLE INFORMATION TABLE

Complete table for all samples to be taken for closure.

Sample #	Substance stored in tank	Sample type[1]	Depth[2]	Compounds[3]	Analysis method(s)[4]

[1] Soil (SS), Groundwater (GW), or Unified Soil Classification (USC).
[2] Approx. depth in feet below grade. The required minimum site assessment samples must be taken at 0-2 feet below the backfill/native soil interface.
[3] Contaminant compounds to be analyzed for each sample (from table on p. 3).
[4] Appropriate analysis methods for contaminant compound(s) in each sample (from table on p. 3).

Facility Site Plat (Closure Plan)

The site plat must be drawn to an appropriate identified scale. It must show planned sampling locations, substances stored in tanks, and other relevant information. Tank and sample identification numbers must be consistent with the information given on p. 1 and 4 of the Closure Plan.

North
⇧

Scale: 1"= ___ Feet

Facility ID:	Drawn By:	Date:

X = Sample locations (SS-#, WS-#, USC-#)
θ = Monitoring Wells (MW-#,)
▬ = Soil boring (SB-#), or Geoprobe Boring (GP-#)
▪ = Water Wells (domestic, livestock, etc.)
Slope of Surface Topography: (N,NW,W,SW,S,SE,E,NE)
Land Use At Site: _Residential _Commercial _Industrial
Surrounding Land: _Residential _Commercial _Industrial

Site Plat Must Indicate Approximate Locations Of:

Y Current & former tanks, piping & dispensers
Y Location of all samples to be taken
Y Buildings, fences, & property boundaries
Y Utility conduits (sewers, gas, water, storm drains, electrical, etc.)

Approximate depth to groundwater in the vicinity of the tanks: feet.			
Regional groundwater flow direction:			
State Certified Laboratory to be used:			
Address	City	State	Zip
Contact Person		Phone	

Please explain any unusual or extenuating circumstances expected regarding the site assessment or closure:

I certify under penalty of law that I am the owner/operator of the tank(s) referenced above and that I am familiar with the information on this form and that it is true, accurate and complete, and further, that the procedures described herein will be followed during tank closure.

Signature of tank owner	
Full Name of tank owner	Date

UNDERGROUND STORAGE TANK PERMANENT CLOSURE NOTICE (rev. 3/4/03) **FACILITY ID#** ____________

State Use Only	
Date Processed	by
Date Mailed to LHD	
LUST ID#	
Date to LUST Review	

Closure Notice prepared at the request of the owner/operator (identified below) by			
of (company name)		Phone #	
Address	City	State	Zip

FACILITY INFORMATION

Tank Owner			Phone #
☐ sole proprietorship	☐ partnership	☐ corporation	
Address	City	State	Zip
Facility Name			
Address	City	State	Zip
Contact person			Phone #
Total number of regulated underground tanks at this site before closure			
Total number of regulated underground tanks at this site after closure			

TANKS CLOSED

Tank #						
Type (Steel,FRP,etc.)						
Date Installed						
Capacity (Gallons)						
Substance stored*						
Date last operated						
Date Closed						
Removed/In Place/ Change in Service (CIS)?						

*Indicate the specific substance stored in each tank to be closed (regular, unleaded, diesel, waste oil, etc.)

TANK REMOVER Name		Cert. # TR	Exp. Date
Company		Phone #	
Address	City	State	Zip
SOIL/GROUNDWATER SAMPLER Name		Cert. # GS	Exp. Date
Company		Phone #	
Address	City	State	Zip

CLOSURE INFORMATION

Fuel was emptied ☐	Sludge was removed ☐	Tank was cleaned ☐	
Tank was:	Purged ☐	Inerted ☐	Method Used:
Location of Closure Records:			
For In-Place Closure: tanks filled with:			
For Change-In-Service: Substance to be stored:			

DISPOSAL SITES USED

	Location Name	Contact Name	Phone #	Date	Amount
Tank(s)					Tank #
Product From Tank(s)					
Contaminated Water From Tank Cleaning					
Sludge					
Contaminated Water From Excavation					
Contaminated Soil					

SITE ASSESSMENT

Complete the Facility Site Plat (Closure Notice) and Sample Information Table (Closure Notice) on pages 3 and 4 to show the locations, depths, and other information on all soil/groundwater samples taken for closure. The samples must be consistently identified by sample ID # on the site plat, table, and lab analysis report.

☐ Completed Facility Site Plat (Closure Notice) is attached.

The following **must** be included (enter the distance, and direction (N,S,E,W) from the area of contamination or, where applicable, use OH for overhead, NP for not present):

_____Water Line _____Sewer Line _____Natural Gas _____Storm Drain _____Telephone _____Electrical _____Property Line _____ Buildings

☐ Completed Sample Information Table (Closure Notice) is attached.
☐ Certified lab analytical environmental sample results are attached.
☐ Unified Soil Classification (USC) sample results are attached.
☐ Chain of Custody form is attached.
Samples were properly: ☐ Collected ☐ Labeled ☐ Packaged ☐ Transported
☐ Samples were in sight of the person in custody at all times or in a secured locked place.

I certify under penalty of law that the closure site assessment at this facility was conducted in accordance with R311-202 (parts 280.52 and 280.72) and R311-205 U.A.C., and that any additional samples required by R311-202 parts 280.52 and 280.72 and R311-205-2(a)(1) were properly collected.

Signature of Certified Groundwater/Soil Sampler	
Full name of Certified Sampler	Date

If contamination at the facility is confirmed, any person providing remedial assistance for a fee must be a Certified UST Consultant. The Certified UST Consultant providing assistance is:

CERTIFIED UST CONSULTANT

Name		Cert. #CC	Exp. Date
Company	Address		
City	State	Zip	Phone #

Please explain any unusual or extenuating circumstances expected regarding the site assessment or closure:

Facility Site Plat (Closure Notice)

The site plat must be drawn to an appropriate identified scale. It must show planned sampling locations, substances stored in tanks, and other relevant information. Tank and sample identification numbers must be consistent with the information given on p. 1 and 4 of the Closure Notice.

North ⇧

Scale: 1"= ___ Feet

Facility ID:	Drawn By:	Date:

X = Sample locations (SS-#, WS-#, USC-#)
= Monitoring Wells (MW-#,)
= Soil boring (SB-#), or Geoprobe Boring (GP-#)
● = Water Wells (domestic, livestock, etc.)
Slope of Surface Topography: (N,NW,W,SW,S,SE,E,NE)
Land Use At Site: _Residential _Commercial _Industrial
Surrounding Land: _Residential _Commercial _Industrial

Site Plat Must Indicate Actual Locations Of:
√ Current & former tanks, piping & dispensers
√ Location of all samples to be taken
√ Buildings, fences, & property boundaries
√ Utility conduits (sewers, gas, water, storm drains, electrical, etc.)
√ Depth to groundwater (if encountered)
√ Excavations, GW monitoring wells & soil stockpiles

SAMPLE INFORMATION TABLE (Closure Notice)

Complete table for all samples that were taken for closure. Sample ID numbers on the table must be consistent with the sample ID numbers given on the site plat and in the lab analysis report.

Sample #	Substance stored in tank	Sample type[1]	Depth[2]	Compounds[3]	Analysis method(s)[4]

[1] Soil (SS), Groundwater (GW), or Unified Soil Classification (USC).
[2] Final depth (in feet) below grade at which samples were taken.
[3] Contaminant compound(s) analyzed for each sample (TPH, BTEXN, O&G, etc).
[4] Appropriate analysis methods for contaminant compound(s) in each sample

State Certified Laboratory used			
Address	City	State	Zip
Contact Person	Phone #		

I certify under penalty of law that I am the Owner of the tank(s) described above and that I am familiar with the information on this form and that it is true, accurate and complete and further, that the procedures described herein were followed during tank closure.

Signature of UST owner	
Full Name of owner	Date

Return completed Closure Notice form, Facility Site Plat and Sample Information Table, Soil/Groundwater sample lab analysis results, USC sample results, and Chain of Custody form within 90 days of UST Closure to:

State of Utah Dept. of Environmental Quality
Division of Environmental Response and Remediation / UST Section
P.O. Box 144840
168 North 1950 West
Salt Lake City, Utah 84114-4840

UTAH UST PROGRAM
TEMPORARY CLOSURE NOTICE (REVISED 12/05)

FACILITY ID# ____________

State Use Only	
Date Received	
Date Processed	by

Temporary Closure Notice prepared at the request of the owner/operator (identified below) by			
of (company name)		Phone #	
Address	City	State	Zip

OWNER AND FACILITY INFORMATION

Tank Owner		Phone #	
Address	City	State	Zip
Facility Name			
Address	City	State	Zip
Contact person		Phone #	
Number of regulated USTs at this facility:	Number of regulated USTs to be temporarily closed:		

TANKS TEMPORARILY CLOSED

Tank #						
Type (Steel,FRP,etc.)						
Date Installed						
Capacity (Gallons)						
Substance stored*						
Date last operated						
Inches of Product remaining in tank (to the nearest 1/8 inch)						

* Indicate the specific substance stored in each tank to be closed (regular, unleaded, diesel, waste oil, etc.)

☐ Vent lines open and functioning
☐ Fuel was emptied to less than 1"
☐ Product lines capped/secured
☐ Corrosion protection is operating
☐ Pumps, manways secured
☐ Release detection equipment is operating

Temporary closure requirements:

When an UST system is temporarily closed, the owner/operator must:

- continue operation and maintenance of corrosion protection on tanks, lines, flex connectors, and other metallic system components.
- continue operation and maintenance of release detection **OR** empty the UST system to **less than 1 inch** of product.

When an UST system is temporarily closed for 3 months or more, the owner/operator must also:

- leave vent lines open and functioning
- cap and secure all other lines, pumps, manways, and ancillary equipment
- send a properly-completed Temporary Closure Notice form to the DERR/UST Section.

I certify under penalty of law that I am the Owner of the tank(s) described above and that I am familiar with the information on this form and that it is true, accurate and complete and further, that the procedures described herein were followed during tank closure.

Full Name of UST Owner: ____________________

Signature of UST Owner: ____________________ Date: __________

Return completed Temporary Closure Notice form to:

State of Utah Dept. of Environmental Quality
Division of Environmental Response and Remediation / UST Section
PO Box 144840
168 North 1950 West
Salt Lake City, Utah 84114-4840

Utah Petroleum Storage Tank Fund

Tank owners/operators are not longer required to participate in the PST Fund. However, they must demonstrate that they meet the required financial responsibility through participating in the PST Fund or providing an alternate mechanism: private insurance, self insurance, etc.

It is important to remember that all tank closure activities are ineligible for reimbursement under the PST Fund.

Contents:
Utah's Petroleum Storage Tank Fund Guidebook, 1999

Utah's Petroleum Storage Tank Fund Guidebook

Of the several million underground storage tanks containing petroleum products nationally, tens of thousands have leaked and many more are expected to leak in the future. The Division of Environmental Response and Remediation (DERR) has investigated more than 3,800 cases of petroleum contamination from tanks in Utah.

The Underground Storage Tank Program works to assure that tanks are safely managed. Besides the dangers of fire or explosion, leaking underground storage tanks (LUSTs) can contaminate soil and groundwater. Groundwater accounts for 96% of Utah's drinking water sources. Toxic and explosive petroleum vapors can also get into utility conduits, homes, schools and workplaces. LUSTs are a serious problem that need proper attention to protect our limited natural resources. The Federal Environmental Protection Agency and the State of Utah require that owners/operators of USTs cleanup petroleum leaks and releases when they occur.

The costs of stopping, investigating and cleaning up the damage caused by a petroleum leak or release can be enormous. Several site cleanups in Utah have approached $1,000,000. Federal law requires all tank owners/operators to have the financial ability to pay for investigation, cleanup and other costs associated with damages caused by a petroleum leak or release. The amount of financial assurance varies depending upon the type of business operated, but the law applies to all owners/operators of regulated systems. In response, Utah's Legislature passed the Underground Storage Tank (UST) Act. Utah's law also created the Petroleum Storage Tank Trust Fund (PST Fund). Owners and operators do not have to use the PST Fund to demonstrate financial assurance. See the section below on alternate financial assurance mechanisms.

The PST Fund functions similarly to insurance with the owner/operator having a "deductible." The first $10,000 or $25,000 in eligible costs must be met by the owner/operator (the larger figure is for releases which occurred and were reported prior to July 1, 1994, the smaller for releases after that date). The fund will then cover eligible costs up to a set limit of either $500,000 or $1,000,000 (minus the deductible), depending upon the type of business - petroleum non-marketer or marketer.

Levels Of Coverage Required

The law requires all petroleum marketers to have financial assurance or coverage of $1 million per occurrence. Multiple occurrences or aggregate coverage is the same amount if the marketer has fewer than 100 tanks, and $2 million if more than 100 tanks. Marketers are those selling, producing or refining petroleum products.

Non-marketers with monthly petroleum usage of less than 10,000 gallons must have $500,000 coverage per occurrence. Multiple occurrences or aggregate coverage is $1 million if the non-marketer has fewer than 100 tanks, $2 million if more than 100 tanks. Non-marketers with monthly usage in excess of 10,000 gallons must have the same coverage as a marketer. Non-marketers are those who own or operate USTs, but do not sell, produce or refine petroleum products.

Alternate Financial Assurance Mechanisms

Owners/operators are not required to participate in the PST Fund. However, they must demonstrate that they meet the required financial responsibility through an alternate mechanism as specified by Federal law. The most commonly used mechanisms are private insurance and self insurance based on net worth. The existence and adequacy of one or a combination of these alternate mechanisms must be reported to the state yearly.

How The PST Fund Is Funded

The initial PST Fund tank fee charged the year the tank is installed is $250. Renewal each subsequent year is $50 per tank if the entire facility's petroleum throughput is less than 400,000 gallons per year, or $150 per tank if the throughput exceeds that amount. The PST Fund receives its money from these annual assessments applied to participating USTs and an environmental assurance fee of one quarter cent per gallon on petroleum delivered to these tanks.

Certificate Of Compliance

A UST may not be used until it is issued a Certificate of Compliance by the Division of Environmental Response and Remediation who ensures that it meets both state and federal rules and regulations. To obtain a Certificate of Compliance, owners/operators must register their USTs and pay an annual tank fee.

How To Join the PST Fund

- Obtain a Certificate of Compliance.
- Conduct a complete system tightness test on each underground storage tank.
- Describe any previous pollution incidents at the facility.
- Obtain independent financial assurance to cover the deductible amount.
- Fill out and submit the "PETROLEUM STORAGE TANK FUND APPLICATION."
- Pay the annual PST Fund fee.
- In order to rejoin the PST Fund after voluntarily withdrawing or lapsing for non-payment of fees, environmental sampling must be conducted to determine existing levels of contamination, if any.

Accessing the PST Fund

To access funds, the following eligibility requirements must be met:

- The leak or release must have occurred during a period for which the tank was covered by the PST Fund, and;
- A claim must be filed during the period when the tank was covered by the PST Fund, or;
- Within one year after the PST Fund covered tank was closed, or;
- Within six months after the end of the period during which the tank was covered by the PST Fund.

HOW TO APPLY

There are four steps which must be completed prior to receiving the approval to access the PST Fund:

- Report a known or suspected release to the DERR.

- Submit a PST Fund “ELIGIBILITY APPLICATION.”
- Keep all receipts and canceled checks for work done at the site.
- A “Work Plan and Budget” must be submitted to the DERR for review and approval prior to initiating any work above the deductible amount.
- Submit claims for reimbursement on a “SUMMARY VOUCHER” and attach all supporting documents.

Report the Leak or Release

When a petroleum leak or release is reported to the DERR, it will be assigned a LUST Release Site designation (four letters) and a project manager. The project manager will be available to assist in completing the approval process and accessing monies needed to complete the site investigation and cleanup.

PST Fund Eligibility Application

The PST Fund “ELIGIBILITY APPLICATION” is a one page form which organizes information about the facility, tank and what type of petroleum leak or release is known or suspected. Once the form has been submitted a notification of eligibility status will be issued to the owner/operator.

Documentation of Expenses

Owner/Operators must document what has been spent to meet the deductible amount ($10,000 or $25,000) and all additional expenses for which reimbursement is requested. This documentation should consist of a summary voucher; itemized expenses for labor, services, materials, equipment purchases and rentals, utilities and other expenses; backup invoices for all expenditures including outside services; proof of payment (canceled checks or lien waivers); and proof that all expenses were eligible, reasonable, customary and legitimate. Things to consider when obtaining a contractor or outside services include getting three competitive bids, providing “sole source” justification or other justification such as previous work successfully completed under similar conditions.

If a Pay for Performance agreement is entered into by the owner/operator, the consultant and the DERR, submission of this expense documentation is not necessary. For more information contact your project manager or the PST Fund section manager.

Work Plan and Budget

Work plans are usually submitted in stages as the investigation proceeds and more data is obtained. A good work plan includes the scope and objectives of the proposed work, a description of the work to be completed broken down by task, any technical details which may apply, and a schedule or time frame for performing each task. An estimated budget which corresponds to the work plan must also be submitted to the DERR for approval. The budget should be itemized by task and include bids for any outside services or subcontractors. A work plan and budget is necessary as the DERR must approve any work (after the standard deductible has been met) at the site before the work is performed. Following this process will help ensure reimbursement from the PST Fund.

Starting The Work

After receiving approval to access the PST Fund, an owner/operator may continue with the project. When the approved work plan and associated work has been completed, the owner/operator will have claims to submit to the DERR for reimbursement. Claims for reimbursement should be submitted regularly in the same format as the original submission for documenting proof of meeting the deductible. It is recommended that the first claim combine the expenses to meet the deductible with ongoing reimbursable costs.

ELIGIBLE COSTS - WHAT THE PST FUND WILL PAY FOR

- Abatement - Actions taken to limit, reduce or eliminate a petroleum leak or release, or the damage caused by the leak or release from a UST.
- Investigation - Activities to determine the degree and extent of contamination. This includes soil borings, groundwater monitoring wells, test pits or excavations, environmental sampling, researching past site history, etc.
- Monitoring - Costs include well installation, sample collection, analytical laboratory costs, report writing and other associated costs.
- Site Assessments - Those costs necessary to obtain specific information including localized groundwater flow direction, native soil types, area water well information, migration pathways (such as utility conduits, surface water, etc.), potentially affected populations, current land use (i.e., residential, commercial or industrial), etc.
- Alternative Drinking Water - Supplies that are needed for the people affected by a LUST site.
- Corrective Action - Activities which include cleanup or removal of the release source, containment or isolation of the release, treatment of the release, monitoring and maintenance of the site impacted by the release, reasonable and legitimate costs of repairing surface damage arising from the release and other associated costs.
- Risk-Based Corrective Action - Investigation and analysis necessary to determine the potential risks presented by a release and the appropriate site specific cleanup levels to adequately protect human health and the environment.
- Third Party Damage Claims and Settlements - As recommended by the State Risk Manager and approved by the Executive Secretary or determined by legal proceedings.
- Any other costs determined by the Executive Secretary on a site specific basis.

INELIGIBLE COSTS - WHAT THE PST FUND WILL NOT PAY FOR

Common ineligible costs include expenses to achieve compliance, upgrading systems and tank removals.

Ineligible Expenses To Achieve Compliance Include:

- Tank registration fees.
- Tank PST Fund fees.
- Leak detection equipment.
- UST system tightness testing.
- UST system repairs.

Ineligible Expenses For System Upgrades Include:

- Overfill protection.
- Spill containment basin.
- Corrosion protection.
- New tanks and associated supplies, equipment and services.

Other Ineligible Expenses Include:

- UST system removal - including all expenses related to UST closure activities.
- Landscaping to improve the site beyond the previously existing condition.
- Asphalt, concrete, gravel or other surfacing materials placed to improve the site beyond the previously existing condition.
- Percentage markups on subcontractors, outside services, equipment or materials.
- Loss of business.
- Legal fees.
- Interest.
- Standard office expenses.
- Other costs as determined by the Executive Secretary.

Last Things Last

As an owner/operator follows through on a project and completes the approved work, contact with the state project manager must be maintained. The project manager should be consulted on any changes to the approved work plans or budgets needed to close the site as quickly and as cost effectively as possible. The project manager should also be notified if any emergency work is required. Following completion of the investigation or cleanup project, a close-out letter from the DERR may be requested which explains that "no further action" is required at the site.

NOTE: The Eligibility Application and Summary Voucher along with other tank program information is available on the Internet at www.eq.state.ut.us/eqerr/errhmpg.htm.

Environmental Contamination; Reporting a Release

Any contamination found during closure activities must be reported to DERR by both the owner/operator AND the certified tank remover within 24 hours.

Review: R311-201-6(f) Standards of Performance

Any individual who provides consulting service relating to the management, abatement, investigation, corrective action or evaluation of a release for a fee must be a Utah certified UST consultant.

Review: R311-204-5 Remediation

A Utah certified UST Remover can, at the time of tank removal, remove up to 50 cubic yards of contaminated soil and properly dispose of. This is in addition to the amount of soil that is removed in the normal course of tank removal. Any remediation or additional over-excavation must be done under the supervision of a certified UST consultant.

Hazardous Substances & Wastes

Several hundred substances were designated as "hazardous" in Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

The UST regulations apply to the same hazardous substances identified by CERCLA, except for those listed as hazardous wastes. These hazardous wastes are already regulated under Subtitle C of the Resource Conservation and Recovery Act and are not covered by the UST regulations. (See 40 CFR Parts 260-270 for the hazardous waste regulations.) Information on the CERCLA hazardous substances is available from EPA through the RCRA/CERCLA Hotline at 800 424-9346.

UST Removers should understand the Toxicity Characteristic Rule and which "petroleum-contaminated media and debris" are deferred under Subtitle C of RCRA.

Review: A Toxicity Characteristic Rule Cheat Sheet, and Toxicity Characteristic Rule (Regulatory Review)

Contents:

Information Requested When Reporting A Release From Underground Storage Tank(s) (UST)

Some of the information may not be known, this is common. The person taking the phone call at the Division of Environmental Response and Remediation (DERR) will assist you with any questions you have. DERR (801) 536-4100.

INFORMATION NEEDED AS COMPLETE AS POSSIBLE

- Facility ID (7 digit numbers that **may** begin with a zero used to identify facilities with UST's).
- The name and address of the facility where the UST release is being reported.
- The name, company, and telephone of the person reporting the release of the UST (anonymous is acceptable, but a name is helpful if further information is needed).

INFORMATION NEEDED AS MUCH AS POSSIBLE OR PERTINENT

- Have fumes been noticed in homes, businesses, utilities, outdoors, soils, and/or water?
- Has any damage occurred to soils, ground water, surface water, drinking water, utilities, land surface, plants/wildlife, or a 3rd party?
- Is free product (any petroleum product that is not dissolved in water or soil) present?
- What other agencies have been notified (Health Dept., Fire Dept., Department of Environmental Quality, etc.)?
- What has been done to clean-up this release already?
- Where did the release come from (i.e., piping, tank itself, spill/overfill, the pump island)?
- What is the age of the tank and pipe, along with what they are made of (steel or fiberglass for example)?
- When did the release occur?
- How much was released (estimate)?
- How was the release detected (tank tightness test, line tightness test, leak detector, inventory, field instruments, analytical, etc.)?
- What was the substance released (gasoline, diesel, waste oil, new oil, solvents, other)?
- What type of soil is present (sand, clay, etc.), and the depth to contaminated soil?
- How deep is ground water in the area, and its flow direction?
- What is the slope direction of the land in this area?
- What is the distance and direction to the nearest water well, underground utilities, surface water, buildings, and property boundaries?
- What is the current and surrounding land use where the release occurred (commercial, industrial, residential, agricultural)?
- How much annual precipitation is received in this city?
- What is the ground cover at the site (lawn, asphalt, gravel, etc.)?

GUIDELINES FOR DISPOSITION AND TREATMENT OF PETROLEUM CONTAMINATED SOILS FROM UNDERGROUND STORAGE TANK SITES

Improper disposition and aeration of petroleum-contaminated soils from leaking underground storage tank (LUST) sites in close proximity to residential and environmentally sensitive areas could present a direct or potential threat to human health and the environment. This document represents advisory guidelines set by the Executive Secretary (UST) of the Utah Solid and Hazardous Wastes Control Board when soil management activities are proposed at any facility.

As outlined in Utah Admin. Code Section R311-204-2, the Executive Secretary reviews and approves closure plans, which include information concerning management of petroleum contaminated soils. If a closure plan (or corrective action plan for LUST sites) indicates that a specific form of soil management or disposal will be performed at a facility, the Executive Secretary will require additional information concerning this activity. Because of the potential for improper management of petroleum contaminated soils, the following information should be provided to the Executive Secretary (UST) for review*.

GENERAL SOIL MANAGEMENT GUIDELINES AND CONDITIONS FOR CONSIDERATION:

All underground storage tank owners/operators who are planning to close their tank systems should plan for the possibility that they will be generating contaminated soils during the removal process. Proper disposal of the soil should be arranged before beginning any removal activities to minimize the concerns discussed above. If aeration is not proposed as part of the closure plan, but later proposed following any activity which will probably generate contaminated soil, then the responsible party must immediately take the following actions upon the overexcavation or generation of the impacted soils:

- the contaminated soils should be placed on an impermeable liner (to minimize leaching of the contamination into the ground);
- the contaminated soils should be covered by an impermeable liner (to minimize both emissions of volatile hydrocarbons to the atmosphere, and to limit potential human contact); and,
- the site should be secured from the general public to minimize any potential exposure.

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* *A staff member from the UST compliance section will assist you in meeting the UST closure requirements. If petroleum contaminated soils are reported or confirmed at the site, a project manager from the LUST section will be assigned to assist you. Contacting the appropriate person will save time and avoid confusion. If you have questions about what to do, call either section at (801) 536-4100.*

The proposed soil aeration plan is discussed in more detail below. The following items provide general considerations which must be satisfied or completed prior to submitting the proposal. If the following conditions at a site cannot be met, it is doubtful that approval for the actual aeration would be granted by the Executive Secretary (UST). If that is the case, and you cannot satisfy the following conditions, then you should start making arrangements for the proper disposal of the soil at an acceptable facility.

If you can meet the following conditions, and plan on submitting a proposal as discussed below, and if you have already generated any contaminated soil, it is important that any stockpiled soil should be properly managed pending either the aeration approval, or other final disposition of the soil.

- The owner/operator or responsible party of the underground storage tank system is responsible for notifying and obtaining approval from the Local Health Department, the Utah Division of Air Quality, and Local Fire Agency prior to any soil management or treatment activity. The Executive Secretary (UST) will require the documentation of these approvals from other agencies prior to considering granting final authorization of any soil treatment activity. In the event that the other agencies do not approve of the aeration plan, or, even if they have approved the plan, but the Executive Secretary (UST) does not approve of the proposed plan, then the owner will be required to dispose of the soil properly at an acceptable disposal facility. It should be noted that these guidelines <u>do not</u> preempt or supersede any other federal, state or local law, ordinance or jurisdiction.
- If the aeration plan is not approved by any of the agencies involved, including the Executive Secretary (UST), then proper disposal of the contaminated soil at an approved facility will need to occur within **30** days of the disapproval.
- Contaminated soils should not be placed in direct contact with groundwater/surface water or in an area which may impact groundwater/surface water. Soils should not be placed near structures, utility conduits, or other conduits (such as irrigation ditches, water wells, or surface/subsurface drainage systems) that may serve as pathways for migration of contamination.
- Contaminated soils should be placed on level ground, on an impermeable liner, cordoned off, and bermed to reduce the potential health risks and prevent runoff from leaving the site. Contaminated soils should be placed such that the environment cannot be affected or degraded.
- Contaminated soils should not be placed in close proximity to the general public. The placement of the soils must provide sufficient distance from nearby residences and buildings to prevent potential health risks or nuisance to surrounding populations. The area used for the treatment of the soils should be secured to prevent access by the general public. In addition, the contaminated soils should be covered by an impermeable liner (to minimize both emissions of volatile hydrocarbons to the atmosphere, and to limit potential human contact).

PROPOSAL FOR SOIL MANAGEMENT OR AERATION:

- The notification to the DERR must be in the form of a written underground storage tank closure plan, or leaking underground storage tank corrective action plan which is to be submitted for the Executive Secretary's review and approval, disapproval, or conditional approval. The proposal should give specific information about the following:

  - Verification of the approval from the other referenced regulatory agencies.
  - Documentation that the conditions discussed above have been satisfied.
  - The methodology or treatment technology to be used for the soil management activity.
  - The sampling plan to be used to monitor the progress of the soil treatment activities (e.g., frequency of sample collection, type of samples collected, analytical methods to be used, and certified samplers and laboratories to be used).
  - The proposed final disposition (or the final disposal location to be used) of the soil.
  - A vicinity map and site map providing a complete graphical description of the facility and the land surrounding the facility. The maps should be drawn to scale with proper orientation (showing a North arrow) and should be no larger than 11" x 17". The maps should provide the following information:
    - The facility address or location, with an appropriate scale (e.g., bar scale with 1 inch = 20 feet, etc.) and North arrow.
    - Underground utilities (e.g., water supply, sewer or septic systems, natural gas lines, storm drains, power lines, and telephone lines).
    - Property boundaries, on-site buildings, on- and off-site land use, and any adjacent buildings surrounding the property where the soil treatment will occur.
    - Location of soil stockpile(s) and proposed treatment area(s).
    - Land features surrounding the site including; lakes, rivers, streams, irrigation canals, wetlands, slope of land surface, irrigation, agricultural or other types of water wells, etc.

- The maximum volume and concentration of the contaminated soils to be treated should be indicated in the proposed plan. If the approved levels of volatile emissions are exceeded during the soil management activity, a revised plan must be submitted to the DERR for approval prior to treatment of the exceeded amounts.

IMPLEMENTATION OF THE APPROVED TREATMENT PLAN:

- Any deviation from the plan, which was approved by the Executive Secretary, should be submitted in written form and approved prior to implementation.
- Progress reports (in regards to their content and frequency of submittals) for the implemented soil treatment technology or plan are to be submitted to the DERR in accordance with the approval letter issued by the Executive Secretary.
- Once the soil treatment activities are completed, submit a proposal to conduct final confirmation sampling to verify meeting established cleanup levels. Upon meeting cleanup levels, document the same to the DERR by providing the required information as outlined in the approval letter (e.g., sampling, reporting, disposal and other related issues), and request a closure letter for the soil management area. If cleanup levels have not yet been met, additional treatment or work may be required prior to site closure.

A TOXICITY CHARACTERISTICS RULE CHEAT SHEET

*In LUSTLine's Bulletin #13 article, **A Hazardous Waste, Or What?**, we discussed EPA's new rule that establishes a toxicity characteristics (TC) test for determining whether a waste contains hazardous characteristics. This rule includes a provision that defers from regulation under Subtitle C, "petroleum-contaminated media and debris" that fail the TC test and are regulated under RCRA's Subtitle I UST corrective action requirements. Under Subtitle C, if these materials had failed the TC test, they would have been regulated as hazardous wastes and, therefore, subject to RCRA's "cradle to grave" hazardous waste management system. This deferral only applies to the 25 newly listed organic chemicals.*

The following "Cheat Sheet" is a rough reference for what's deferred and what's not deferred within the context of this rule. The fine points of interpretation (and there are fine points) are not included:

1. Which UST-related "Petroleum Contaminated Media and Debris" are we talking about?

Deferred	Not Deferred
Materials outside the UST: Soil (before & after treatment) Groundwater (before & after treatment) Floating Plume Surface Water Rock, Grass, Stumps Empty Tanks (per Subtitle I definition) Piping	Materials inside the UST: Sludge Water Product Tanks with product or sludge in them

2) How do we know which materials are subject to "UST corrective action requirements?"

Deferred	
Materials listed above as deferred, if generated in response to known or suspected releases from a petroleum UST (including contamination found at closures, site assessments, and replacements).	

3) How do we know which materials are subject to Subtitle I of RCRA?

Deferred	Not Deferred
Materials from USTs as defined in Section 9001 of RCRA and EPA's technical regulations.	Materials from Non-Subtitle I tanks, e.g., heating oil tanks, farm & residential motor fuel tanks < 1,100 gals., and above-ground tanks. However, under Subtitle C of RCRA, all wastes generated from households (single and multiple residences) are excluded from EPA's hazardous waste management regulations. For USTs, this includes contaminated soils from household heating oil tanks and household carbon filter units.

Unresolved Issues:

4) What is the status of newly generated wastes (e.g., spent carbon) resulting from treatment of petroleum contaminated debris? As yet, these residual materials have not been designated as deferred.

5) What about above-ground tanks, pipelines, and spills which are not deferred under the rule? EPA is considering a New York State petition that calls for deferring above-ground tanks, pipelines, and spills from the TC requirement in states with adequate management programs.

TOXICITY CHARACTERISTIC RULE

After four years of comments and changes, the Environmental Protection Agency has promulgated the Toxicity Characteristic Rule. This regulation brings more new waste into the Resource Conservation and Recovery Act (RCRA) hazardous waste program than any regulation since the original promulgation of RCRA in 1980. This regulation is so far-reaching that most industries, regardless of size, are affected.

Old testing methods must be changed as the Toxicity Characteristic Leaching Procedure (TCLP) replaces the EP Toxicity testing requirements. Twenty-six (26) specific **organic** constituents have to be investigated at levels in the parts-per-billion (ppb) range, to determine whether a waste is characteristic.

Chemical Waste Management, Inc. is prepared to handle these wastes at our facilities across the country. As a service to our customers, we have prepared this review of the Toxicity Characteristic Rule. No matter what business you're in, you should familiarize yourself with this regulation to determine the possible effects on your operation.

REGULATORY HISTORY

In 1984, Congress passed the Hazardous and Solid Waste Amendments (HSWA) to RCRA. Included in these amendments was a Congressional mandate that EPA identify additional hazardous waste characteristics, including measures of toxicity. On June 13, 1986, EPA proposed the first version of the Toxicity Characteristic Rule. This version contained the new testing procedure, TCLP, as well as thirty-eight (38) new organic characteristic wastes with codes between D018 and D055. The proposed regulatory levels were as low as 1 ppb.

After changes to the test, as well as to the list of wastes, EPA promulgated the Toxicity Characteristic Rule on March 29, 1990. The final rule incorporates the changes to the testing procedure, reduces the number of new characteristic wastes to twenty-six (26) and raises the regulatory levels on most of the new wastes.

EFFECTIVE DATE: SEPTEMBER 25, 1990

RCRA requires that hazardous waste regulations become effective six months after the date of promulgation, unless EPA has good cause to establish an earlier effective date. As a result, this regulation is effective on September 25, 1990. Since this regulation is subject to the 1984 HSWA, it is effective in every state and does not require state approval prior to the effective date.

Due to the far-reaching impact of this regulation, EPA established "compliance" dates for two different categories of waste generators: 1) All generators of more than 100 but less than 1,000 kg/month of hazardous waste (small quantity generators) must come into compliance by March 29, 1991; and 2) all generators of 1,000 kg/month or more must comply with the hazardous waste regulations by September 25, 1990.

CHARACTERIZING HAZARDOUS WASTE

In the current RCRA hazardous waste program, a generator of a solid waste has the responsibility to determine whether the waste is hazardous. This decision is guided by the regulations contained in 40 CFR Part 261. If a waste is not subject to any exemption, then the generator must determine whether the waste is listed and characteristic.

Listed wastes are referred to by F, K, P and U codes. For example, the F wastes reflect waste from non-specific sources (e.g., spent halogenated solvents used in degreasing — F001), while the K wastes identify waste from specific sources (e.g., spent potliner from primary aluminum reduction — K088). The P and U wastes describe discarded, off-spec or spill residues from commercial chemical products.

Characteristic wastes are identified by a "D" code and are not specifically associated with any manufacturing process. While assessing a waste stream to determine its regulatory status, a generator must identify whether the waste is ignitable (D001), corrosive (D002), reactive (D003) or EP toxic (D004-D017). The new toxicity characteristic and its associated test, the TCLP, will replace the EP toxicity test on September 25, 1990. After September 25, 1990, the toxicity characteristic will include waste codes D004-D043.

Under current law, when characterizing a hazardous waste, a generator must assign all the listed and characteristic waste codes for the purpose of compliance with the land disposal restrictions found in 40 CFR Part 268. Remember, it is the generator who bears the responsibility to characterize a waste. At the initial point of generation, the waste should be reviewed against the hazardous waste listings (i.e., F, K, P and U wastes). Next, the generator must answer a second question: that is whether the waste exhibits a characteristic (i.e., D001-D017). This two-stage process is not applicable for TC waste codes (D018-D043), until they are restricted under the land disposal restrictions.

While evaluating a waste's regulatory status, a generator may test the waste or characterize it by using knowledge of the process. There is no regulatory requirement to conduct analytical testing. However, because of the low regulatory thresholds for the new 26 organic "D" wastes, CWM recommends that generators conduct a TCLP analysis to minimize their liability by insuring their wastes are accurately characterized and properly managed.

APPLICATION OF LAND DISPOSAL RESTRICTIONS

As a result of the HSWA, Congress directed EPA to issue treatment standards for all hazardous wastes prior to land disposal. These standards were required to be issued by certain dates, or the wastes were banned from land disposal. This regulatory program, commonly referred to as the "Land Ban," has dramatically impacted the way hazardous wastes are managed, since most wastes now require treatment prior to land disposal.

The HSWA amendments allow EPA to address newly identified wastes (those wastes brought into the RCRA hazardous waste management system after November 8, 1984) differently than pre-HSWA wastes. EPA must evaluate treatment standards for newly identified wastes within six months of promulgation, but the wastes are not banned from land disposal if EPA fails to meet this deadline.

The land disposal restrictions **do not** apply to the new 26 organic "D" codes. EPA must eventually issue treatment standards for these wastes, and this process is expected to be completed within the next two years.

IMPACT ON SPECIFIC WASTE TYPES

- **Previously Delisted Wastes**
  Though EPA believes that there is no significant impact on previously delisted wastes because the agency considers that the delisting requirements are already more stringent than the new rule, previously delisted wastes are subject to this regulation. If a previously delisted waste exhibits a characteristic under the Toxicity Characteristic Rule, it **is subject** to the hazardous waste regulations.

- **Wastes Previously Excluded from RCRA**
  Wastes previously excluded from RCRA, such as household waste, mining waste and oil and gas exploration waste, are **not affected** by this regulation.

- **Treated Wood Wastes**
  Wood wastes that were treated with arsenic are currently protected from the hazardous waste management standards by a regulatory exemption. If this wood also contains pentachlorophenol or creosol in excess of the new TC levels, then these wastes **are subject** to the hazardous waste regulations.

- **Underground Storage Tanks (USTs)**
  With the exception of petroleum-contaminated media and debris subject to Part 280 Corrective Action requirements, material from the cleanup of leaking underground storage tanks **is subject** to the hazardous waste regulations.

- **Underground Petroleum Tanks**
  EPA has decided to **indefinitely defer** a final decision on petroleum-contaminated media and debris subject to the underground storage tank Corrective Action requirements, pending further evaluation. Until further EPA action, these wastes are **not** subject to the hazardous waste regulations.

- **Publicly Owned Treatment Works (POTW) Sludges**
  EPA's Office of Water tested 18 POTW sludge samples using the TCLP and found that none of these exhibited the TC at the regulatory levels. Based on that information, EPA has determined that this rule does not affect POTW sludges and does not require a specific exemption. Therefore, any POTW sludge that exhibits a characteristic under this rule **is subject** to the hazardous waste regulations.

- **Commercial Applicators of Pesticides and Fungicides**
  Commercial applicators of pesticides and fungicides, who are not eligible for the special requirements applicable to farmers and who exceed the generation volumes previously stated, **are subject** to hazardous waste regulations if they generate waste materials that exhibit a characteristic under this rule.

- **Pharmaceutical and Cosmetic Waste**
  Drug and cosmetic wastes from non-household situations, such as discarded or recalled products, **are subject** to hazardous wastes regulations if they exceed the regulatory levels for any of the hazardous waste characteristics.

- **Used Oil**
  Currently, used oil which is burned for energy recovery is subject to a limited number of requirements. When recycled, it is completely exempt from hazardous waste regulations.

  The toxicity characteristic regulations do not affect these existing exemptions. Used oil that does not exhibit the characteristic of ignitability, corrosivity, reactivity or EP toxicity can be disposed in nonhazardous waste facilities. After the effective date of the TC Rule, used oil destined for disposal that exceeds any of the TC levels **is subject** to the hazardous waste regulations. Used oil that fails the new toxicity characteristic but is recycled, will remain outside of the RCRA standards.

  EPA is currently examining a number of regulatory options, including stricter regulation of recycled oil, to ensure that these activities do not pose undue risk to health and the environment.

- **TSCA Wastes**
  PCB-containing dielectric fluids removed from electrical transformers and associated PCB contaminated electrical equipment which are fully regulated under TSCA and that exceed one of the 26 organic characteristic levels (e.g., D018-D043) are exempt from this rule. However, PCB wastes that are contaminated with any listed wastes (i.e., F, K, P, U) or the characteristic waste codes D001-D017 remain subject to TSCA/RCRA regulation.

- **Surface Impoundments**

  EPA has determined that the point at which a surface impoundment should be characterized for hazardous waste determination is the point of influent (when the waste is generated). If a surface impoundment is determined to be receiving a **new** hazardous waste at this point, it must meet minimum technology requirements (e.g., leachate collection systems, groundwater monitoring and double liners) within four (4) years or cease operation as a hazardous unit before that date.

  In November 1988, it became illegal to discharge hazardous waste into a non-minimum technology surface impoundment. Via court decision, it was ruled that nonhazardous operations could be continued in non-minimum technology units after November, utilizing available capacity and deferring closure. These impoundments will continue to be regulated as hazardous waste management units and must meet minimum technology requirements, if they intend to receive waste that is hazardous under the TC Rule after September 25,1990. If operations cannot be changed to continue nonhazardous receipt in these non-minimum technology impoundments, operators must immediately begin closure.

TCLP

Through HSWA, Congress directed EPA to reexamine the existing EP Toxicity Characteristic and to identify additional hazardous waste characteristics. Congress was particularly concerned that the existing Extraction Procedure test did not include many organic constituents that could pose a threat to human health and the environment.

As a result, EPA set out to revise the test method to utilize a more aggressive leaching medium and to identify additional organic constituents. Briefly, in the agency's new TCLP test, an acetic acid solution is added to the solids from a sample, and the resultant mixture is tumbled for 18 hours at 22 ± 3°C in a zero headspace extractor which prevents volatilization of certain constituents. The liquids are expressed out of the container and collected in an airtight bag. An aliquot of the liquid is introduced into a purge and trap device where helium is bubbled through the liquid to remove the volatile fractions which are concentrated on a Tenax Trap. The trap is then heated, and the volatile organics are swept or flushed into a gas chromatograph/mass spectrometer (GC/MS). The semi-volatiles in the liquid go through a sample extraction/preparation stage and then are directly injected into the GC/MS. The final values are then compared to the regulatory thresholds to determine whether the waste should be classified as hazardous.

Please note that the EPA has recently required the use of data correction to account for the recoveries of sample spikes. This change in data calculation may cause more waste to become subject to the hazardous waste regulations.

CONCLUSION

The Toxicity Characteristic Rule regulates waste containing a number of organic constituents found in many products and commonly used in industrial processes. These regulatory provisions should drive generators, both small and large, to reexamine their waste management practices. In some instances, this review will result in modifications of the actual production process in order to minimize hazardous waste generation.

We recommend that all waste generators carefully re-evaluate the regulatory status of each waste managed at their facilities and, where appropriate, analyze each waste to determine whether it is regulated as a hazardous waste under the new Toxicity Characteristic Rule. If you have questions about complying with the requirements of this regulation or other regulations, contact your local Chemical Waste Management representative or call us at **1-800-843-3604**.

TABLE 1.
Toxicity Characteristic Constituent
and Regulatory Levels

EPA #[1]	Constituent	Reg. Level (mg/1)
D004	Arsenic	5.00
D005	Barium	100.00
D018	Benzene	.50
D006	Cadmium	1.00
D019	Carbon Tetrachloride	.50
D020	Chlordane	.03
D021	Chlorobenzene	100.00
D022	Chloroform	6.00
D007	Chromium	5.00
D023[3]	o-Cresol	200.00
D024[3]	m-Cresol	200.00
D025[3]	p-Cresol	200.00
D026[3]	Cresol	200.00
D016	2,4-D	10.00
D027	1,4-Dichlorobenzene	7.50
D028	1,2-Dichloroethane	.50
D029	1,1-Dichloroethylene	.70
D030[2]	2,4-Dinitrotoluene	.13
D012	Endrin	.02
D031	Heptachlor (and its hydroxide)	.008
D032[2]	Hexachlorobenzene	.13
D033	Hexachloro-1,3-butadiene	.50
D034	Hexachloroethane	3.00
D008	Lead	5.00
D013	Lindane	.40
D009	Mercury	.20
D014	Methoxychlor	10.00
D035	Methyl Ethyl Ketone	200.00
D036	Nitrobenzene	2.00
D037	Pentachlorophenol	100.00
D038[2]	Pyridine	5.00
D010	Selenium	1.00
D011	Silver	5.00
D039	Tetrachloroethylene	.70
D015	Toxaphene	.50
D040	Trichloroethylene	.50
D041	2,4,5-Trichlorophenol	400.00
D042	2,4,6-Trichlorophenol	2.00
D017	2,4,5-Trichlorophenoxypropionic Acid (Silvex)	1.00
D043	Vinyl Chloride	.20

1. Hazardous Waste Number

2. Quantitation limit is greater than the calculated regulatory level. The quantitation limit therefore becomes the regulatory level.

3. If o-, m- and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level for total cresol is 200 mg/l.

United States Environmental Protection Agency

FAQ 7: What Are The Requirements For Hazardous Substance USTs?

Office of Underground Storage Tanks

FOR HAZARDOUS SUBSTANCE USTs ONLY

Several hundred substances were designated as "hazardous" in Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

The UST regulations apply to the same hazardous substances identified by CERCLA, except for those listed as hazardous wastes. These hazardous wastes are already regulated under Subtitle C of the Resource Conservation and Recovery Act and are not covered by the UST regulations. (See 40 CFR Parts 260-270 for the hazardous waste regulations.) Information on the CERCLA hazardous substances is available from EPA through the RCRA/CERCLA Hotline at 800 424-9346.

What Requirements Apply To New Hazardous Substance USTs?

New hazardous substance USTs are those installed after December 22, 1988. These USTs have to meet the same requirements described earlier for new petroleum USTs concerning correct installation, spill, overfill and corrosion protection, corrective action, and closure.

In addition, new hazardous substance USTs must have secondary containment and interstitial monitoring for leak detection, as described below.

Secondary Containment

All new hazardous substance USTs must have "secondary containment." A single-walled tank is the first or "primary" containment. Using only primary containment, a leak can escape into the environment. But by enclosing an UST within a second wall, leaks can be contained and detected quickly before harming the environment. There are several ways to construct secondary containment:

- Placing one tank inside another tank or one pipe inside another pipe (making them double-walled systems).
- Placing the UST system inside a concrete vault.
- Lining the excavation zone around the UST system with a liner that cannot be penetrated by the hazardous substance.

Interstitial Monitoring

The hazardous substance UST must have a leak detection system that can indicate the presence of a leak in the confined space between the first and the second wall. Several devices are available to monitor this confined "interstitial" space.

("Interstitial" simply means "between the walls.") The UST regulations describe these various methods and the requirements for their proper use.

You can apply for an exception, called a variance, from the requirement for secondary containment and interstitial monitoring. To obtain a variance you must demonstrate to the regulatory authority that your alternative leak detection method will work effectively by providing detailed studies of your site, proposed leak detection method, and available methods for corrective action.

What About Existing Hazardous Substance USTs?

Existing UST systems are those installed before December 22, 1988. In addition to immediately starting tank filling procedures that prevent spills and overfills, you will need to meet the following requirements for existing USTs.

Leak Detection

Deadlines for compliance with leak detection requirements were phased in according to the age of the UST. By December 22, 1993, all existing USTs were required to have leak detection. Pressurized piping must meet the requirements for new pressurized piping.

You can meet the leak detection requirements in one of the following three ways:

- Until December 1998, you can use any of the leak detection methods described on page 19 but only if the method you choose can effectively detect releases of the hazardous substance stored in the UST.
- After December 22, 1998, your UST must meet the same requirements for secondary containment and interstitial monitoring that apply to new hazardous substance USTs.
- After December 22, 1988, a variance can be granted if you meet the same requirements described above for receiving a variance for a new hazardous substance UST.

Spill, Overfill, and Corrosion Protection

By December 22, 1998, you must improve your USTs:

- By using devices that prevent spills and overfills.
- By adding corrosion protection to steel tanks and piping.

Although the regulatory deadline is in 1998, you should make these improvements as soon as you can to reduce the chance that you will be liable for damages caused by your unimproved UST.

What If You Have A Hazardous Substance Release?

You must follow the basic actions described below for petroleum releases, with the following two exceptions.

- First, you must immediately report hazardous substance spills or overfills that meet or exceed their "reportable quantities" to the National Response Center at 800 424-8802 or 202 267-2675.

- Second, you must also report hazardous substance spills or overfills that meet or exceed their "reportable quantities" to the regulatory authority within 24 hours. However, if these spills or overfills are smaller than their "reportable quantities" and are immediately contained and cleaned up, they do not need to be reported. You can get information on the "reportable quantities" by calling the EPA RCRA/CERCLA Hotline at 800 424-9346.

Warning signals indicate that your UST may be leaking and creating problems for the environment and your business. You can minimize these problems by paying careful attention to early warning signals and reacting to them quickly before major problems develop.

You should suspect a leak when you discover the following warning signals:

- Unusual operating conditions (such as erratic behavior of the dispensing pump). Check first to see if this problem results from equipment failure that can be repaired.

- Results from leak detection monitoring and testing that indicate a leak. What at first appears to be a leak may be the result of faulty equipment that is part of your UST system or its leak detection. Double check this equipment carefully for failures.

You need to call your regulatory authority and report suspected leaks. Then find out quickly if these suspected leaks are actual leaks using the following investigative steps:

- Conduct tightness testing of the entire UST system.

- Check the site for additional information on the presence and source of contamination.

If these system tests and site checks confirm a leaking UST, follow the actions for responding to confirmed leaks described below.

You must also respond quickly to any evidence of leaked petroleum that appears at or near your site. For example, neighbors might tell you they smell petroleum vapors in their basements or taste petroleum in their drinking water. If evidence of this type is discovered, you must report this discovery immediately to the regulatory authority and take the investigative steps and follow-up actions noted above.

Contact your regulatory authority for specific timeframes, necessary steps, and guidance in doing site assessments and Corrective Action Plans

In response to a release, you should:

- Take immediate action to stop and contain the release.
- Report the release to the regulatory authority within 24 hours. However, petroleum spills and overfills of less than 25 gallons do not have to be reported if you immediately contain and clean up these releases.
- Make sure the release poses no immediate hazard to human health and safety by removing explosive vapors and fire hazards. Your fire department should be able to help or advise you with this task. You must also make sure you handle contaminated soil properly so that it poses no hazard (for example, from vapors or direct contact).
- Remove petroleum from the UST system to prevent further release into the environment.
- Find out how far the petroleum has moved and begin to recover the leaked petroleum (such as product floating on the water table). Report your progress and any information you have collected to the regulatory authority no later than 20 days after confirming a release.
- Investigate to determine if the release has damaged or might damage the environment. This investigation must determine the extent of contamination both in soils and groundwater. You must report to the regulatory authority what you have learned from an investigation of your site according to the schedule established by the regulatory authority. At the same time, you must also submit a report explaining how you plan to clean up the site. Additional site studies may be required.

Based on the information you have provided, the regulatory authority will decide if you must take further action at your site. You may need to develop and submit a Corrective Action Plan that shows how you will meet requirements established for your site by the regulatory authority. Make sure you implement the corrective action steps approved by the regulatory authority for your site.

[OUST Home Page][Frequently Asked Questions]

URL: http://www.epa.gov/OUST/hazusts/hazusts.htm

Last Updated: September 30, 1998

UST Safety

Nothing is more important than safety on the job site!!! Safety of the work crew should be the primary concern for UST Removers.

Review: Health & Safety Notes: Trenching, Shoring and USTs and Health and Safety Training (EPA).

Monitoring Equipment

The use of environmental monitoring equipment is essential to safe UST removal. Many UST accidents could have been prevented if UST Removers were trained and accurately used environmental monitoring equipment.

Review: Oxygen Monitors, CGIs and Specific Chemical Monitors and understand equipment limitations and considerations.

Contents:
MSDS for gasoline
Trenching, Shoring, and USTs
Health and Safety Training for Underground Storage Tank Inspectors
Oxygen Monitors, CGIs and Specific Chemical Monitors

AMERADA HESS CORPORATION

MATERIAL SAFETY DATA SHEET

Gasoline, All Grades **MSDS No. 9950**

EMERGENCY OVERVIEW

DANGER!

EXTREMELY FLAMMABLE - EYE AND MUCOUS MEMBRANE IRRITANT - EFFECTS CENTRAL NERVOUS SYSTEM - HARMFUL OR FATAL IF SWALLOWED - ASPIRATION HAZARD

NFPA 704 (Section 16)

High fire hazard. Keep away from heat, spark, open flame, and other ignition sources.

If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs). Contact may cause eye, skin and mucous membrane irritation. Harmful if absorbed through the skin. Avoid prolonged breathing of vapors or mists. Inhalation may cause irritation, anesthetic effects (dizziness, nausea, headache, intoxication), and respiratory system effects.

Long-term exposure may cause effects to specific organs, such as to the liver, kidneys, blood, nervous system, and skin. Contains benzene, which can cause blood disease, including anemia and leukemia.

1. CHEMICAL PRODUCT and COMPANY INFORMATION (rev. Jan-04)

Amerada Hess Corporation
1 Hess Plaza
Woodbridge, NJ 07095-0961

EMERGENCY TELEPHONE NUMBER (24 hrs):	**CHEMTREC (800)424-9300**
COMPANY CONTACT (business hours):	Corporate Safety (732)750-6000
MSDS Internet Website	www.hess.com/about/environ.html

SYNONYMS: Hess Conventional (Oxygenated and Non-oxygenated) Gasoline; Reformulated Gasoline (RFG); Reformulated Gasoline Blendstock for Oxygenate Blending (RBOB); Unleaded Motor or Automotive Gasoline

See Section 16 for abbreviations and acronyms.

2. COMPOSITION and INFORMATION ON INGREDIENTS * (rev. Jan-04)

INGREDIENT NAME (CAS No.)	CONCENTRATION PERCENT BY WEIGHT
Gasoline (86290-81-5)	100
Benzene (71-43-2)	0.1 - 4.9 (0.1 - 1.3 reformulated gasoline)
n-Butane (106-97-8)	< 10
Ethyl Alcohol (Ethanol) (64-17-5)	0 - 10
Ethyl benzene (100-41-4)	< 3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Tertiary-amyl methyl ether (TAME) (994-05-8)	0 to 17.2
Toluene (108-88-3)	1 - 25
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 - 15

A complex blend of petroleum-derived normal and branched-chain alkane, cycloalkane, alkene, and aromatic hydrocarbons. May contain antioxidant and multifunctional additives. Non-oxygenated Conventional Gasoline and RBOB do not have oxygenates (Ethanol or MTBE and/or TAME). Oxygenated Conventional and Reformulated Gasoline will have oxygenates for octane enhancement or as legally required.

3. HAZARDS IDENTIFICATION (rev. Dec-97)

EYES

Moderate irritant. Contact with liquid or vapor may cause irritation.

SKIN

Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.

INGESTION

The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death.

Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.

INHALATION

Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS and CARCINOGENICITY

Contains benzene, a regulated human carcinogen. Benzene has the potential to cause anemia and other blood diseases, including leukemia, after repeated and prolonged exposure. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with systemic toxicity. See also Section 11 - Toxicological Information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash). Chronic respiratory disease, liver or kidney dysfunction, or pre-existing central nervous system disorders may be aggravated by exposure.

4. FIRST AID MEASURES (rev. Dec-97)

EYES

In case of contact with eyes, immediately flush with clean, low-pressure water for at least 15 min. Hold eyelids open to ensure adequate flushing. Seek medical attention.

SKIN

Remove contaminated clothing. Wash contaminated areas thoroughly with soap and water or waterless hand cleanser. Obtain medical attention if irritation or redness develops.

INGESTION

DO NOT INDUCE VOMITING. Do not give liquids. Obtain immediate medical attention. If spontaneous vomiting occurs, lean victim forward to reduce the risk of aspiration. Small amounts of material which enter the mouth should be rinsed out until the taste is dissipated.

INHALATION

Remove person to fresh air. If person is not breathing, ensure an open airway and provide artificial respiration. If necessary, provide additional oxygen once breathing is restored if trained to do so. Seek medical attention immediately.

5. FIRE FIGHTING MEASURES (rev. Dec-97)

FLAMMABLE PROPERTIES:

FLASH POINT:	-45 °F (-43°C)
AUTOIGNITION TEMPERATURE:	highly variable; > 530 °F (>280 °C)
OSHA/NFPA FLAMMABILITY CLASS:	1A (flammable liquid)
LOWER EXPLOSIVE LIMIT (%):	1.4%
UPPER EXPLOSIVE LIMIT (%):	7.6%

FIRE AND EXPLOSION HAZARDS

Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

EXTINGUISHING MEDIA

SMALL FIRES: Any extinguisher suitable for Class B fires, dry chemical, CO2, water spray, fire fighting foam, or Halon.

LARGE FIRES: Water spray, fog or fire fighting foam. Water may be ineffective for fighting the fire, but may be used to cool fire-exposed containers.

During certain times of the year and/or in certain geographical locations, gasoline may contain MTBE and/or TAME. Firefighting foam suitable for polar solvents is recommended for fuel with greater than 10% oxygenate concentration - refer to NFPA 11 "Low Expansion Foam - 1994 Edition."

FIRE FIGHTING INSTRUCTIONS

Small fires in the incipient (beginning) stage may typically be extinguished using handheld portable fire extinguishers and other fire fighting equipment.

Firefighting activities that may result in potential exposure to high heat, smoke or toxic by-products of combustion should require NIOSH/MSHA- approved pressure-demand self-contained breathing apparatus with full facepiece and full protective clothing.

Isolate area around container involved in fire. Cool tanks, shells, and containers exposed to fire and excessive heat with water. For massive fires the use of unmanned hose holders or monitor nozzles may be advantageous to further minimize personnel exposure. Major fires may require withdrawal, allowing the tank to burn. Large storage tank fires typically require specially trained personnel and equipment to extinguish the fire, often including the need for properly applied fire fighting foam.

See Section 16 for the NFPA 704 Hazard Rating.

6. ACCIDENTAL RELEASE MEASURES (rev. Dec-97)

ACTIVATE FACILITY SPILL CONTINGENCY or EMERGENCY PLAN.

Evacuate nonessential personnel and remove or secure all ignition sources. Consider wind direction; stay upwind and uphill, if possible. Evaluate the direction of product travel, diking, sewers, etc. to confirm spill areas. Spills may infiltrate subsurface soil and groundwater; professional assistance may be necessary to determine the extent of subsurface impact.

Carefully contain and stop the source of the spill, if safe to do so. Protect bodies of water by diking, absorbents, or absorbent boom, if possible. Do not flush down sewer or drainage systems, unless system is designed and permitted to handle such material. The use of fire fighting foam may be useful in certain situations to reduce vapors. The proper use of water spray may effectively disperse product vapors or the liquid itself, preventing contact with ignition sources or areas/equipment that require protection.

Take up with sand or other oil absorbing materials. Carefully shovel, scoop or sweep up into a waste container for reclamation or disposal - caution, flammable vapors may accumulate in closed containers. Response and clean-up crews must be properly trained and must utilize proper protective equipment (see Section 8).

7. HANDLING and STORAGE (rev. Dec-97)

HANDLING PRECAUTIONS

******USE ONLY AS A MOTOR FUEL******
******DO NOT SIPHON BY MOUTH******

Handle as a flammable liquid. Keep away from heat, sparks, and open flame! Electrical equipment should be approved for classified area. Bond and ground containers during product transfer to reduce the possibility of static-initiated fire or explosion.

Special slow load procedures for "switch loading" must be followed to avoid the static ignition hazard that can exist when higher flash point material (such as fuel oil) is loaded into tanks previously containing low flash point products (such as this product) - see API Publication 2003, "Protection Against Ignitions Arising Out Of Static, Lightning and Stray Currents.

STORAGE PRECAUTIONS

Keep away from flame, sparks, excessive temperatures and open flame. Use approved vented containers. Keep containers closed and clearly labeled. Empty product containers or vessels may contain explosive vapors. Do not pressurize, cut, heat, weld or expose such containers to sources of ignition.

Store in a well-ventilated area. This storage area should comply with NFPA 30 "Flammable and Combustible Liquid Code". Avoid storage near incompatible materials. The cleaning of tanks previously containing this product should follow API Recommended Practice (RP) 2013 "Cleaning Mobile Tanks In Flammable and Combustible Liquid Service" and API RP 2015 "Cleaning Petroleum Storage Tanks".

WORK/HYGIENIC PRACTICES

Emergency eye wash capability should be available in the near proximity to operations presenting a potential splash exposure. Use good personal hygiene practices. Avoid repeated and/or prolonged skin exposure. Wash hands before eating, drinking, smoking, or using toilet facilities. Do not use as a cleaning solvent on the skin. Do not use solvents or harsh abrasive skin cleaners for washing this product from exposed skin areas. Waterless hand cleaners are effective. Promptly remove contaminated clothing and launder before reuse. Use care when laundering to prevent the formation of flammable vapors which could ignite via washer or dryer. Consider the need to discard contaminated leather shoes and gloves.

8. EXPOSURE CONTROLS and PERSONAL PROTECTION (rev. Jan-04)

EXPOSURE LIMITS

Component (CAS No.)				Exposure Limits
	Source	TWA (ppm)	STEL (ppm)	Note
Gasoline (86290-81-5)	ACGIH	300	500	A3
Benzene (71-43-2)	OSHA	1	5	Carcinogen
	ACGIH	0.5	2.5	A1, skin
	USCG	1	5	
n-Butane (106-97-8)	ACGIH	800	--	2003 NOIC: 1000 ppm (TWA) Aliphatic Hydrocarbon Gases Alkane (C1-C4)
Ethyl Alcohol (ethanol) (64-17-5)	OSHA	1000	--	
	ACGIH	1000	--	A4
Ethyl benzene (100-41-4)	OSHA	100	--	
	ACGIH	100	125	A3

Component (CAS No.)	Exposure Limits			
	Source	TWA (ppm)	STEL (ppm)	Note
n-Hexane (110-54-3)	OSHA	500	--	
	ACGIH	50	--	skin
Methyl-tertiary butyl ether [MTBE] (1634-04-4)	ACGIH	50		A3
Tertiary-amyl methyl ether [TAME] (994-05-8)				None established
Toluene (108-88-3)	OSHA	200		Ceiling: 300 ppm; Peak: 500 ppm (10 min.)
	ACGIH	50	--	A4 (skin)
1,2,4- Trimethylbenzene (95-63-6)	ACGIH	25	--	
Xylene, mixed isomers (1330-20-7)	OSHA	100	--	
	ACGIH	100	150	A4

ENGINEERING CONTROLS

Use adequate ventilation to keep vapor concentrations of this product below occupational exposure and flammability limits, particularly in confined spaces.

EYE/FACE PROTECTION

Safety glasses or goggles are recommended where there is a possibility of splashing or spraying.

SKIN PROTECTION

Gloves constructed of nitrile or neoprene are recommended. Chemical protective clothing such as that made of of E.I. DuPont Tychem ®, products or equivalent is recommended based on degree of exposure.

Note: The resistance of specific material may vary from product to product as well as with degree of exposure. Consult manufacturer specifications for further information.

RESPIRATORY PROTECTION

A NIOSH-approved air-purifying respirator with organic vapor cartridges or canister may be permissible under certain circumstances where airborne concentrations are or may be expected to exceed exposure limits or for odor or irritation. Protection provided by air-purifying respirators is limited. Refer to OSHA 29 CFR 1910.134, NIOSH Respirator Decision Logic, and the manufacturer for additional guidance on respiratory protection selection and limitations.

Use a positive pressure, air-supplied respirator if there is a potential for uncontrolled release, exposure levels are not known, in oxygen-deficient atmospheres, or any other circumstance where an air-purifying respirator may not provide adequate protection.

9. PHYSICAL and CHEMICAL PROPERTIES (rev. Jan-04)

APPEARANCE

A translucent, straw-colored or light yellow liquid

ODOR

A strong, characteristic aromatic hydrocarbon odor. Oxygenated gasoline with MTBE and/or TAME may have a sweet, ether-like odor and is detectable at a lower concentration than non-oxygenated gasoline.

ODOR THRESHOLD

	Odor Detection	Odor Recognition
Non-oxygenated gasoline:	0.5 - 0.6 ppm	0.8 - 1.1 ppm
Gasoline with 15% MTBE:	0.2 - 0.3 ppm	0.4 - 0.7 ppm
Gasoline with 15% TAME:	0.1 ppm	0.2 ppm

BASIC PHYSICAL PROPERTIES

BOILING RANGE:	85 to 437 °F (39 to 200 °C)
VAPOR PRESSURE:	6.4 - 15 RVP @ 100 °F (38 °C) (275-475 mm Hg @ 68 °F (20 °C)
VAPOR DENSITY (air = 1):	AP 3 to 4
SPECIFIC GRAVITY (H_2O = 1):	0.70 – 0.78
EVAPORATION RATE:	10-11 (n-butyl acetate = 1)
PERCENT VOLATILES:	100 %

SOLUBILITY (H_2O):	Non-oxygenated gasoline - negligible (< 0.1% @ 77 °F). Gasoline with 15% MTBE - slight (0.1 - 3% @ 77 °F); ethanol is readily soluble in water

10. STABILITY and REACTIVITY (rev. Dec-94)

STABILITY: Stable. Hazardous polymerization will not occur.

CONDITIONS TO AVOID

Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources

INCOMPATIBLE MATERIALS

Keep away from strong oxidizers.

HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

11. TOXICOLOGICAL PROPERTIES (rev. Dec-97)

ACUTE TOXICITY

Acute Dermal LD50 (rabbits): > 5 ml/kg	Acute Oral LD50 (rat): 18.75 ml/kg
Primary dermal irritation (rabbits): slightly irritating	Draize eye irritation (rabbits): non-irritating
Guinea pig sensitization: negative	

CHRONIC EFFECTS AND CARCINOGENICITY

Carcinogenicity: OSHA: NO IARC: YES - 2B NTP: NO ACGIH: YES (A3)

IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain.

This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

This product may contain methyl tertiary butyl ether (MTBE): animal and human health effects studies indicate that MTBE may cause eye, skin, and respiratory tract irritation, central nervous system depression and neurotoxicity. MTBE is classified as an animal carcinogen (A3) by the ACGIH.

12. ECOLOGICAL INFORMATION (rev. Jan-04)

Keep out of sewers, drainage areas and waterways. Report spills and releases, as applicable, under Federal and State regulations. If released, oxygenates such as ethers and alcohols will be expected to exhibit fairly high mobility in soil, and therefore may leach into groundwater. The API (www.api.org) provides a number of useful references addressing petroleum and oxygenate contamination of groundwater.

13. DISPOSAL CONSIDERATIONS (rev. Dec-97)

Consult federal, state and local waste regulations to determine appropriate disposal options.

14. TRANSPORTATION INFORMATION (rev. Jan-04)

DOT PROPER SHIPPING NAME:	Gasoline
DOT HAZARD CLASS and PACKING GROUP:	3, PG II
DOT IDENTIFICATION NUMBER:	UN 1203
DOT SHIPPING LABEL:	FLAMMABLE LIQUID

PLACARD:

15. REGULATORY INFORMATION (rev. Jan-04)

U.S. FEDERAL, STATE, and LOCAL REGULATORY INFORMATION

This product and its constituents listed herein are on the EPA TSCA Inventory. Any spill or uncontrolled release of this product, including any substantial threat of release, may be subject to federal, state and/or local reporting requirements. This product and/or its constituents may also be subject to other federal, state, or local regulations; consult those regulations applicable to your facility/operation.

CLEAN WATER ACT (OIL SPILLS)

Any spill or release of this product to "navigable waters" (essentially any surface water, including certain wetlands) or adjoining shorelines sufficient to cause a visible sheen or deposit of a sludge or emulsion must be reported immediately to the National Response Center (1-800-424-8802) or, if not practical, the U.S. Coast Guard with follow-up to the National Response Center, as required by U.S. Federal Law. Also contact appropriate state and local regulatory agencies as required.

CERCLA SECTION 103 and SARA SECTION 304 (RELEASE TO THE ENVIRONMENT)

The CERCLA definition of hazardous substances contains a "petroleum exclusion" clause which exempts crude oil, refined, and unrefined petroleum products and any indigenous components of such. However, other federal reporting requirements (e.g., SARA Section 304 as well as the Clean Water Act if the spill occurs on navigable waters) may still apply.

SARA SECTION 311/312 - HAZARD CLASSES

ACUTE HEALTH	CHRONIC HEALTH	FIRE	SUDDEN RELEASE OF PRESSURE	REACTIVE
X	X	X	--	--

SARA SECTION 313 - SUPPLIER NOTIFICATION

This product contains the following toxic chemicals subject to the reporting requirements of section 313 of the Emergency Planning and Community Right-To-Know Act (EPCRA) of 1986 and of 40 CFR 372:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION WT. PERCENT
Benzene (71-43-2)	0.1 to 4.9 (0.1 to 1.3 for reformulated gasoline)
Ethyl benzene (100-41-4)	< 3
n-Hexane (110-54-3)	0.5 to 4
Methyl-tertiary butyl ether (MTBE) (1634-04-4)	0 to 15.0
Toluene (108-88-3)	1 to 15
1,2,4- Trimethylbenzene (95-63-6)	< 6
Xylene, mixed isomers (1330-20-7)	1 to 15

US EPA guidance documents (www.epa.gov/tri) for reporting Persistent Bioaccumulating Toxics (PBTs) indicate this product may contain the following deminimis levels of toxic chemicals subject to Section 313 reporting:

INGREDIENT NAME (CAS NUMBER)	CONCENTRATION - Parts per million (ppm) by weight
Polycyclic aromatic compounds (PACs)	17
Benzo (g,h,i) perylene (191-24-2)	2.55
Lead (7439-92-1)	0.079

CANADIAN REGULATORY INFORMATION (WHMIS)

Class B, Division 2 (Flammable Liquid)
Class D, Division 2A (Very toxic by other means) and Class D, Division 2B (Toxic by other means)

16. OTHER INFORMATION (rev. Jan-04)

NFPA® HAZARD RATING	HEALTH:	1	Slight
	FIRE:	3	Serious
	REACTIVITY:	0	Minimal
HMIS® HAZARD RATING	HEALTH:	1 *	Slight
	FIRE:	3	Serious
	REACTIVITY:	0	Minimal
	* CHRONIC		

SUPERSEDES MSDS DATED: 12/30/97

ABBREVIATIONS:

AP = Approximately
< = Less than
> = Greater than
N/A = Not Applicable
N/D = Not Determined
ppm = parts per million

ACRONYMS:

ACGIH	American Conference of Governmental Industrial Hygienists
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute (212)642-4900
API	American Petroleum Institute (202)682-8000
CERCLA	Comprehensive Emergency Response, Compensation, and Liability Act
DOT	U.S. Department of Transportation [General Info: (800)467-4922]
EPA	U.S. Environmental Protection Agency
HMIS	Hazardous Materials Information System
IARC	International Agency For Research On Cancer
MSHA	Mine Safety and Health Administration
NFPA	National Fire Protection Association (617)770-3000
NIOSH	National Institute of Occupational Safety and Health
NOIC	Notice of Intended Change (proposed change to ACGIH TLV)
NTP	National Toxicology Program
OPA	Oil Pollution Act of 1990
OSHA	U.S. Occupational Safety & Health Administration
PEL	Permissible Exposure Limit (OSHA)
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit (NIOSH)
SARA	Superfund Amendments and Reauthorization Act of 1986 Title III
SCBA	Self-Contained Breathing Apparatus
SPCC	Spill Prevention, Control, and Countermeasures
STEL	Short-Term Exposure Limit (generally 15 minutes)
TLV	Threshold Limit Value (ACGIH)
TSCA	Toxic Substances Control Act
TWA	Time Weighted Average (8 hr.)
WEEL	Workplace Environmental Exposure Level (AIHA)
WHMIS	Workplace Hazardous Materials Information System (Canada)

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HEALTH & SAFETY NOTES

TRENCHING, SHORING, AND UST'S

OSHA's Excavations Standards Must Be Met During Underground Storage Tank Excavation Work

by Matthew E. Fitzgerald

After a four-man crew had removed an underground filter tank at a car-wash construction site, they entered the 9-foot deep, 6-foot by 14-foot excavation to hand grade the bottom. The sides of the excavation were neither shored nor sloped. A wall of the trench collapsed, killing one worker and seriously injuring another. The employer was in clear violation of the OSHA standards that cover excavations (29 CFR Subpart P, sections 650-652).

EXCAVATION CAVE-INS ARE REAL hazards that happen all too often, and underground storage tank (UST) installation and removal operations are no exception. Bureau of Labor Statistics (BLS) for 1993 state that 138 workers were killed by collapsing materials. That figure represents 2 percent of all work-related fatalities that were caused by injury in that year.

Yet, there is no shortage of stories about employers who go to great lengths to avoid having to comply with these important OSHA requirements, which clearly saves lives. (Did you hear the one about the tank installer who was found installing tanks at 3:00 am to avoid the OSHA inspectors?) The safety requirements for excavations are not unduly burdensome regulations that have no real life impact on workers; these requirements save lives...everyday.

Are these requirements that tough to meet? Just imagine if you'd been the foreman on the car-wash job described above, and the onus was on you to inform the worker's spouse and children that their loved one was crushed to death at work today. And more often than not, the loved one does have dependent children—BLS reports that 66 percent of workers killed on the job are less than 45 years of age. Considering these potentially tragic consequences, compliance with the OSHA requirements seems the smart thing to do.

OSHA Requirements For Excavations

The 29 CFR 1926.651 *General Requirements for excavations* are laid out in paragraph form and include the following subsections:

(a) Surface encumbrances.

According to the standard, "All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees." When trenches are dug alongside of buildings or fixed objects, the weight of the building on the side of the trench may cause the trench wall to collapse. This type of situation can be especially true in the tight areas associated with remediations.

For example: *During a pipe laying operation, a tree adjacent to the excavation was undercut at the roots, 3 feet below ground level. The tree fell and when it did, it pinned a worker against the pipe that was being laid at the bottom of the trench.*

(b) Underground installations.

According to the standard, "The estimated location of utility installations—such as sewer, telephone, fuel, electric, or water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work—shall be determined prior to opening an excavation."

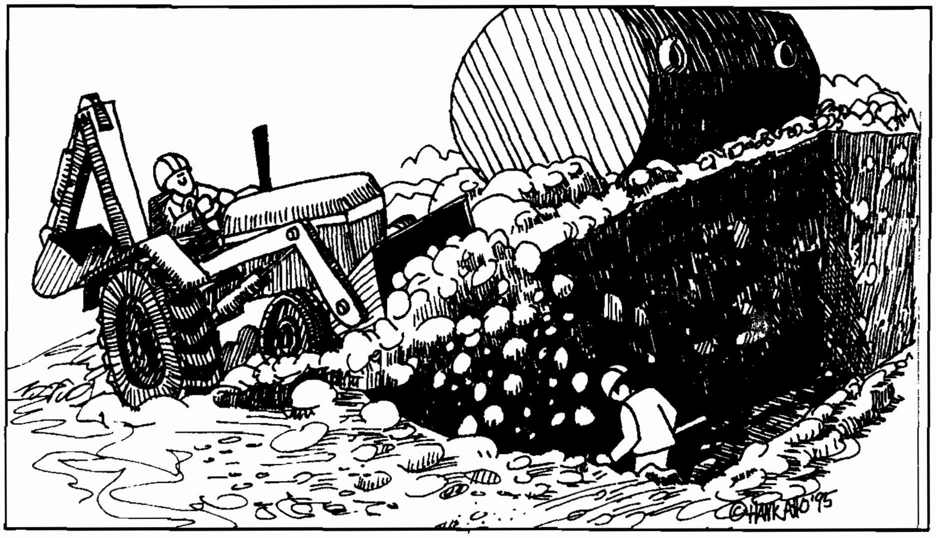
Clearly, the potential of striking an underground electrical or fuel line needs to be addressed before an excavation is begun. Usually utilities companies can be contacted directly and are very responsive to requests for review of a planned excavation. Potential hazard also lurks in a situation where a trench intersects an area of previously disturbed soils. Many fatalities associated with trenching accidents have occurred at the intersection of a trench and a previously filled trench (e.g., a utility conduit).

For example: *A trench, 10.5 feet long, had been dug in preparation for laying a sewer pipe. A gas main was located 4 feet to the east of the trench. As the worker was grading the bottom of the trench, the east wall collapsed. The worker was crushed to death. The section that fell consisted of fill material from the previous installation of the gas main.*

(c) Access and egress.

This paragraph requires that adequate consideration be given to access and egress into and out of the trench and brings to mind the children's story of Mike Mulligan and his steam shovel, Mary Ann. Taking up a challenge to dig the basement of Popperville's city hall in one day, they worked so fast and furiously that they forgot to dig themselves a way out. Fortunately for Mike and Mary Ann, things worked out fine—Mike was hired on as maintenance man at the new town hall, and Mary Ann was transformed into the town hall boiler.

In the real world, however, getting out of an excavation can be quite hazardous. The very act of scaling a vertical wall can cause it to collapse. Consequently, OSHA requires that either ramps and runways, designed by a "competent person", or stairways or ladders be included in all excavations. A **competent person** is defined by OSHA as an individual who is "capable of identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate or control these hazards and conditions." (Note: OSHA published an "intent" of its definition of a competent person in the 10/31/89 *Federal Register.* It states that a competent person must have specific training in and be knowledgeable about soil analysis, the use of protective systems, and the requirements of the standards.) A means of egress is also required for all excavations greater than 4 feet deep and must be placed in such a manner so as to require no more than 25 feet of lateral travel distance for employees.



What's wrong with this picture?

(d) Exposure to vehicular traffic.

UST operations often take place at gas stations, where vehicular traffic can be a real hazard. In 1993, 361 workers died as a result of being struck by vehicles—6 percent of occupational fatalities for that year. Because trenching operations often take place adjacent to or in roadways, OSHA requires that workers exposed to vehicular traffic be provided with warning vests or other suitable garments marked with or made of reflective or high visibility material.

(e) Exposure to falling loads.

There are many examples of workers in trenches being crushed by falling loads. Workers must not be permitted underneath loads that are being handled by lifting or digging equipment. For example, when a tank is being lifted out of an excavation, workers must be restricted from entering the tank excavation or drop zone.

(f) Warning system for mobile equipment.

Because construction equipment operators are often unable to see everything that is going on to their rear during operations, a general practice of construction safety is to equip all heavy equipment that is used on site with backup alarms. When working from the surface into an excavation, these operators are also very limited in terms of what they can see in the excavation. Consequently, where mobile equipment is used adjacent to an excavation where the operator does not have a clear and direct view of the edge of the trench, OSHA requires a warning system, such as barricades, hand or mechanical signals, or stop logs, to be utilized.

For example: *A sewer pipe was being laid in an 8-foot deep trench. One end of the trench was being back filled by a front end loader. A worker, new to the job, entered the area of the trench that was being backfilled and was crushed to death when a load of fill was dropped on him. The other workers in the area did not realize the worker was missing until several minutes had passed. Only after searching did they determine that their co-worker must have been buried in the backfilled area. The operator of the front end loader, who's view of the excavation was obscured, had no idea that he had buried his co-worker.*

(g) Hazardous atmospheres.

Hazardous atmospheres can be a problem in trenches. Because of the nature of a trench (i.e., because a trench is a narrow depression in the earth) hazardous gases may accumulate as they are released from the soil or groundwater. This potential for concentrations of gases is particularly true at hazardous waste sites and may pose a problem at UST remediation sites where the tank has leaked. If there is the potential for a hazardous atmosphere to exist in a trench greater than 4 feet deep, OSHA requires atmospheric testing of the trench before employees are allowed to enter—oxygen levels must be greater than 19.5 percent, the atmosphere must not exceed 20 percent of any lower explosion limit (LEL), and toxics below the permissible exposure limit (PEL). Hazardous atmospheres and entry into confined spaces, such as trenches greater than 4 feet, can be extremely hazardous. For this reason, if an UST removal operation is being performed in contaminated soil where the potential exists for hazardous atmospheres, a competent safety professional should be consulted.

For example: *An UST was removed from an excavation approximately 6.5 feet wide and 6 feet deep. There was approximately one foot of water at the bottom of the excavation. In preparation for installation of the new tank, two workers entered the excavation to splice two pipes. Unbeknownst to the entrants, propane gas had leaked from an underwater joint on the pressurized side of the pipe being spliced. Both workers were killed by asphyxiation.*

(h) Protection from hazards associated with water accumulation.

OSHA requires employers to adequately protect workers from the hazards associated with water accumulation in an excavation. OSHA outlines three strategies for doing so, including shield systems, removal of accumulated water, or use of a safety harness and life line. Heavy rainfall or water accumulation from groundwater seepage is often associated with trench collapse. Particular care should be taken when inspecting trenches with water accumulation.

■ *continued on page 26*

■ **Health & Safety** *from page 25*

(i) Stability of adjacent structures.

This paragraph of the standard requires that proper precautions be taken when the stability of an adjacent structure is jeopardized by the excavation. Support systems must be designed by a competent person, or a professional engineer must certify that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity. The standard also states that if sidewalks and pavements will be undermined, there must be an appropriate support system to protect employees from the possible collapse of such structures.

(j) Protection of employees from loose rock or soil.

OSHA requires that employees be afforded adequate protection from the hazard of loose rock or soil falling or rolling from the face of an excavation. Specifically, OSHA requires that all materials and equipment be kept at least two feet from the edge of an excavation.

(k) Inspections.

OSHA requires that daily inspections be performed to identify evidence of situations that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, and other hazardous conditions. These inspections must be performed by a "competent person."

(l) Fall protection.

Where a falling hazard exists, an employer must mitigate the hazard. Because trenches and excavations may pose a fall hazard, employers are required to provide physical barriers to prevent inadvertent entry. The standard requires:

- Walkways or bridges with standard guardrails where employees or equipment have to cross over an excavation.
- "Adequate barrier physical protection" at all remotely located excavations. Wells, pits, shafts, etc. must be barricaded or covered. Temporary wells, pits, shafts, etc. must be backfilled upon completion of exploration operations.

OSHA Requirements For Sloping And Shoring

The following section, 29 CFR 1926.652, *Requirements for protective systems*, describes how employees who must enter excavations are to be protected. There are essentially two options to ensure the safety of workers who enter excavations: Sloping or shoring.

Proper sloping of trenches is described in paragraph (b) *design of sloping and benching systems.* Employers have four options for proper compliance:

- *Option 1* - requires a slope of 1 and 1/2 horizontal to 1 vertical for a slope of 34 degrees measured from the horizontal. This requires that the slope be cut back 1 and 1/2 foot from the trench for every foot of depth. A 6-foot trench, therefore, would require a slope 9 feet out from the base of the trench.
- *Option 2* - allows for steeper slopes, based on the type of soil in which the excavation will be dug. For an in-depth discussion of soil types and required slopes see 29 CFR 1926.652 Appendix A, *Soil Classification*, and Appendix B, *Sloping and Benching*. There are essentially four types of soils: Stable rock, type A, type B, and type C. The angle of sloping in Option 1 assumes a type C soil. By definition, UST remediation work cannot possibly be done in type A soil, because type A soil, as defined by the standard, must never have been previously disturbed. Soil around a tank removal operation has obviously been previously disturbed (i.e., when the tank was installed). Type B soil requires a slope of 1 horizontal unit to one vertical for a slope of 45 degrees. It is probably easiest to simply dispense with the process of classifying soil and to assume it is type C, which requires a slope of 1.5 to 1.
- *Option 3* - requires the use of tabulated data approved by a registered professional engineer.
- *Option 4* - requires sloping systems designed and approved by a registered professional engineer.

The requirements for shoring systems are found in paragraph (c) *Design of support systems, shield systems and other protective systems.* As with sloping, there are several options for using acceptable shoring devices, including systems which meet the requirements of Appendices A, C, and D of the standard; systems which are used in accordance with the specifications, limitations, and recommendations issued or made by the manufacturer; systems based on tabulated data approved by a registered professional engineer; or systems designed by a professional engineer. Protective systems which meet the intent of the standard are discussed in some detail in Appendix C, *Timber Shoring for Trenches*, and Appendix D, *Aluminum Hydraulic Shoring for Trenches.*

Staying Out of Harm's Way

In 1985 OSHA prepared a report entitled, *Selected Occupational Fatalities Related to Trenching and Excavation as Found in OSHA Fatality/Catastrophe Investigations*, which was a review of some 206 trenching and shoring fatalities. The conclusion listed several recurrent problem areas, including:

- Failure to provide adequate support systems (shoring);
- Failure to set excavated material back an adequate distance (required 2-foot minimum) from the edge of the excavation;
- Inadequate sloping of trench walls;
- Causing equipment and vehicles to come into contact with sources of electrical current;
- Operating equipment and vehicles too close to the edge of the excavation;
- Failure of workers to communicate in such a way as to prevent co-workers from being struck by equipment; and
- Failure to properly brace standing walls adjacent to trenches.

OSHA went on to list secondary causes of fatal accidents. These included:

- Inexperienced workers or workers new to a particular job;
- Employees taking unnecessary personal risks;
- Dangerous work practices (e.g., shortcuts that increase the likelihood of an accident);
- Failure to coordinate work in small areas; and
- Health problems relating to the

physical condition of workers (e.g., alcohol).

OSHA concludes the report by listing several sets of measures which can be taken to prevent the complex events that are a function of human, machine, and environmental interactions that too often result in fatal trenching accidents. These preventive measures include:

- Establishing and strictly enforcing trenching and excavation safety measures, such as shoring, sloping, and removal of spoil from the edge of the excavation;
- Increasing training and education for work safety procedures and activities; and
- Improving supervision over required safety measures.

Excavations associated with UST installation and remediation are by their nature dangerous, and no worker should be expected to enter a trench without the proper protection. Yet as hazardous as such work may be, there are some very effective strategies for protecting workers. A good place to start is by complying with the OSHA regulations. ■

References:

OSHA, 29 CFR Part 1926 Occupational Safety and Health Standards-Excavations; Final Rule. *Federal Register*, Tuesday October 31, 1989.

OSHA, *Selected Occupational Fatalities Related to Trenching and Excavation as Found in OSHA Fatality/Catastrophe Investigations*. July 1985.

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Bureau of Labor Statistics. *National Census of Fatal Occupational Injuries*. August 1994.

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EPA

Health and Safety Training for Underground Storage Tank Inspectors

FIRES AND EXPLOSIONS

EXHIBIT 2-1

ACCIDENTS INVOLVING HANDLING AND TRANSFER OF PETROLEUM PRODUCTS

Some reported accidents involving the Handling and Transfer of Petroleum Products are presented below. Notice that a large number of accidents occur during closure.

Explosion in Tank "Deemed Safe" Kills One

Georgia, 1990 - A Snellville, Georgia man dies April 17 when a 10,000-gallon underground gasoline storage tank explodes at Dry Storage of Georgia. The tank was deemed safe one-half hour before the explosion occurred. The worker was a five-year employee of Westinghouse Environmental and Geotechnical Services, a company that specializes in removing underground tanks. This is the third death in Georgia in less than a year involving a tank closure.

Worker Dies in "Preventable" Accident

Tulsa, 1990 - An underground storage tank explosion kills a worker and blows out the windows in nearby stores. The explosion occurs when two workers are attempting to cut a fill pipe from an UST containing a small amount of water and some residual fuel. The metal cutting saw they are using creates a spark that ignites the gasoline vapors. The ensuing blast blows the 5-foot end off the tank. The flying metal disk travels 20 feet and decapitates a co-worker who is returning to the job site from a convenience store located across the street. A Tulsa Fire Department spokesman characterizes the incident as "a highly preventable accident."

Worker Dies from Trauma Following Explosion

Tulsa, 1990 - An explosion in an empty gasoline storage tank kills a worker as he is dismantling it with an acetylene torch. According to authorities, the steel tank was removed from the ground the week prior to the explosion and a substance was placed in it to help ventilate fumes. The plumbing company returned to begin dismantling the tank, assuming it to be free of fumes. The 2,000-gallon steel tank explodes when the worker, employed by the plumbing contractor, applies an acetylene torch to it. The end of the tank blows out and propels the worker backwards about 25 feet, where he hits a building. The man dies, apparently from trauma suffered when thrown by the explosion. In addition, a building on the property and a truck owned by the plumbing contractor are damaged.

Explosion Crushes Worker

Indianapolis, 1990 - Employees of a company which collects empty fuel tanks and cuts them up into scrap metal are in the midst of purging vapors and cutting tanks when the accident occurs. A worker is using an acetylene torch to cut a tank when an adjacent tank explodes, pushing it 6 feet forward into the one he is working on. The worker is crushed between the tank he is working on and a wrecker parked nearby. Investigators suspect that the tank that exploded either had not yet been cleaned or had been cleaned improperly.

EXHIBIT 2-1 (con.)

ACCIDENTS INVOLVING HANDLING AND TRANSFER OF PETROLEUM PRODUCTS

Man Killed While "Scrapping" Abandoned Underground Storage Tank

A scrapion and metal dealer is working alone and using an acetylene torch to cut a tank into scrap when the flame from the torch ignites fumes inside the tank and touches off an explosion. The force of the blast lifts the 10,000-gallon tank into the air, sending it about 50 feet from its initial spot. A tank end is blown about 450 feet into a nearby field.

The tank, measuring 20 feet by 10 feet, was reportedly used for underground storage of residential heating oil. However, individuals at the accident scene speculated the tank actually contained gasoline or gasoline residue, and that fumes from the gasoline ignited. The victim's brother said the worker was experienced in cutting scrap metal and "knew better than to cut up a gas tank."

OHIO - Sandblasting Incident

A man retained to sandblast an underground storage tank dies when he turns on an electric vacuum cleaner as he prepares to clean sand from the tank bottom. A spark from the vacuum cleaner ignites the vapors inside the tank, causing it to explode. He dies later as a result of the burns suffered in the blast.

Tank Abandonment Kills Three

While cutting the top off an empty tank at Kerr-McGee's Cotton Valley Refinery, a piece of equipment apparently ignites vapors inside the tank. The blast kills three men inside the tank; a fourth man left the tank to get some tools and escaped unharmed.

Explosion Narrowly Avoided

1990 - Two employees breaking out the concrete inside a pump island in order to relocate the product line, instead of capping the exposed line, stuff a rag in it to keep the dirt and broken concrete out. While cleaning the island with shovels, a spark ignites the fumes coming through the rag. The rag immediately catches fire and burns until the employees smother it with dirt.

Tank Worker Dies During Vapor Check

1990 - An Oregon tank worker places a lighted rag down a fill pipe to determine if the tank contains vapors. It does, and an explosion results, killing the worker.

THE FIRE TRIANGLE

For a fire to burn, three primary elements must exist in appropriate ranges or concentrations

Oxygen

Fuel **Ignition Source**

THE FIRE TRIANGLE

Fire is a rapid and persistent chemical reaction accompanied by the emission of heat and light. Three primary elements, represented by the fire triangle, must be present for a fire to burn: **oxygen**, **fuel**, and a **source of ignition**.

Each side of the fire triangle represents one of the necessary elements of fire. The center of the triangle represents the optimal fuel-to-oxygen ratio with enough heat to ignite the mixture. If any of the elements are removed, however, there can be no fire (this is represented by the corners of the triangle). For example, if the wood on a campfire is consumed or removed, the fuel supply is no longer sufficient to sustain combustion.

A more modern fire triangle would have these three elements: oxidizer, fuel, and energy source. Energy can be produced by chemical reaction, mechanical action or electrical discharge. All these factors may come into play at UST sites.

It is important to understand that it is not the liquid which burns. Vapors are produced, which are heated and broken into simpler compounds (such as methane) which will readily oxidize. The flame above a solid material is also the result of the burning of heated gases. Surface burning may occur after all the volatile materials are driven off, as in the case of burning charcoal. Surface burning also occurs when metals burn.

Once started, a fire will continue until the fuel or oxygen concentration falls below a minimum value. A fire commonly results from the combination of some combustible material with oxygen, but the oxidizer does not have to be O_2. The oxygen may be part of a chemical compound such as nitric acid or ammonium percholorate. Combustion may also occur, in some cases, without oxygen being involved; for example, break fluid can be ignited by chlorine.

Oxidation can occur with any chemical material that can easily yield oxygen, or a similar element. Similar compounds include fluorine, chlorine, and bromine. However, simply because a compound contains these elements does not make it a strong oxidizer. Carbon dioxide has two oxygens, but is not an oxidizer.

FACTORS IMPORTANT IN COMBUSTION

- Flammability range
- Ignition temperature
- Flash point

FACTORS IMPORTANT IN COMBUSTION

Combustion is the burning of any substance, whether gaseous, liquid, or solid.

Flammability is the ability of a material to generate a sufficient concentration of combustible vapors to be ignited. The **flammable range** is the range of vapor-air mixtures which will support combustion. It is bounded by the **upper flammable limit (UFL)** or the highest concentration of a product that is flammable and the **lower flammable limit (LFL)** or lowest concentration of a product that is flammable. Concentrations outside this range that are too vapor-rich or too vapor-poor, will not ignite.

Combustion and flammability have technical and regulatory definitions. It is important to understand this difference. (The technical, or scientific, definition is given here). The Department of Transportation has its own definitions for flammable and combustible. Any liquid with a flash point of 100°F or less is considered flammable. Any liquid with a flash point greater than 100°F is considered combustible. This is strictly a regulatory definition. What's the difference between material with a flash point of 99°F and one with a flash point of 102°F?

Ignition temperature is the minimum temperature to which a substance in air must be heated in order to initiate, or cause, self-sustained combustion independent of the heating element.

Ignition temperature is also referred to as "auto-ignition temperature." Ignition temperature is important in many applications, but not so much for determining fire hazard, strangely enough. For instance, gasoline is much more of a fire hazard than diesel, yet the auto-ignition temp of diesel is at least 100°F less than gasoline!

Flash point is the minimum temperature at which a substance produces sufficient flammable vapors to support a flame when an ignition source is present.

The availability of vapor, not the ignition temperature, is the key indicator of hazard.

Table 2-1 delineates fire hazard properties of various flammable liquids, gases, and volatile solids.

TABLE 2-1
FIRE HAZARD PROPERTIES OF PETROLEUM PRODUCTS

Chemical	Flash point °F (°C) Lower	Ignition temperature °F (°C) Upper	Flammable limits % by vol.		Specific gravity (Water=1)	Vapor density (Air=1)	oiling point F (°C)
Benzene	12 (-11)	928 (498)	1.3	7.9	0.9	2.8	176 (80)
Fuel oil, No. 6	150-270 (66-132)	765 (407)			1.0		
Gasoline,[1] C_xH_{12} to C_xH_2O	-45 (-43)	536 (280)	1.4	7.6	0.8	3-4	100-400 (38-204)
Gasoline,[1] aviation	-50 (-46)	824 (471)	1.3	7.1			
Toluene	40 (4)	896 (480)	1.2	7.1	0.9	3.1	231 (111)
m-xylene	81 (27)	982 (527)	1.1	7.0	0.9	3.7	282 (139)

Chemical	Water solubility	Extinguishing method	Hazard Identification	
			Health	Flammability
Benzene	No[2]	1	2	3
Fuel oil, No. 6	No[2]	0	2	0
Gasoline,[1] C_xH_{12} to C_xH_2O	No[2]	1	1	3
Gasoline,[1] aviation	No[2]		1	3
Toluene	No[2]	1	2	3
m-xylene	No[2]	1	2	3

Fire hazard properties of some flammable liquids, gases and volatile solids (abstracted from NFPA 325M-1984, p. 9-95, 1984).

[1] Values may vary for different gasoline grades.

[2] Water solubilities are very low.

FLASH POINT/FLAMMABILITY RELATIONSHIP

Highly Flammable	Flash point < 100°F
Moderately Flammable	Flash point > 100°F but < 200°F
Relatively Inflammable	Flash point > 200°F

RELATIONSHIP OF FLASH POINT AND FLAMMABILITY

The relative flammability of a substance is based on its flash point.

Flash point is defined as the minimum temperature at which a substance produces sufficient flammable vapors to ignite when an ignition source is present. An ignition source could be the spark from static electricity, an electrical tool, or a wayward cigarette butt. Note: In the case of liquids, it is not the liquid itself that burns, but the vapor above it.

Flash point is the single most important factor to look at in determining fire hazards. Flash points are determined by the National Fire Protection Association (NFPA). If the temperature of a liquid has reached the flash point, or higher it will be ignited by a spark, if the fuel/air mixture is right. There is a value called the "Fire Point." The "Fire Point" is the temperature the liquid must reach to generate enough vapors to sustain a flame. For practical purposes, however, we are only concerned with the flash point. If the liquid is at the flash point, and an ignition source is present, there will be a fire.

There are two methods of measuring flash point: open cup (o.c.) and closed cup (c.c.). The open cup method does not attempt to contain the vapors as they are generated, while the closed cup method does. The closed cup flash point is always lower than the open cup, since the concentration of vapors are not lowered by dispersion. This is important to UST inspectors, who deal with closed containers and confined areas frequently.

Flash points do not apply to solids or gases. Finally, flash points are variable. Gasolines are different, and lab tests differ. It is not uncommon to see flash points differ 10° from one reference to the next; therefore, it is recommended that one allow a generous margin of safety.

FLAMMABLE CHARACTERISTICS OF GASOLINE

- **Readily generates flammable vapors** at atmospheric temperatures (NFPA = 3)
- **Flash point**: -45°F
- **Flammability limits:** LFL = 1.4 percent; UFL = 7.6 percent

FLAMMABLE CHARACTERISTICS OF GASOLINE

NOTES

Gasoline is one of the most dangerous petroleum products because it readily generates flammable vapors at atmospheric temperatures (down to -45°F) and generates these vapors within an UST. It is this vapor, not liquid gasoline itself, that burns or explodes when mixed with air and an ignition source. In addition, gasoline has a very low flash point that means even the smallest source of ignition can cause an explosion.

The concentration of vapors in USTs storing gasoline is normally too rich to burn, that is, above the upper flammability limit (UFL). However, if the temperature of the liquid gasoline is in the -10°F to -50°F range, the concentration of vapors will be within the flammable range.

The National Fire Protection Association (NFPA) developed Standard 704M, a five step ranking system from 0 (lowest) to 4 (highest), to identify relative hazard levels. The NFPA standard addresses three categories: flammability, health, and reactivity. Gasoline is rated **3** in the NFPA category for flammability. An NFPA value of three indicates that gasoline is a liquid that readily ignites under typical ambient conditions.

FLAMMABLE CHARACTERISTICS OF GASOLINE (con.)

NFPA Flammability

Rating		Example
0	Will not burn in air when exposed to 1500° for five minutes.	Asbestos
1	Material must be preheated before it will burn.	Diesel
2	Materials that must be moderately heated before ignition can occur. "Liquids with flash points between 100°-200°F."	
* 3	Materials can be ignited under most ambient conditions.	Gasoline
4	Materials that rapidly disperse in air and burn readily.	Flammable gases

FLAMMABLE CHARACTERISTICS

Middle Distillate Fuels

Diesels and fuel oils No. 1 and 2	**Relatively non-flammable (NFPA ratinc 2)**
Kerosene grades Jet-A/A-1, JP-5/7/8	**Relatively non-flammable (NFPA ratin 2)**
Jet B, JP-4 (gasoline/kerosene blends)	**Greater fire hazard (NFPA rating =**

FLAMMABLE CHARACTERISTICS OF MIDDLE DISTILLATES

Much of the nomenclature in the petroleum industry is rather vague. For instance, fuel oils can be classed as middle, heavy, or residual distillates. Jet fuel may range from kerosene-like blends, with middle distillate properties, to blends more like gasoline, a light distillate. Don't get hung up on the light-middle-heavy-residual distillate terminology. It is general. Look at the properties of the fuel or oil of concern.

Middle distillates are the fractions of crude oil which possess a moderate boiling point. These fractions include kerosene, aviation fuels, diesel fuels and Fuel Oil Nos. 1 and 2, and have a wide range of flammabilities.

The **diesel fuels and fuel oils** are relatively non-flammable. They require limited heating at ambient temperatures to ignite. Flammability is expressed in units (percent) by volume of the material in air. The lower flammability limit (LFL) for diesel fuel is 1.3 percent. The upper flammability limit (UFL) is 6 percent.

While diesel is not typically a flash hazard, if the fuel is spilled on hot concrete or metal, or stored in direct sunlight, the heat may be sufficient to make diesel a serious hazard.

Aviation fuels are divided into the kerosene grades (Jet A, A-1, JP-5, 7 and 8) and the "wide cut" blends of gasoline and kerosene (JP-4 and Jet B). Wide cuts are lighter blends and more closely resemble gasoline. The kerosene grades are relatively non-flammable, but the wide cut blends represent a significantly higher fire hazard.

The vapor space in a tank storing a low vapor pressure liquid, such as kerosene, contains a mixture too lean to burn, that is, below the LFL. The vapor space of UST storing materials such as JP-4 and Jet B (and other liquids of similar vapor pressure between 2 and 4 psi) presents a fire hazard because the vapors are normally in the flammable range.

FLAMMABLE CHARACTERISTICS

Residual Fuels (Fuel Oil Nos. 4, 5, 6)

Relatively non-flammable

- NFPA = 2

Flash points

• Nos. 4, 5	130°F to 335°F
• No. 6	150°F to 270°F

LFL

• Nos. 4, 5, 6	1.0 percent

UFL

• Nos. 4, 5, 6	5.0 percent

FLAMMABLE CHARACTERISTICS OF RESIDUAL FUELS

NOTES

Residual fuels (Fuel Oils Nos. 4, 5, and 6) are defined as the product remaining after the removal of appreciable quantities of the more volatile components of crude oil. They have a high flash point; ignition will not occur until the liquid reaches a temperature of 130 or higher. They are not as dangerous as gasoline, however, they do pose a threat.

FLAMMABLE CHARACTERISTICS

Used Oils

- Significant variability exists
- Solvent additions may reduce flash point
- 30 percent of 1,000 samples tested = flash point < 140°F

FLAMMABLE CHARACTERISTICS OF USED OILS

NOTES

Used oils in general are relatively non-flammable, yet they pose special dangers. The characteristics of used oils are not uniform because the oils take on additional characteristics and components during use. Thus, used oils may contain toxins or other dangerous products of which an inspector may not be aware.

For instance, the "other products" (often solvents) found in used oils can greatly reduce their flash point, making them much more flammable. Virgin lubricating oil has a flash point of 350°F. By comparison, when 1,000 samples of waste oils were tested, 30 percent of them had a flash point under 140°F.

The components of some used oils, particularly chlorinated solvents, pose a special toxicological hazard in a fire because of their ability to release toxic fumes.

All associated hazards are affected by ambient conditions. For instance, a used oil may be difficult to ignite, but if a nearby fire heats the oil it may ignite and burn fiercely.

EXPLOSIONS

- Rapid chemical reactions producing large quantities of gas and heat
- Explosivity is expressed as percent by volume of material in air, with levels the same as for flammability (that is, LEL/UEL)
- Not always result of combustion; may occur when compressed vapors expand and burst a container

EXPLOSIONS

Explosions are rapid chemical reactions that produce large quantities of gas and heat, a shock wave, and noise. **Explosivity** is expressed as a percentage of a given material in a volume of air. The lower explosivity limit (LEL) is the lowest concentration of a product that is explosive. The upper explosivity limit (UEL) is the highest concentration of a product that is explosive.

UEL and LEL, for all intents and purposes, are the same as UFL and LFL.

Generally, explosions can do serious harm much more rapidly than toxic exposure. Explosions and fires are the most immediate hazard during tank removal or closure activities, and when release investigation techniques are performed in a confined space.

Bear in mind that the difference between a fire and explosion is not a large one. It can simply be the speed of the reaction. Any material that can burn, if placed under sufficient heat, and confined as in a tank, can explode with tremendous force.

Explosions are not necessarily the result of combustion. In a closed container (such as an UST), flammable liquids expand when heated. Gasoline, for example, expands about 0.06 percent in volume for every 10°F increase in temperature. When the pressure inside the UST exceeds the designed pressure resistance, a "pressure release explosion" can occur.

Although not directly related to standard petroleum products, **Boiling Liquid Expanding Vapor Explosions (BLEVEs)** are important due to their tremendous destructive force. BLEVEs occur when compressed gases, such as LPG, are stored as liquids at temperatures above their normal boiling points If the vessel is exposed to a fire, the rapid buildup of pressure coupled with heat-induced weakening of the tank sides, results in a sudden and violent rupture, with the superheated liquid vaporizing and creating a fireball.

WORKING NEAR EXPLOSIVE VAPORS OR IGNITABLE LIQUIDS

- Use only explosion-proof cameras
- Remove flash camera batteries, or do not use
- Do not smoke or use matches or lighters
- Immediately change oil-saturated clothing

WORKING NEAR EXPLOSIVE VAPORS OR IGNITABLE LIQUIDS

NOTES

If an inspector discovers that vapors or liquids are present in a confined structure and a rapid assessment indicates the potential for an explosion or fire, the inspector should take general safety measures at once.

- All persons should be kept away from the danger area, except those properly trained and equipped.
- The local fire department should be alerted.
- A trained operator of a combustible gas indicator should determine the concentration of vapors present. Oxygen levels must also be monitored.
- Persons in the area should not smoke, start or use vehicles or equipment with internal combustion engines, or touch electrical switches or extension cords.
- Instruments used at UST sites must not contribute to the potential for an explosion or fire. Insurance and safety organizations have developed codes for testing electrical devices used in hazardous situations, and an electrical instrument certified for use in hazardous locations will indicate this. If an instrument does not have an approved rating, it should not be used in a hazardous or potentially hazardous situation.

PURGING

- Controls "fuel" point of fire triangle
- Replaces flammable vapors with air
- Reduces flammable vapors (<LEL)
- Assure procedure's effectiveness with monitoring equipment

PURGING

Purging is an effective method for controlling the fuel point of the fire triangle. The goal of purging a tank is to reduce the flammable vapors in the tank well below the lower explosive limit. Purging or ventilating the tank dilutes the tank's flammable vapors with air, reducing the mixture of fuel and oxygen.

An eductor-type air mover, typically driven by compressed air, draws vapors out of the tank and forces fresh air into the tank. The fill (drop) tube should remain in place to ensure proper ventilation of the tank bottom. Discharge vapors should be dispersed 12 feet from the tank in order to ensure that flammable vapors are being vented effectively into the upper atmosphere.

Most petroleum products have a flammable range of 1 to 10 percent by volume in air, the amount of fuel vapor necessary to become flammable in the presence of oxygen and an ignition source. Below a fuel vapor level of 1 percent (the lower explosive limits or LEL), the mixture of fuel and oxygen is too small to support combustion.

Purging should not be undertaken on hot, humid, or still days because the still air will not disperse the flammable vapors. In order to maintain safe conditions, site work should be put off for a day.

Purging is a temporary procedure. Product trapped in bottom sludge and wall scale regenerates flammable vapors inside the tank. Therefore, when purging, lower the flammable concentration to 20 percent of the accepted LEL value of the mixture. The tank should be constantly monitored to ensure that LEL value does not exceed 20 percent.

Use a Combustible Gas Indicator (CGI) to measure the reduction in the concentration of flammable vapors during purging. Periodically test the percentage LEL inside the tank, in the excavation, and any other below grade areas.

CAUTION: In air purging, with plenty of oxygen present, the concentration of vapors in the tank begin in the flammable range, or may go from too rich through the flammable range before a safe concentration is achieved. It is especially important to ensure all ignition sources have been removed from the area before beginning this process.

INERTING

- Controls "oxygen" point of fire triangle
- Displaces oxygen with inert gas
- Reduces oxygen below the combustion level
- Common inerting materials: dry ice (CO_2) and compressed nitrogen
- Assure procedure's effectiveness with oxygen meter

INERTING

NOTES

Inerting controls the oxygen element of the fire triangle. Inerting reduces the concentration of oxygen needed to support combustion (below 12 to 14 percent oxygen by volume) by replacing the oxygen with an inert gas.

Common inerting materials include dry ice (CO_2) and compressed nitrogen. During the inerting process, gases should be introduced under low pressure in order to avoid producing static electricity. CO_2 is best applied in solid, dry ice form, rather than as a compressed gas.

It is important to recognize that the inert gas does not "neutralize" the flammable vapors in the tank; it simply displaces the oxygen. To measure the effectiveness of the inerting procedure, test the air inside the tank with an oxygen indicator. Eight percent or less oxygen by volume is a safe and acceptable level.

IGNITION SOURCES

- Static electricity
- Electrical appliances
- Open flame
- Smoking cigarettes
- Lightning
- Sparks

IGNITION SOURCES

NOTES

The Ignition Source is the easiest point of the fire triangle to control.

There are many possible sources of ignition during handling and transfer of petroleum products. These sources include static electricity, sparks generated by tools, monitoring equipment and engines in the area, lit cigarettes, or even electrical appliances and lightning. Any one of these ignition sources is enough to complete the fire triangle.

SPARK GENERATION

Sparks can be generated by:

- Static electricity
- Striking tank with a metal instrument (hammer, backhoe)
- Striking rock with metal during excavation
- Electrical instruments (camera, drill)

SPARK GENERATION

NOTES

Sparks can be generated at an UST site by static electricity, striking metal on metal, such as a hammer on the tank, or striking metal on rock, as when digging with a backhoe. Sparks are also created by the ignition of electrical or combustion engines and pumps, use of non-intrinsically safe monitoring instruments, and lightning. Precautions need to be taken to eliminate the possibility of these activities causing fire and explosions.

STATIC ELECTRICITY SOURCES

- Tank filling (by splashing and movement against piping surface)
- Settling of rust or sludge particles
- Motorized equipment
- Self-generation by humans
- Induction

STATIC ELECTRICITY SOURCES

NOTES

The primary manifestation of static electricity is the discharge or sparking of accumulated charges. Under the right conditions, these sparks can be the ignition source for a fire or explosion. Sparks can also be self-generated by humans or created through induction.

The static charge resulting from flowing liquids is of primary importance during the transfer of petroleum products. Static electricity is generated by the separation of like and unlike bodies. When liquid flows, charging occurs because absorbed ions are separated from free ions that are carried into the body of the liquid by turbulence. For example, static results from liquid dropping into a tank during product deliveries, liquid flowing through a hose when product is pumped from the tank, or compressed gas or air being released into the tank atmosphere.

During product transfer, static electricity can be generated by the flow of fuel through small holes into the tank. The movement of the fuel against the pipe also generates a static charge. Furthermore, static electricity can be generated by the settling of rust or sludge particles.

Motorized equipment used during tank installation, testing, and closure may generate static electricity. In order to minimize such risk personnel should ground all equipment during operation.

REDUCING STATIC ELECTRICITY AND SPARKING

Two effective methods

Bonding

- equalizes static electricity
- creates conductive connection between two entities (such as UST and tank truck)

Grounding

- diverts static electricity into earth
- eliminates static buildup

REDUCING STATIC ELECTRICITY AND SPARKING

NOTES

Bonding and **grounding** are effective methods to reduce the potential for electrostatic charge generation and sparking, and the subsequent chance of fires and explosions.

Bonding entails running a conductive line from one metal object to another. This equalizes static electricity by creating a conductive connection between two objects, reducing the likelihood of sparks jumping from metal to metal. Cargo tanks should be electrically bonded to the fill stem, piping, or steel loading rack. Also, all metal parts of the fill pipe assembly should form a continuous electrically conductive path downstream from the point of bond connection.

Bonding insures that individual components of a system do not build up charges. In essence, you slow down the charge buildup by distributing it over a bigger area. However, the entire bonded system will eventually build a significant charge. Bonded systems should also be grounded.

Grounding entails running a conductive line from a metal object to the ground. This will dissipate any charge on the outside surface of the tank by having it flow into the ground.

FIRE AND EXPLOSION POTENTIAL

Potential greatest when handling or transferring product

Installation/Upgrades	Explosion can occur during pressure testing
Release Investigation	Spilled product or vapors
Leak Detection Testing	Presence of leaking product or vapors
Installation of Monitoring Wells/Sampling	Drilling into buried utility lines

FIRE AND EXPLOSION POTENTIAL

NOTES

Assuming an UST is well-maintained, the greatest fire and explosive hazard occurs during the transfer of the product to or from storage and during the cleaning and removal of USTs.

Although petroleum products have been handled and transferred safely for decades, UST inspectors should not believe that this transfer is risk- and hazard-free.

The transfer of flammable and explosive products (liquids and vapors) may occur during tank testing or repair, tank upgrades, tank closure or removal, tank re-filling or corrective actions. UST inspectors should be aware of the risks associated with these activities.

Due to the danger of violent rupture, use extreme caution when performing pipe and tank testing during tank installation. Do not pressure-test any piping or tanks that contain flammable or combustible liquids. Do not exceed internal tank pressures of 5 pounds psig during pressure testing. Install a pressure relief valve at 6 pounds psig. Use a pressure gauge with a range of 10 to 15 psig, and test

FIRE AND EXPLOSION POTENTIAL (con.)

Closures and removals	Product or vapors present while draining tank If vapors removed, product may remain trapped in slu Vapors can regenerate in inert or purged tank

both the inner and outer shells of double-wall tanks. Outer wall should be filled by bleeding off pressure from the inner tank. Do not pressurize directly. Avoid standing near endcaps of an UST. The endcaps are the most vulnerable to explosion.

Whether a tank is to be removed from the ground, or closed in place, product trapped in the sludge at the bottom of the tank, absorbed in the tank walls, or trapped under the scale is a continuous source of vapor regeneration. Cleaning the tank will decrease the amount of vapor regeneration.

To make it safe for handling, after the tank is purged or inerted the sludge can be washed to one end of the tank and pumped out while the tank is still in the excavation.

Make sure appropriate safety procedures are followed (see Confined Space Entry in Section 3), and a continuous stream of fresh air is introduced into the tank. Make sure the contractor blocks the tank to prevent any movement. If tank sludge contains sufficient lead or other substances to be considered a hazardous waste, it must be handled and disposed of consistent with the Resource Conservation and Recovery Act (RCRA), Subtitle C requirements.

Tanks should be removed from the site as promptly as possible after purging or inerting procedures have been completed, preferably the same day. If the tank remains on-site overnight or longer, additional vapor may be regenerated from any liquid, sludge, or wall scale remaining in the tank. Regardless of when they are removed, tanks should be checked with an explosimeter to ensure that 20 percent of the lower explosivity limit (LEL) is not exceeded.

If a leak has occurred, contaminated soil and free product will also generate vapors outside of the tank. An explosimeter should be used to check explosive levels in the excavation as well as in the tank itself.

OXYGEN DEPLETION

CAUSES OF OXYGEN DEPLETION

- Gasoline vapors displace oxygen in confined spaces.
- Oxygen is consumed through oxidation (rusting).
- Inert gas is pumped into tank.
- Other gasses displace oxygen in sewers, manholes, and tunnels.

CAUSES OF OXYGEN DEPLETION

NOTES

Oxygen content in the air may decrease due to biological decay, oxidation (rusting), combustion or displacement by other gases, such as methane, hydrogen sulfide, and carbon monoxide.

It is critical to keep in mind that even when oxygen concentration is deficient for human well-being, there may be enough oxygen to oxidize a combustion or explosion. For example, a 16 percent oxygen concentration could be sufficient for a fire or explosion, while being too low for humans to comfortably breathe.

Eleven percent O_2 is considered the theoretical lower limit for a fire. However, a reaction with a strong oxidizer could result in a flame in the total absence of oxygen.

HAZARD AREAS FOR OXYGEN DEPLETION

- Tanks
- Excavations
- Basements
- Sewers
- Any confined space

HAZARD AREAS FOR OXYGEN DEPLETION

NOTES

Oxygen depletion can occur in any confined space, especially those typically encountered by UST inspectors. Tanks and dug-out trenches are potentially oxygen deficient; basements and sewers are other areas where oxygen may be depleted. Old USTs are particularly susceptible to oxygen depletion through oxidation.

Inspectors should always be alert to situations that could create oxygen depletion, and should never enter into such situations without first measuring the oxygen level.

EPA considers the minimum level of oxygen for a safe entry to be 19.5 percent. Below this entry into an oxygen-depleted area is absolutely necessary, inspectors must enter with an air supplying respirator. Air purifying respirators are not permitted in atmospheres containing less than 19.5 percent oxygen.

PHYSIOLOGICAL EFFECTS OF OXYGEN DEPLETION

Typical air is 21 percent oxygen.

Health effects at lower oxygen levels:

16 to 21 percent	Accelerated breathing and heartbeat; impaired attention, thinking, and coordination
10 to 14 percent	Faulty judgment; poor muscular coordination; rapid fatigue, possibly permanent heart damage
6 to 10 percent	Nausea; vomiting; loss of movement; unconsciousness
< 6 percent	Death in minutes

PHYSIOLOGICAL EFFECTS OF OXYGEN DEPLETION

Oxygen depletion produces a range of physiological effects that worsen as oxygen content is lowered or exposure time is increased. Generally, there are no detrimental effects above a 21 percent concentration oxygen in air, which is the general concentration of oxygen in air at sea level (it could be more or less in other geographical areas). Below this concentration, however, potential life threatening situations exist.

The first signs of depletion occur when oxygen concentration is between 16 percent and 21 percent. With this level of oxygen, a person's respiration and heartbeat accelerate. Also, attention and coordination begin to be impaired. Lower concentrations of oxygen can cause rapid fatigue, heart damage, nausea, unconsciousness and death. See Figure 2-1 for an oxygen scale illustrating the physiological effects of depletion.

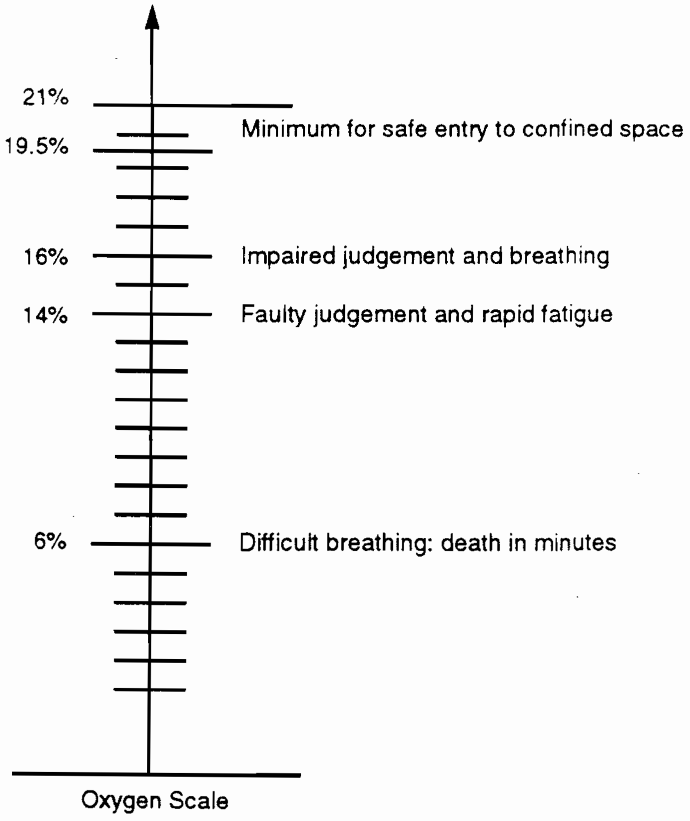
Many times, O_2 depletion occurs in a very seductive fashion. The victim may simply become sleepy, and suddenly see nothing wrong with closing the eyes for a short nap, from which he does not wake. The impairment of judgement is drastic, but insidious. After all, it is hard to be alert to symptoms that involve loss of alertness. Plan ahead and use your instrumentation.

When on-site, UST inspectors should be alert to the symptoms outlined in the page above. If they experience any of these symptoms in a confined space, they should immediately leave the area and seek medical attention if necessary.

Asphyxiation is most likely to occur in low-lying areas where heavier-than-air vapors accumulate. An exception to this is methane, or natural gas, which is slightly lighter than air, and may rise to higher levels. Methane is a simple asphyxiant, having no true toxic effect, but it is extremely flammable.

FIGURE 2-1

SUMMARY OF THE EFFECTS OF OXYGEN DEPLETION



ACTIVITIES HAVING ASPHYXIATION POTENTIAL

Petroleum Release Investigations

- entering sewers, basements, trenches

Tank Removals/Repairs

- entering inerted tanks
- entering trenches

NOTES

HEAVY EQUIPMENT

EXHIBIT 2-3

HEAVY EQUIPMENT ACCIDENTS

Some examples of reported accidents involving heavy equipment are presented below.

Coal Worker Accidently Crushes Himself

Indianapolis, IN, 1990 - A worker using a backhoe to remove four 8,000-gallon fuel tanks from the AMAX Coal Co.'s Minehaha mine leans out a broken window of the backhoe cab to remove a chain from the bucket, and accidentally strikes an operating lever. The bucket drops down and crushes him. The federal Mine Safety and Health Administration cites the company for the broken window in the cab and a broken ignition switch on the backhoe.

Worker Maimed in Installation Accident

Tulsa, OK, 1990 - A contractor and his sub-contractor are on a job site preparing to compact the backfill material around a new tank installation. The contractor's employee motions for the track hoe operator (the sub-contractor) to use the bucket to lower the tamper into the hole. The track hoe operator swings the bucket over and sets it down by the employee, who is ready to load the tamper. The employee, thinking the bucket is not moving, turns his back to the bucket to lift the tamper. The track hoe operator as still in the process of tipping the bucket when the employee turns around and catches his foot underneath the teeth of the bucket. The teeth of the bucket pinch off one of his toes and break two others.

EXHIBIT 2-4

GENERAL SITE ACCIDENTS

Some reported accidents caused by a violation of general safety procedures are presented below. Notice the wide variety of forms they take.

Using an air compressor

When an employee using an air compressor shuts down the unit the hose is apparently kinked. The employee grabs the hose, releasing the kink and the pressure that built up in the hose. The force tears the employee's safety glasses off and blows the contact lenses from his eyes. Luckily, he is not injured.

Repairing a submersible pump

Two mechanics called to a service station to repair a submersible pump disable it by turning off the power at the breaker box. As they pull the leak detector, someone in the store turns the breaker back on, causing gasoline to gush out on one of the technicians. He is drenched with fuel and actually swallows some. The other technician runs into the store to turn the pump off and instructs all employees not to touch the breaker panel. The fuel-covered technician loses a day of work due to chemical exposure. The lesson learned by this incident is to make certain every employee in the store is aware that the power is off and that they are not to touch the breaker panel.

Working around unsecured objects

A wooden box lid left unsecured atop the box is blown off by a strong wind and strikes an employee working in the warehouse yard. The employee is transported to the hospital by ambulance and undergoes x-rays and a CAT scan. Luckily, he escapes with a mild concussion and a minor cut on his ear, and is able to return to work the following day.

Repairing a submersible pump

A veteran serviceman is dispatched to a convenience store in response to a report that the customer can not dispense regular unleaded fuel. The serviceman suspects a problem with the submersible pump capacitor. The store operator is present and says he will turn off the power to the unit in question. Upon opening the capacitor housing, the serviceman observes that it is filled with fuel. Without checking the power (which was still on), the serviceman pulls a terminal off the capacitor. This creates a spark which ignites the fumes in the cavity. The serviceman has the presence of mind to snuff out the fire immediately. There is no physical damage or injuries caused by this incident, and all involved are very lucky to have avoided a major disaster. The serviceman points out the company procedures that he did not follow: 1) Don't rely solely upon another person to turn off power to a device. See that you agree with what has been done; 2) "Lock-Out" the breaker or switch that has been turned off by means of a sign or a mechanical device; 3) Check the device being turned off with an electrical tester before proceeding with repairs. Haste can also be faulted in this incident as it was late Friday afternoon.

EXHIBIT 2-4 (con.)

GENERAL SITE ACCIDENTS

Breaking concrete

A jackhammer operator breaking concrete is not paying attention to what he is doing and jackhammers his foot. Unfortunately, he is wearing tennis shoes instead of the steel-toed shoes the company requires. He lacerates his foot, breaks his toe, and loses several weeks of work.

Building a wooden box

An employee building a wooden box steps backward onto a nail which protruded from a board and loses 10 days work as a result of the puncture wound to his foot. This is the second time in the last 2 months the company experiences incidents involving foot punctures. Both accidents involve employees who were on the job six months or less.

Repairing a ceiling-hung reel

The reel is hung from a 2x4 covered by a suspended ceiling at an automobile dealership. In order to repair the reel, the service tech walks out on the 2x4 framing. As he reaches to unbolt the reel he loses his balance and falls through the ceiling. Fortunately, he is able to grab a 2x4 and pull himself back up. The alternative was a 14-foot fall to the cement.

Testing pumps and dispensers

A crew bleeds the pressure off the product lines (or so they think) at a new tank installation and begins to prepare the leak detectors for installation. They dope up the first detector and pull the two-inch plug off the submersible. Product blows out the 2-inch opening and gasoline soaks both employees working in the area. The workmen strip off the clothes they are wearing and wash under a nearby water hose. No fire or explosion results. Procedures now call for pulling the submersible pump completely to drain the product from it before installing leak detectors.

Repairing a card lock system with a defective flow switch

A mechanic called to repair a defective flow switch at a card lock system shuts off the power at the breaker panel, removes the pump panels, and barricades the area surrounding the pump. A friend of the operator comes to the station for product. He goes into the pump control room, turns on the power at the breaker, and somehow finds his way around the barricade. As he starts the pump, fuel sprays from the flow switch opening. Fortunately, the incident does not cause a fire. Procedures now call for locking the breaker out, locking the pump handle, and plugging the hole from which the flow switch is removed.

EXHIBIT 2-4 (con.)

GENERAL SITE ACCIDENTS

Repairing a faulty petroleum pump

A man repairing a faulty pump is working on the hydraulics and electrical components at the same time. A spark from a shorted wire ignites the vapors in the test can, causing it to explode. He dies later that evening as a result of burns suffered in the blast.

Ladder accident

A warehouse employee is standing on ladder while transferring 60-pound boxes from the top of a raised forklift to a storage shelf. One of the boxes catches on a rail at the top of the shelf. While struggling to free the box, the latter starts to tip, causing him to lose his footing. The employee falls approximately 5 feet to the ground, landing on his left hand. He is taken to an area hospital where x-rays revealed a fracture of his left wrist. Surgery is required to repair the damaged joint. Several pins remain in the wrist for 8 weeks, and extensive physical therapy is necessary in order for the employee to regain the function of his wrist and hand. The employee is off work 16 weeks.

Disconnecting equipment from a truck.

A man disconnects a portable air compressor from a truck and forgets to lower the wheel stand on the compressor before disconnecting it from the truck bumper. As he raises the compressor and moves it away from the truck bumper, he loses his balance. The tongue of the compressor chassis drops to the ground and crushes his finger under the hitch. He is off work 5 weeks.

Working inside a sump

An employee is working inside a piping sump at a convenience store that has just been built. The manhole lid and sump cover were removed, and an orange traffic cone was placed adjacent to the hole. As a salesman drives out of the parking lot, he first drives over the traffic cone and then over the manhole where the employee was working. The salesman stops his car only because the traffic cone became wedged in the undercarriage of his vehicle. The mechanic is low enough in the sump to escape injury.

New procedures call for parking a service truck in such a way as to protect the workers from traffic, whether employees are working in an open or closed station.

COMMONLY USED HEAVY EQUIPMENT

- Backhoes
- Front end loaders
- Dump trucks
- Cranes
- Drill rigs

COMMONLY USED HEAVY EQUIPMENT

NOTES

Installing or moving USTs requires the use of a variety of earth-moving and other heavy equipment. Examples of such equipment include backhoes, front end loaders, dump trucks, cranes, and drill rigs. Any one of these pieces of equipment can be dangerous and can cause injury or death.

Some examples of accidents associated with the use of heavy equipment are described in Exhibit 2-3.

SAFETY PRECAUTIONS AROUND HEAVY EQUIPMENT

- Use qualified equipment operators.
- Park vehicles away from trucks and equipment.
- Avoid stacked pipes, hoisting equipment, and heavy rotating components.
- Wear appropriate protective gear.
- Avoid wearing loose or torn clothing.

SAFETY PRECAUTIONS AROUND HEAVY EQUIPMENT

NOTES

To avoid creating unnecessary hazards, operators of heavy equipment should be properly trained and certified to operate equipment they are using. Vehicles should be parked far enough away from other vehicles and equipment to avoid possible collisions.

Stacked pipes can pose a serious construction hazard. Personnel should avoid standing near stacked piping because a single dislodged pipe may cause the entire stack to collapse.

Individuals with long hair should have it tied back or otherwise constrained. Applicable protective gear such as hard hats, goggles, high visibility clothing, hearing protectors, and heavy boots should be worn at all times. Shirts with loose sleeves, trousers with baggy cuffs, torn clothing, and jewelry have a tendency to get caught in machinery and, therefore, should not be worn.

ADDITIONAL GENERAL SAFETY PRECAUTIONS

- Do not touch moving parts.
- Know location of "Emergency Shut Off" switches.
- Do not smoke or use spark-producing equipment.
- Know location of underground and overhead utilities.
- Terminate machine operations during thunderstorms.
- Stay well away from moving equipment.

ADDITIONAL GENERAL SAFETY PRECAUTIONS

Many heavy equipment accidents result when workers touch the moving parts of the machinery. Personnel must pay close attention when operating or working near machinery. Furthermore, personnel must be aware of the location of "Emergency Shut Off" switches on the machinery to avoid serious accidents.

Do not smoke or use spark-producing equipment around excavations because the use of a backhoe or a drill rig may release flammable gasses from the subsurface environment.

There is also the potential of a backhoe or drill rig coming into contact with buried gas, water, electric, sewer, or product lines and even the USTs themselves. This can cause sudden explosions, electrocution, or flooding. Therefore, all lines should be located and clearly marked prior to initiating operations. An additional electrocution hazard can occur during periods of lightning, as the lightning may be attracted to backhoes or crane booms. All operations should be stopped during a thunderstorm.

Many pieces of diesel equipment are not killed by turning off the key. There is typically a fuel shutoff knob that must be pulled, and, in some cases, held, to kill the engine. If there is a high concentration of flammable vapor in the air, it may be impossible to shut off a diesel engine. (This is very rare.)

Older equipment may start while in gear. Do not stand near the equipment when it is being started.

BACKHOES/FRONT END LOADER HAZARDS

Backhoes are used for excavation and soil transfer

Excavations can damage or break underground utilities or product lines, causing:

- Electrocution
- Exposure to toxic substances
- Flooding
- Power outages

Physical hazards of backhoes include swinging buckets and unstable loads

BACKHOE/FRONT END LOADER HAZARDS

NOTES

Earth moving equipment posing the greatest danger includes backhoes and front end loaders. These machines are generally used for excavating trenches and soil transfer during installation and removal actions. During excavation and soil transfer, backhoes and front end loaders can dig up or break utility or product lines. This can result in death due to electrocution, exposure to toxic chemicals, or flooding. Additionally, operation of this equipment creates physical hazards to those not aware of its presence or operation.

The backhoe arm travels from side to side, as well as lengthwise and up and down. Be sure to stand well away from the entire radius of the arm swing.

Backhoes are equipped with outriggers, which help stabilize it during digging. No digging or moving of earth using the arm should be performed without setting the outriggers. Backhoe/front-end loader hybrids are common. The front bucket of these hybrids is operated without the use of outriggers.

DRILL RIGS

Drill rigs are used for soil borings and well installation monitoring

Three types: Mud rotary, air rotary, and plain auger flight

Hazards of drill rigs:

- high pressure air hoses can break, causing serious injury
- rotating parts can sever digits and limbs
- utility lines pose possibility of electrocution

DRILL RIGS

NOTES

Drill rigs may be of the mud rotary or the air rotary types. Note that using an air rotary drill will increase the likelihood of exposure via inhalation, while a mud rotary drill will increase the potential for dermal absorption of chemicals.

Mud rotary rigs may also pose a disposal problem. The muds used often contain traces of barium and other metals which are toxic. EPA has begun to view drilling muds with a critical eye.

Air rotary drills have a number of high pressure hoses that might break and cause injury. The rotating parts of either type of drill rig can sever a digit or limb. Furthermore, digging into the ground always raises the possibility of electrocution from broken utility lines.

Unless wearing the proper protective equipment (see Section 3), avoid contact with cuttings, drilling liquids, and groundwater because they may be contaminated.

CRANES (con.)

- Place hook directly over load being lifted.
- Major hazard; keep minimum 6 feet between boom and overhead power lines.
- When operating under power lines, safety guard installation is recommended.

Cranes should be operated only by trained personnel. Before daily operations start, all equipment used for hoisting, including cables, sheaves, pulleys, boom and hook stops, should be inspected.

A standard set of operating signals should be agreed upon before crane operation, and UST inspectors should become familiar with them. Only one individual should be permitted to give signals to the crane operator.

Personnel should never ride along with loads carried by the crane and crane operators should not swing a load over the heads of other workers around the construction site.

In order to reduce strain on the crane and to prevent the sliding of loads, the crane hook should be directly over the load being lifted.

Workers should use cables or rods to position suspended tanks. They should not stand underneath tanks and use their hands and bodies to adjust the tank's position, or to guide it.

Another serious potential hazard involving cranes is electrocution through contact with a hanging power line. <u>Operators should maintain a minimum distance of 6 feet between the crane's boom and power lines.</u> In order to avoid possible electrocution, <u>ground personnel must refrain from touching the crane if it comes in contact with a power line.</u>

Operators in cabbed equipment should remain in the cab if they come in contact with a live power line, sit still, and avoid touching the cab controls and all metal surfaces.

Installation of a safety guard is also recommended when working beneath power lines. The safety guard, which can consist of an insulated section of the upper boom or an insulated lifting hook, will help to protect both the crane operator and ground personnel.

It should be noted that electrocution can result from more than just contact with power lines. <u>During high humidity conditions, an electrical arc can jump several feet from a power line to a crane</u>.

CRANES (con.)

- Personnel on ground touching the crane or attached wires have greatest electrocution danger during power line contact.

GENERAL SAFETY HAZARDS

- Slips, trips, and falls due to loose materials, such as soil piles and ropes
- Cuts, punctures, and abrasions due to improper use of tools such as cutting torches and jackhammers
- Misuse of compressed gases

OTHER GENERAL SAFETY HAZARDS

NOTES

Besides the specific heavy equipment hazards, UST operations also pose a number of general construction hazards. The majority of general construction accidents are small ones. While not fatal, these accidents are responsible for large amounts of lost work time, personal trauma, and costly medical claims. Injuries due to falls or trips are common, as are puncture wounds, cuts, and abrasions caused by careless use of tools. UST inspectors must be aware that injuries can occur anywhere and at any time. They need to prepare for such eventualities and remain constantly alert while on the job site.

Guidance for the control of general construction hazards can be found in OSHA regulations (29 CFR 1910), which stipulate detailed requirements for the use, storage, and maintenance of equipment and tools.

Some examples of general construction type accidents are described in Exhibit 2-4.

TOXICITY

EXPOSURE ROUTES

- Inhalation
- Skin Absorption
- Ingestion

EXPOSURE ROUTES

There are a number of general symptoms which result from toxic exposure to most of the compounds found at petroleum UST sites. These symptoms include irritation of the eyes, mucous membrane and respiratory tract as well as depression or excitation of the central nervous system.

Petroleum products generally enter the body through inhalation of vapors, absorption (skin or eye contact), or ingestion. Of these three routes, inhalation is the quickest and most efficient route into the body. The adverse affects of inhalation of toxins can be almost instantaneous because the lungs quickly transfer the toxin into the bloodstream. The toxic effect will be proportional to the concentration of the toxin, its toxicity, and the individual's sensitivity to the toxin.

The symptoms of **inhalation** can be vague. Headaches, nausea, dizziness, insomnia, and tremors should not be overlooked.

Exposure via **ingestion** of contaminated water is generally limited, as petroleum in water can be detected by most people in levels as low as 1 ppm.

Visual and olfactory clues as well as site safety screening instruments should be used to assess exposure hazards. Visual cues include seeing stained soils, vapors, or iridescence in water.

Vapors from petroleum products can be smelled when they are at levels far below those considered toxic to humans. However, UST inspectors should not rely solely on their senses to detect toxic levels of vapors, particularly since noses become desensitized to some odors after prolonged exposure. Olfactory sensitivity also decreases with age.

Table 2-8 summarizes the various types of petroleum products and their exposure potentials, exposure target organs and acute and chronic symptoms. Each of these areas is discussed in detail throughout this section.

TYPES OF EXPOSURE

Acute exposure

- short-term, high-level exposure
- effects are usually immediate

Chronic exposure

- long-term, low-level exposure
- effects may take years to appear

TYPES OF EXPOSURE

NOTES

An inspector can face either chronic or acute exposure at a site. **Chronic** is defined as long-term, low-level exposure, while **acute** is defined as short-term, high-level exposure. Both are dangerous and have immediate and long-term health implications. UST-associated work can also expose workers to multiple chemicals which may have **synergistic** effects. This means that the effect of two chemicals together may be greater than the sum of their separate effects. All exposures should be kept as low as reasonably achievable.

Many materials stored in USTs are very common, and many have very low acute toxicity. However, the exposures of the UST inspector are more frequent, of longer duration, and higher than those of the average person. It is this repeated, low-level exposure that is so dangerous, as effects may not be seen for many years. Avoiding unnecessary exposure now can help you enjoy your later years, instead of combatting a chronic illness.

Most exposure can be eliminated if common clues, such as strong odors and instrument readings, are heeded.

ACTIVITIES HAVING TOXIC EXPOSURE POTENTIAL

Release investigations/corrective actions

- petroleum product and vapors
- H_2S in sewers
- asbestos and termiticides in basements

In-place tank closure

- vapors, product, and sludges

Tank/pipe repair/removal

- product and vapors
- "coating" chemicals and petroleum

Leak detection testing

- product and vapors

GENERAL SYMPTOMS OF TOXIC EXPOSURE

- Irritation of eyes, mucous membranes, and respiratory system
- Central nervous system depression and/or excitation
- Headache, nausea, drowsiness, dizziness, insomnia, confusion, tremors
- Dry and red skin upon contact

TOXICITY OF GASOLINE CONSTITUENTS

Aromatics and alkanes may be responsible for most adverse health effects

- carcinogenic properties are attributed to aromatic fractions, particularly benzene (4 to 10 percent of gasoline)
- other aromatics of concern are ethylbenzene, xylene, toluene, and naphthalene
- alkanes have relatively low toxicity
- some alkanes are associated with central nervous system depression, kidney damage (n-hexane and octane)

TOXICITY OF GASOLINE CONSTITUENTS

All petroleum products share the characteristic of causing central nervous system depression. The early symptoms of acute over-exposure can include dizziness, drowsiness, impaired coordination, nausea, euphoria, convulsions, coma, and death, in high enough doses.

The primary route of exposure for these products is **inhalation**. If the products are ingested, do not induce vomiting, since the product may be aspirated into the lung easily. Activated charcoal, followed by "stomach pumping," is the preferred treatment.

Skin contact is not typically an immediate hazard. Prolonged contact will cause burning and blistering. Repeated exposures to skin will result in defatting and possible dermatitis.

ALKANES

Hexane may be the most toxic member of the alkanes. It comprises 11 to 13 percent of gasoline by weight. **Acute exposure** to hexane occurs primarily through inhalation. Vertigo, headaches and nausea are the first symptoms of exposure to be noticed. At high concentrations, central nervous system (CNS) depression results in a narcosis-like state. Pre-narcotic symptoms occur at vapor concentrations of 1,500 to 2,500 ppm as the central nervous system is depressed. Skin contact primarily causes fat removal and irritation. Hexane also irritates the eyes and mucous membranes with even a fairly short-term exposure, for example. 880 ppm for 15 minutes.

Chronic exposure to hexane vapors causes nerve damage. The first clinical sign of nerve damage is a feeling of numbness in the toes and fingers. Further exposure leads to increased numbness in the extremities and to loss of muscular stretching reflexes. Paralysis develops with varying degrees of impaired grasping and walking. In the most severe cases nerve conductivity is neutralized and cranial nerve involvement is also observed and may require several years to recover. In mild or moderate cases, recovery begins six to 12 months after exposure ceases.

Octane, if it is taken into the lungs, may cause rapid death due to cardiac arrest, respiratory paralysis, and asphyxia. It has a narcotic potency similar to heptane. Prolonged skin contact results in a blistering and burning effect.

TOXICITY: AROMATICS

Acute Exposure

- central nervous system effects
- may cause dermatitis, vertigo, headache, nausea, and vomiting

Chronic Exposure

- benzene is a carcinogen, linked to leukemia
- increased risk of kidney cancer and lymphoma
- nerve damage, possible paralysis

TOXICITY OF AROMATICS

NOTES

It is almost impossible to assign a fuel product's acute effects to any given component, since they all have similar actions. Worrying about air concentrations of specific components is not practical. We typically look at total organics.

Benzene is found at concentrations up to 4 percent by weight in gasoline. Older gasolines may contain as much as 13 to 15 percent benzene. **Acute exposure** will depress the central nervous system (CNS) and may cause acute narcotic reactions. The lowest observed threshold for acute exposures is 25 ppm. Headaches, lassitude, and dizziness may become increasingly evident at exposures between 50-250 ppm. Concentrations of 3,000 to 7,500 ppm may result in toxic signs within the hour. Depending on the concentrations and duration of exposure, these effects range from mild symptoms such as headaches and light-headedness to more severe effects such as convulsions, respiratory paralysis, and death. Skin absorption is not considered to be as important a route of entry as inhalation or ingestion because skin absorption is extremely low, with the highest absorption through the palm. Direct contact with the liquid may cause redness and dermatitis.

Benzene is a known carcinogen. Chronic exposure to benzene has been linked to leukemia and irreversible chromosome damage. At the early stages, reversible leukemia, anemia, or a decrease in the blood platelet count may occur. Continued exposure leads to severe bone marrow damage, which results in a deficiency of all cellular elements of the blood. The direct, life-threatening consequence of this is an increased susceptibility to infection and hemorrhaging. The lowest air levels of benzene capable of producing these effects are in the range of 40 to 50 ppm. Effects of high exposure levels (>100 ppm) may persist for many years after exposure has been discontinued. The most important effect resulting from chronic benzene exposure is its hematotoxicity, the targets being the cells of the bone marrow. UST workers may be exposed to as much as 10 ppm in their everyday activities.

Toluene is found in concentrations of up to 4 to 7 percent in gasoline. The primary hazard of acute inhalation exposure is CNS depression. Reaction times will begin to be impaired after exposures of 20 minutes at 300 ppm. Toluene will also cause eye irritation, and prolonged or repeated skin contact may cause dermatitis. As concentrations increase, symptoms can include: muscular fatigue, confusion, tingling skin, euphoria, headache, dizziness, lacrimation, dilated pupils, eye irritation, nausea, insomnia, nervousness, and impaired reaction time. Occupational exposure to toluene has been linked to a higher reported incidence of menstrual disorders. Children born to these women may experience more frequent fetal asphyxia and be underweight.

Xylenes are found in concentrations of 6 to 8 percent in gasoline. Short-term inhalation exposures are associated with narcotic effects on the central nervous system, and high concentrations may lead to CNS depression. Both liquids and vapors are irritating to the skin, eyes, and mucous membranes. Skin absorption of xylenes occurs readily and xylenes can also be transferred across the placenta. Incomplete brain development has been reported in the fetuses of mothers exposed to xylene. **Chronic**, high-level human inhalation exposure results primarily in CNS effects, lack of coordination, nausea, vomiting, and abdominal pain. There are variable effects on the liver, kidneys, and gastro-intestinal tract. Chronic effects of xylenes resemble the acute effects but are more severe. They include headache, irritability, fatigue, digestive and sleep disorders, CNS excitation followed by depression, tremors, apprehension, impaired memory, weakness, vertigo, and anorexia. Xylenes are skin irritants and prolonged contact may cause formation of blisters.

Ethylbenzene is known to be toxic to the liver and kidneys. It will irritate the skin, eyes, and upper respiratory tract. Inhalation of small amounts may exacerbate the symptoms of obstructive airway diseases and cause extensive fluid buildup and hemorrhaging of lung tissue. Although a tolerance to the eye and respiratory effects may develop after a few minutes, CNS effects will usually begin at this stage, leading to CNS depression.

TOXICITY: GASOLINE ADDITIVES

- Tetramethyl and tetraethyl lead (TML and TEL)
- Ethylene dibromide (EDB) and ethylene dichloride (EDC)
- Tri-ortho-cresyl-phosphate (TOCP)

TOXICITY OF ADDITIVES

Gasoline often contains substances that have been added to improve the fuel's performance properties. Gasoline additives of general concern for leaded gasolines are tetramethyl lead (TML) and tetraethyl lead (TEL), as well as ethylene dibromide (EDB) and ethylene dichloride (EDC). Both TML and TEL are used as anti-knock agents; EDB and EDC are used to prevent lead deposition. These compounds are present in low concentrations in gasoline (relative to benzene, toluene, and xylene), but they are quite toxic.

TML and TEL can be absorbed through the skin, ingested, or inhaled. TEL intoxication is caused by inhalation or absorption through the skin. Acute intoxication can occur through absorption of a sufficient quantity of TEL either through brief exposure at a very high rate (100 mg/m^3 for 1 hour) or for prolonged periods at lower concentrations. Exposure can cause acute intoxication. liver and thymus damage, and possibly death from a combination of depression of the central nervous system, respiratory irritation, and bronchiolar obstruction.

Most severe exposure to TEL and TML have resulted from sniffing gasoline. Some victims have shown the symptoms listed as well as fluid buildup in the brain, resulting in swelling and increased intracranial pressure.

NOTES

The signs and symptoms of exposure are often vague and easily missed. The onset of symptoms may even be delayed up to 8 days after exposure and include weakness, fatigue, headache, nausea, vomiting, diarrhea, anorexia, insomnia, and weight loss. Symptoms peculiar to TEL exposure are the sensation of hairs in the mouth and the feeling of insects crawling on the body.

As intoxication worsens, there is confusion, delirium, manic excitement, and catatonia. Nightmares, anxiety, and anorexia are also seen. Loss of consciousness and death may follow after several days. Severe intoxication causes recurrent or continuous episodes of disorientation and intense hyperactivity which may rapidly convert to convulsions that may terminate in coma or death. TEL is likely to have adverse effects on human reproduction and embryonic development.

GASOLINE ADDITIVES: ACUTE EXPOSURE

- Affects central nervous system
- Irritating to mucous membranes, eyes, and skin
- Severe respiratory tract irritation
- Vomiting, diarrhea, abdominal pain
- Delayed lung damage

GASOLINE ADDITIVES: ACUTE EXPOSURE

Acute exposure to gasoline additives is a serious health threat. In general, brief exposure to additives (100 mg/m^3 for 1 hour) can cause acute intoxication and depress the central nervous system. Symptoms include insomnia, confusion, headaches, and tremors, and may be delayed for up to 8 days. Specifically, both EDB and EDC are highly toxic and identified as carcinogenic, although EDC has a much lower potency.

Acute exposure also causes vomiting, diarrhea, abdominal pain and, in some cases, lung damage. The vapor is irritating to the eyes and mucous membranes and may cause liver, kidney, and lung damage, including delayed pulmonary lesions. The liquid form is highly irritable to the skin, causing redness and blistering. Death has occurred following ingestion of 4.5 ml. Recent studies by NIOSH have shown adverse reproductive effects in men.

GASOLINE ADDITIVES: CHRONIC EXPOSURE

Chronic exposure to additives has equally serious health effects. In general, chronic human exposure is associated with adverse effects on the central nervous system, peripheral nerves, kidneys, and vascular system. Adverse effects are also likely on the human reproductive system and embryonic development.

Symptoms of chronic exposure include weight loss, anemia, emotional instability, and toxic psychosis. Recovery may take months to years, and 25 to 30 percent of cases never recover.

GASOLINE ADDITIVES: CHRONIC EXPOSURE

- Weight loss, anemia, emotional instability, and toxic psychosis
- Adverse effects on central nervous system, peripheral nerves, and vascular system
- Adverse effects on reproductive and embryonic development
- Liver and kidney damage.

TOXICITY: MIDDLE DISTILLATE FUELS

- Kerosene, aviation fuels, diesel fuels, and Fuel Oils Nos. 1 and 2
- Oral, dermal, and inhalation exposure
- Major systemic reaction: central nervous system depression
- Skin and mucous membrane irritation
- Constituents of concern: polyaromatic hydrocarbons (PAHs), cresols, phenols

TOXICITY OF MIDDLE DISTILLATES

The **middle distillates** include kerosene, aviation fuels, diesel fuels, and Fuel Oil Nos. 1 and 2. They are referred to as the middle distillates because of the similarity in their degree of volatility during the distillation process. They can be taken into the body by ingestion, absorption, or inhalation.

Kerosene has the least amount of aromatic hydrocarbons of the middle distillate fuels, with benzenes, indanes, and naphthalenes being the major aromatic components. Kerosene and related hydrocarbons are irritating to the skin and mucous membranes, and skin absorption may be significant.

Jet and aviation fuels are mixtures of distillate hydrocarbons that vary in composition from those similar to motor gasoline to kerosene-based fuels used in commercial aircraft. Jet fuels contain additives such as anti-oxidants, metal deactivators, and de-icing agents.

Diesel fuels contain high amounts of naphthalenes, acenaphthalenes, phenanthrenes, and anthracenes. Dermal exposure to diesel oil is toxic to the kidneys.

Generally, No. 2 fuel oil (heating oil) contains a higher volume percentage of benzenes and naphthalenes compared to kerosene and diesel fuels.

Polynuclear Aromatic Hydrocarbons (PAHs) are present in higher concentrations in middle distillate fuels than in gasoline, but less than in the residual fuels. Specific PAHs detected in the middle distillates include naphthalene, benzo(a)anthracene, and benzo(a)pyrene. Benzo(a)anthracene and benzo(a)pyrene are known to be very **carcinogenic** (cancer-causing). PAHs have been shown to cause cytotoxicity in rapidly proliferating cells throughout the body, apparently inhibiting DNA repair. Cytotoxicity causes changes in the cytoplasm of the cell. The vascular system, lymphoid system, and testes are frequently noted as targets of PAHs.

No information about the carcinogenicity of middle distillates in humans is available. However, several members of the middle distillate family, in particular Fuel Oil No. 2 and diesel, have been shown to be weak to moderate carcinogens in animals. **Teratogenic** compounds affect fetal development. No teratogenic effects have been observed in animal tests using kerosene, diesel fuel, and Fuel Oil No. 2.

The chief systemic reaction to the middle distillates is depression of the central nervous system. Effects of exposure are expected to resemble those of kerosene, that is, low oral, moderate dermal, and high inhalation hazard. Symptoms include irritation to the skin and mucous membranes as well as headaches and nausea.

MIDDLE DISTILLATE FUELS: SYMPTOMS OF ACUTE EXPOSURE

- Headache, nausea, mental confusion
- Irritation of respiratory tract, skin, and mucous membranes
- Hemolytic anemia
- Cardiovascular disturbances

MIDDLE DISTILLATE FUELS: SYMPTOMS OF ACUTE EXPOSURE

Acute exposure to middle distillate fuels can lead to headaches, nausea, mental confusion, and irritation of the respiratory system. Further exposure can cause hemolytic anemia and cardiovascular disturbances; in some extreme cases, loss of consciousness can occur. The compounds in the middle distillate fuels that are most likely to be of toxicological concern are non-carcinogenic PAHs, such as naphthalene; the carcinogenic PAHs, benzo(a)-anthracene and benzo(a)-pyrene; and cresols and phenols.

Ingestion or inhalation of naphthalene produces nausea, vomiting and disorientation. It is irritating to the skin and eyes and may cause cataracts. Benzo(a)-anthracene and benzo(a)-pyrene have been detected in Fuel Oil No. 2 and have been classified as probable human carcinogens.

Cresols are highly irritating to the skin, mucous membranes and eyes. They can impair liver and kidney function and cause central nervous system and cardiovascular disturbances. Phenol is toxic to the liver and kidneys.

Several of the components of gasoline are also found in the middle distillate fuels. For example, toluene, xylenes, and ethylbenzene are found in the middle distillates, although in much lower concentrations than in gasoline. Octane on the other hand, is present at much higher concentrations in aviation fuels than in motor gasoline. Additionally, a number of other substances may be found in the middle fractions of petroleum derivatives. These are not covered in this course due to their numbers and complexity. These include components of jet fuel as well as jet and diesel fuel additives, such as Dodecane, Methylcyclopentane, N,N-Dimethylformamide, Manganese Compounds, peroxides, and Alkyl Nitrate and Nitrate/Nitro and Nitroso compounds.

MIDDLE DISTILLATE FUELS:
IMPACTS OF CHRONIC EXPOSURE

- Neurological effects
- Bronchopneumonia
- Toxic to liver and kidneys
- Toxic to vascular and lymphoid systems, and testes
- Probable human carcinogens

MIDDLE DISTILLATE FUELS: IMPACTS OF CHRONIC EXPOSURE

NOTES

Chronic exposure to middle distillate fuels causes neurological effects. One study of aircraft workers consistently exposed to aviation fuel found that a majority experienced recurrent symptoms such as dizziness, headaches, and nausea. Feelings of suffocation, coughs, and palpitations were also prevalent. Inhalation of high concentrations of these vapors can lead to an acute and often fatal bronchopneumonia.

TOXICITY: RESIDUAL FUEL OILS

Fuel Oil Nos. 4, 5, and 6

Cracked bunker fuel and catalytically cracked clarified oil:

- both carcinogenic in animals
- cracked clarified oil is one of the most carcinogenic materials in petroleum refining

Contain higher concentration of polyaromatic hydrocarbons (PAH) than middle distillates, gasolines

TOXICITY OF RESIDUAL FUEL OILS

Fuel Oils Nos. 4, 5, and 6 are commonly referred to as the residual fuels. They are very viscous and have low water solubilities.

Residual fuels are blends of predominately high molecular weight compounds and tend to have a higher concentration of PAHs than gasoline and middle distillates. These fuels often contain blending agents including cracked bunker fuel and catalytically cracked clarified oil. Both of these blending agents have been classified as animal carcinogens. Catalytically cracked clarified oil is recognized as one of the most carcinogenic materials in a petroleum refinery. Acute oral effects of exposure to Fuel Oil No. 6 in animals include lethargy, congestion of liver and kidneys, and intestinal irritation. The heavy metals arsenic, lead, and zinc have been detected in samples of Fuel Oil Nos. 4 and 6.

TOXICITY OF USED OILS

Used oils are the byproduct of using oil as a lubricant. Through this use, the oils pick up a number of substances, such as lead, chromium, cadmium, and chlorinated solvents which are hazardous to human health. Analysis also indicates that PCBs contaminate 18 percent of used oils.

Automotive used oils tend to have a higher concentration of heavy metals, while industrial used oils tend to have a higher concentration of chlorinated solvents and PCBs.

No differences in the concentration of aromatic solvents or PAHs were found.

TOXICITY: USED OILS

- Composition varies: may include lead, chromium, cadmium, chlorinated solvents
- PCBs detected in 18 percent of analyses
- Automotive used oils: higher concentrations of heavy metals
- Industrial used oils: higher concentration of chlorinated solvents and PCBs
- No difference in concentration of aromatic solvents or PAHs

TOXICITY: USED OILS

Heavy metals typically found in used oil include:

Lead	
Pre-1980 stock up	20,000 ppm
1980s stock 100	1,200 ppm
Barium	50 to 500 ppm (4,000 ppm)
Cadmium	2 to 10 ppm
Chromium	3 to 30 ppm
Arsenic	5 to 25 ppm
Zinc	100 to 1,220 ppm

Other contaminants include:

Toluene and xylene	500 to 10,000 ppm
Benzene	100 to 300 ppm
Benzo(a)pyrene and benzo(a)anthracene	50 to 1,000 ppm
Naphthalene	100 to 1,400 ppm

Chlorinated solvents commonly detected in used oil include:

Dichlorodifluoromethane	<1 to 2,200 ppm
Trichlorotrifluoroethane	<20 to 550,000 ppm
1,1,1-Trichloroethane	<1 to 110,000 ppm
Trichloroethylene	<1 to 40,000 ppm
Tetrachloroethylene	<1 to 32,000 ppm

Table 2-3
SUMMARY OF TOXILOGICAL EFFECTS

	Exposure Potential	Exposure Pathway	Target Organs	Symptoms:	
				Acute	Chronic
Motor Gasoline	54.5% of U.S. Petroleum Market	Ingestion Inhalation Absorption	Lungs, Intestinal organs, Kidneys	Low Exposure; drowsiness, vertigo, vomiting. High Exposure: Unconsciousness, hemorrhaging of lungs and intestines, death	Kidney Damage Probable human carcinogen
Middle Distillate Fuels	32.7% of U.S. Petroleum Market	Ingestion Inhalation Absorption	Central Nervous System, Mucous membranes, skin, eyes, liver kidneys	Headache, nausea, mental confusion, irritation of respiratory tract, skin and mucous membranes. Hemolytic anemia, cardiovascular disturbances	Neurological effects, broncho-pneumonia, toxic effect in cells, hemotopoitic system, lymphoid system, and testes. Probable human carcinogen
Residual Oil Fuels	11.7% of U.S. Petroleum Market	Ingestion Inhalation Absorption	Liver, Kidneys, intestines	Oral effects of No. 6 fuel oil in animals include lethargy, congestion of liver and kidneys, and intestinal irritation.	N/A
Constituents: AROMATICS-Benzene	4% of Gasoline (by weight)	Ingestion Inhalation Absorption	Central nervous system, skin, kidneys, bone marrow	Low Exposure: dermatitis, headache, light headedness. High Exposure: dizziness, nausea, vomiting, convulsions, respiratory paralysis, death	Benzene is a known human carcinogen. Anemia, leukemia, and decrease in blood packet count. Severe bone marrow damage resulting in deficiency of all cellular elements of the blood, increased susceptibility to infection and hemorrhagic conditions. Irreversible chromosome damage
Toluene	4-7% of Gasoline (by weight)	Ingestion Inhalation Absorption	Central nervous system, eyes, skin	Muscular fatigue, confusion, tingling skin, euphoria, headache, dizziness, lacrimination, dilated pupils, eye irritation, nausea, insomnia, nervousness, impaired reaction time	Dermititus Higher reported incidence of menstrual disorders, low birthweight and fetal asphyxia. Incomplete fetal brain development due to placental transfer.

Table 2-3 (con.)
SUMMARY OF TOXILOGICAL EFFECTS

	Exposure Potential	Exposure Pathway	Target Organs	Symptoms:	
				Acute	Chronic
Xylenes	6 8% of Gasoline (by weight)	Ingestion Inhalation Absorption Placental transfer	Central nervous system, skin, liver, kidneys, gastrointestinal tract, eyes, nose, throat, mucous membranes, placenta	Narcotic effects on the central nervous system, CNS depression at high concentration Irritation of the skin, eyes, nose, throat, and mucous membranes Impaired reaction time, manual coordination, and body balance Nausea, vomiting, abdominal pain, loss of appetite Placental transfer has resulted in incomplete fetal brain development	Central nervous system excitation followed by depression, tremors, apprehension, irritability, impaired memory, incoordination, fatigue, dizziness, headache, anorexia, sleep disorders Variable effects on liver and kidneys, irritant effects on gastrointestinal trace, abdominal pain, nausea, digestive disorders Prolonged skin contact may cause formation of vesicles
Ethylbenzene		Ingestion Inhalation Absorption	Liver, kidney, skin, eyes, upper respiratory tract, lung tissue, and central nervous system	Irritates the skin, eyes, and upper respiratory tract Inhalation of small amounts causes extensive edema and hemorrhage of lung tissues Skin contact may yield inflamation Eye irritation and lacrimation are immediate and severe at 2000 ppm, accompanied by moderate nasal irritation -- tolerance develops after several minutes; CNS effects begin at roughly six minutes At 5000 ppm irritation to eyes, nose and throat is intolerable	Known to be toxic to liver and kidneys Depresses central nervous system Irritation and damage to lung tissue may exacerbate the systems of other obstructive airway diseases
Trimethylbenzenes	NA	Ingestion Inhalation Absorption	Central nervous system, lungs, blood	Nervousness, tension, anxiety, asthmatic bronchitis, hypochromic anemia, and impacts on blood coagulation	Unknown

Table [illegible] (con.)
SUMMARY OF TOXILOGICAL EFFECTS

	Exposure Potential	Exposure Pathway	Target Organs	Symptoms:	
				Acute	Chronic
ALKANES & ALKENES - Hexane	11-13% of gasoline (by weight)	Ingestion Inhalation Absorption	Central nervous system, skin, eyes, mucous membrances, (kidneys?)	Initially dizziness, headaches, nausea Pre-narcotic symptoms occur at vapor concentrations of 1500 to 2500 ppm CNS depression yields a narcosis-like state at high concentrations Skin, eye, and mucous membrane irritation observed at fairly 880 ppm for 15 minutes	Nerve damage, initially as numbness in the extremeties, increasing to loss of muscular stretching reflexes, eventual paralysis in varying degrees, with neutralized nerve conductivity and cranial nerve involvement in most severe cases Recovery begins 6-12 months after exposure ceases in mild/moderate cases; severe cases may require several years to recover
Octane		Ingestion Inhalation Absorption	Central nervous system, lungs, respiratory system, skin	Direct aspiration into the lungs may cause rapid death due to cardiac arrest, respiratory paralysis, and asphyxia Narcotic potency similar to heptane	Although narcotic effects can be expected from octane exposure, the CNS effects observed with heptane are not found with octane Prolonged dermal exposure results in blistering and burning effects
Isopentane	NA	Ingestion Inhalation Absorption	Central nervous system skin, eyes	Exhilaration, dizziness, headache, nausea, confusion, inability to do fine work, persistent taste of gasoline, loss of consciousness in extreme cases Inhalation of up to 500 ppm appears to have no effect in humans, higher concentrations cause irritation to skin and eyes	Repeated or prolonged skin contact will dry and defat skin resulting in irritation and dermatitus

Table 2-3 (con.)
SUMMARY OF TOXILOGICAL EFFECTS

Exposure Potential	Exposure Pathway	Target Organs	Symptoms:	
			Acute	Chronic
ADDITIVES - Tetraethyl & Tetramethyl Lead	Ingestion Inhalation Absorption	Central nervous system, peripheral nerves, liver, kidney, thymus, human reproductive system, and hematopoietic system	Weakness, fatigue, headache, apllor, tremors, nausea, vomiting, diarrhea, anorexia, weight loss, insomnia, irritability, delirium Peculiar sensation of hair in the mouth, feeling of insects on skin Progressive vegetative disturbances: hypotonia, hypothermia, and bradycardia Higher intoxication: confusion, delirium, manic excitement, and catatonia	Loss of consciousness and death may follow after several days Severe intoxication: recurrent or continuous episodes of disorientation and intensive hyperactivity, rapidly coverting to convulsions, terminating in coma or death Death may occur from a combination of CNS depression, respiratory irritation, and bronchiolar obstruction TEL is likely to adversely affect human reproduction and embryonic development
Ethylene Dibromide & Ethylene Dichloride	Ingestion Inhalation Absorption	Central nervous system, liver, kidneys, lungs, eyes, mucous membranes, skin, human reproductive system	Inhalation exposure causes vomiting, diarrhea, abdominal pain, delayed lung damage and CNS depression Vapor is irritating to eyes and mucous membranes Liquid forms are highly irritating to skin resulting in marked erythema and vesiculation Ingestion has led to death Exposure may result in lung, liver, and kidney damage	EDB and EDC are highly toxic Both EDB and EDC are identified as carcinogens, although EDC has a much lower potency Exposure causes liver and kidney damage and often results in delayed pulmonary lesions Recent studies by NIOSH have shown adverse male reproductive effects
Tri-ortho-cresyl Phosphate (TOCP)	Ingestion Inhalation Absorption	Spinal cord, peripheral nervous system	Nausea, vomiting, diarrhea, and abdominal pain	Acute symptoms followed by a [illegible] period of 3 to 30 days [illegible] soreness, numbness of [illegible] muscles, and toes progressing to foot and wrist drop Recovery may take months to years; 20-25% of cases never recover

MONITORING INSTRUMENTATION

CHEMICAL HAZARDS REQUIRING MONITORING

- Airborne toxics (during product handling, transfer, product release)
- Oxygen-deficient atmospheres (in confined spaces)
- Combustible vapors (in confined spaces, product handling, product release)
- Hydrogen Sulfide/Methane (entering sewers)

CHEMICAL HAZARDS REQUIRING MONITORING

NOTES

As stated earlier, toxic substances enter the body via the skin, ingestion or inhalation. Of these three routes, inhalation is the quickest and most efficient route into the body. The adverse effects produced by inhalation of a toxic substance can be almost instantaneous because the lungs efficiently and rapidly transfer the inhaled substances to the bloodstream, which distributes it to all parts of the body. The toxic effect will be proportional to the concentration of the toxin in the air, its toxicity, and an individuals' sensitivity to the toxin. More detailed information on specific toxicity hazards may be found in the section on toxicity in this manual.

The objective of this section is to introduce various monitoring instruments which can warn inspectors of some of the major chemical hazards they might face such as airborne toxic substances, oxygen deficient atmospheres, combustible gases/vapors, and hydrogen sulfide. These can appear during product handling, transfer or release, or while working in confined spaces.

MONITORING INSTRUMENTS

Hazards can be measured by:

- Direct Reading Instruments (DRIs)
- Compound-Specific Detectors

DRIs effectively detect:

- organic and inorganic vapors
- oxygen deficient atmospheres
- explosive atmospheres
- specific compounds, such as H^2S

MONITORING INSTRUMENTS

The major chemical hazards faced by UST inspectors can be measured by **Direct Reading Instruments** (DRIs) or **Compound Specific Detectors.** The most commonly used instruments are Direct Reading Instruments which can effectively detect both inorganic and organic vapors, oxygen deficient atmospheres, explosive atmospheres, and specific compounds such as hydrogen sulfides.

Most DRIs respond to many different substances. This characteristic is desirable because it allows for fast identification of dangerous situations, yet information about specific substances often cannot be determined directly. All DRIs have inherent constraints in their ability to detect hazards:

- They usually detect and/or measure only specific classes of chemicals.
- They are generally not designed to measure and/or detect airborne concentrations below the 1 ppm level.
- Many of the DRIs that have been designed to detect one particular substance also detect other substances (that is, they are prone to interferences) and may give false readings.

For example, some hydrogen cyanide gas DRIs, if installed backwards will change color in the presence of acetic acid.

INSTRUMENT CERTIFICATION

All instruments should be certified safe in explosive atmospheres.

Certified instruments permanently carry plate showing testing by:

- Underwriters Labs;
- Factory Mutual; or
- Mine Health and Safety Administration.

INSTRUMENT CERTIFICATION

NOTES

Explosion hazards are a major concern at UST sites; instruments used by UST inspectors must not contribute to the hazard by being potential sources of ignition.

A number of engineering, insurance, and safety organizations have established definitions and developed codes for testing electrical devices used in hazardous situations. The National Fire Protection Association publishes the National Electrical Code (NEC) every three years. Underwriters Laboratories, Factory Mutual, and the Mine Health and Safety Administration conduct tests to certify that monitoring instruments meet the minimum standards of acceptance set by the NEC.

An electrical instrument certified for use in hazardous locations under one of these test methods, will carry a permanently affixed plate. This plate will show the logo of the laboratory that granted the certification and the Class(es), Division(s), and Group(s) the instrument was tested against. If an instrument does not have an approved rating, it should not be used in a hazardous or potentially hazardous situation.

INSTRUMENT CERTIFICATION (con.)

Instruments certified by Class, Division, and Group

•	CLASS I	Potentially flammable gas/vapor
•	CLASS II	Potentially explosive dust
•	DIVISION 1	Explosive conditions exist routinely
•	DIVISION 2	Explosive conditions exist only after unintentional release

The instrument certification categories included are divided into classes, divisions, and groups. There are two classes covering "potentially flammable gas/vapor" and "potentially explosive dust." There are two divisions including "explosive conditions exist routinely" and "explosive conditions exist only after an unintentional release." And finally, there are six groups divided according to specific compounds such as acetylene, hydrogen and similar gases, and others. <u>The categories of instruments most likely to be encountered at UST sites are approved for Class 1, Division 1, Groups A, B, C, and D.</u>

Because of the wide variability of compounds that can be encountered at an UST site, instruments are more typically certified for multigroups of substances. This affords the widest applicability possible.

INSTRUMENT CERTIFICATION (con.)

GROUP A	Acetylene
GROUP B	Hydrogen and similar gases
GROUP C	Ethyl ether, cyclopropane, carbon disulfide
GROUP D	Methane, butane and most solvents
GROUP E-F	Explosive dusts

DIRECT READING INSTRUMENTS

- Oxygen meter
- Hydrogen sulfide meter
- Detector tubes
- Combustible gas indicator (CGI)
- Flame ionization detector (FID)
- Photoionization detector (PID)

DIRECT READING INSTRUMENTS

NOTES

This course discusses six instrument types, all of which are Direct Reading Instruments. These include oxygen meters, hydrogen sulfide meters, combustible gas indicators, detector tubes, flame ionization detectors, and photoionization detectors. **UST inspectors should be thoroughly trained in and familiar with the use and interpretation of all of these instruments.**

OXYGEN METER

Function: Detect oxygen percentage in air

- most models detect 0 to 25 percent range
- a few models detect 0 to 10 percent or 1 to 100 percent

How they work: electrochemical sensor

- air pumped into meter diffuses onto semipermeable membrane
- reaction between oxygen and electrodes produces minute current
- current moves the needle indicator

OXYGEN METER

NOTES

The **oxygen meter** has three principal components: the air flow system, the oxygen sensing element, and the microamp meter. Air is drawn into the detector with an aspirator bulb or pump. The detector uses an electrochemical sensor to determine the oxygen concentration. The sensor consists of two electrodes (a sensing and a counting electrode), a housing containing the basic electrolytic solution, and a semipermeable teflon membrane.

Oxygen molecules diffuse through the membrane into the solution. Reactions between the oxygen and the electrodes produce a minute electric current which is directly proportional to the sensor's oxygen content. The current passes through the electronic circuit and the resulting signal is shown as a needle deflection on a meter.

Oxygen measurements are most informative when paired with combustible gas measurement. Together they provide quick and reliable hazard data. A lower oxygen reading will show a lower combustible gas reading; while a higher oxygen reading will show a higher combustible gas reading. In general, oxygen measurements should be taken before combustible gas indicator readings.

OXYGEN METER LIMITATIONS

- Altitudes changes skew calibrations
- Best when paired with CGI measurements (take oxygen readings first)
- Oxidants (such as ozone) affect readings
- CO_2 interferes with the detector

OXYGEN METER LIMITATIONS

NOTES

The use of an oxygen meter has limitations, since its operation depends on absolute atmospheric pressure. An oxygen meter calibrated at sea level and operated at an altitude of several thousand feet will falsely indicate an oxygen-deficient atmosphere. Furthermore, oxidants, such as ozone and interfere with detectors. Chlorine, Fl, Br, and acid gases are all potent oxidants (oxidizers). An oxygen measurement should be paired with a combustible gas measurement in order to ensure reliability.

HYDROGEN SULFIDE INDICATOR

- Function: detect hydrogen sulfide levels in air
- How it works: similar to oxygen meter
- Limitations: cross sensitivity (for example, HCN)

HYDROGEN SULFIDE INDICATOR

NOTES

Hydrogen sulfide indicators range from simple color change devices to sophisticated electronic meters. With the electronic versions, sample air is introduced to the sensor by passive diffusion or active pumps through a gas-porous semipermeable membrane. The cell electro-oxidizes the gas in proportion to the gas partial pressure in the sample. The resulting electrical signal is then amplified to run the meter.

Hydrogen sulfide gas can be fatal if inhaled in sufficiently high concentrations. UST inspectors would be most likely to encounter H_2S in sewers. The gas has a strong "rotten egg" odor. UST inspectors should never rely on their olfactory senses as a means of determining concentrations of H_2S, since the gas "deadens" the sense of smell (i.e., the olfactory nerves will adjust to and tolerate concentrations of H_2S).

Also, some individuals are congenitally unable to smell H_2S.

No hydrogen sulfide meters are sensitive at less than 1 ppm. In addition, they are cross sensitive to hydrogen cyanide, therefore, they can, in certain instances, give misleading readings.

COMBUSTIBLE GAS INDICATOR (CGI)

Function: measures flammable vapor concentrations in air

- results shown as percentage of lower flammable limit
- measure O_2 percentage before using CGI

How it works: operates on "hot wire" principle

- combustion chamber with platinum filament
- gas combustion raises filament temperature
- increased temperature causes resistor circuit "imbalance"

COMBUSTIBLE GAS INDICATOR

NOTES

The **Combustible Gas Indicator** (CGI) or explosimeter is one of the first instruments that should be used when surveying a site. It measures the concentrations of flammable vapors or gases in air and indicates the results as a percentage of the lower explosive limit (LEL) of the calibration gas. Before using a CGI, however, the percentage of oxygen should be measured with an oxygen meter.

The LEL of a combustible gas is the lowest concentration by volume in air which will explode, ignite, or burn when there is an ignition source. The UEL is the maximum concentration of a gas or vapor which will ignite. Above the UEL, there is insufficient oxygen for the fuel level to support combustion. Below the LEL there is insufficient fuel to support ignition.

Most CGIs operate on the "hot wire principle." In the combustion chamber there is a platinum filament that is heated. This filament is an integral part of a balanced resistor circuit called the Wheatstone Bridge. The hot filament combusts the gas(es) on the immediate surface of the element, thus raising the temperature of the filament. Any single gas, or mixture of combustible gases, will cause the meter to react; the effect of this trait must be understood by the CGI operator.

As the temperature of the filament increases so does the resistance. This change in resistance causes an imbalance in the Wheatstone Bridge. This is measured as the ratio of combustible vapor present compared to the total required to reach the LEL of the combustible gas used to calibrate the CGI. If a concentration greater than the LEL and less than the UEL is present, the meter needle will stay beyond the 1.0 (100 percent) level of the meter. This indicates that the ambient atmosphere is readily combustible. When the atmosphere has a gas concentration above the UEL, the meter will rise above the 1.0 mark and then return to zero. This occurs because the gas mixture in the combustion cell is too rich to burn. This permits the filament to conduct a current as if the atmosphere contained no combustibles at all. For this reason, it is critical to always watch the meter, since this rapid deflection may go undetected.

This is not a problem with most of the newer meters equipped with an audible alarm.

There is a relatively new detector system for flammables on the market now. Some detectors are using a tin oxide sensor. The tin oxide coating on the surface of the sensor has only a limited number of electrons available for conduction of electricity. Oxygen, which is highly electronegative, tends to gain electrons. Normal oxygen content will pull most of the electrons away from the tin oxide, reducing its ability to conduct electricity (high resistance). As concentrations of a flammable gas increase, oxygen "turns away" from the tin oxide to interact with the flammable compounds. The newly freed electrons can now flow, and resistance drops. The resistance changes are calibrated to be proportional to a specific flammable gas. This technology can also be used to detect non-flammable vapors as well.

Pros and cons of this technology are not yet fully field-tested, but it is reasonable to assume that varying oxygen concentrations can cause ambiguous readings, and that cross-sensitivities exist. The sensor is reported to be poisoned by halogenated gases.

COMBUSTIBLE GAS INDICATOR LIMITATIONS

Limitations: must watch needle continuously

- when concentrations above UEL but below UEL, meter needle stays beyond 1.0 (100 percent) mark
- when concentrations above UEL, meter rises above 1.0 mark and quickly returns to zero

Always use with oxygen meter

Do not use in oxygen enriched or deficient areas

Leaded gasoline may "poison" internal filament

Gives accurate readings for the "calibration gas" only

COMBUSTIBLE GAS INDICATOR LIMITATIONS

There are limitations to the use of a combustible gas indicator. As mentioned previously, the needle of the indicator must be watched continuously because a reading above UEL will return to zero. For a more accurate measure of combustible gases, readings should be taken at ground, waist, and overhead positions to insure detection of vapors whose densities are greater or less than air.

The following substances may "poison" the detection filaments: fuming acids, leaded gasolines, silicones, silicates and other silicon containing compounds. When it is suspected that these substances have been aspirated, the CGI should be checked with a calibration kit; if leaded gasolines are anticipated, additional filaments should be on hand. There are also catalytic filters available for use with leaded gasolines. The instrument should not be switched On/Off unless it is known that you are in a combustion free environment. The CGI reads only from 0 to 100 percent of the calibration gas, often either methane or propane. Therefore, when another combustible gas is detected, the exact meter reading is not correct and cannot be relied upon. To provide additional safety factors, field crews should discontinue operations where combustible gas is measured above 25 percent of the LEL for a methane or propane calibrated CGI.

DETECTOR TUBES

Function: measure levels of petroleum, other gases

How It Works: "Detecting chemicals" change color

- air is drawn through tube
- color change intensity shows gas concentrations

Limitations

- accuracy only within 25 percent of concentration
- interfering gases can affect readings
- slow and tedious
- subjective results determination

DETECTOR TUBES

Detector tubes (also known as calorimetric and indicator tubes) measure levels of petroleum and other gases. They are small glass tubes filled with a solid absorbent and impregnated with detecting chemicals. Air is drawn through the tube at a controlled rate, and airborne contaminants will change the color of the detecting chemicals. The intensity of the color change is taken as an index of the contaminant concentration. Because specific tubes exist for the detection of hydrocarbons and other petroleum product constituents, they can be effectively used at UST sites as a screening tool, but they are not very accurate.

There are two basic types of detector tubes:

- Stain length
- Color density

Stain length tubes are graduated, and the length of the color change is proportional to concentration. Stain length tubes are more convenient.

One limitation of detector tubes is that their accuracy is limited to within 25 percent of the true concentration of the contaminant. Furthermore, some gases can interfere with the reading. It is a relatively slower and more tedious approach to measuring contaminants than some other instruments. The color or stain must be evaluated immediately, as many colors fade rapidly. Finally, with some tubes, the air flow must be in one direction only; this is typically indicated by an arrow or a dot. This type of tube usually contains a drying agent or a precleaning layer ahead of the indicating chemical, to remove interfering gases or vapors, or an oxidizing layer which releases a certain part of the vapor test molecule which reacts with the indicating chemical.

FLAME IONIZATION DETECTOR (OVA)

Function: two modes

- survey mode detects volatile organic concentrations
- Gas Chromatograph Mode separates and measures individual components

How It Works:

- sample drawn into hydrogen flame
- sample burns, ions produce current, read by meter

FLAME IONIZATION DETECTOR

NOTES

Flame Ionization Detectors (FIDs) (sometimes called organic vapor analyzes or OVAs) are used to detect concentrations of volatile organics. An OVA consists of two major parts: (1) a 9-pound package containing the sampling pump, battery pack, support electronics, flame ionization detector, and hydrogen gas cylinder; and (2) a hand held meter/sampling probe assembly. When the sample reaches the hydrogen flame it burns and the resulting ions carry an electric current. The current is then amplified and displayed on the probe's meter. The measurement equals the total concentration of organic compounds relative to the calibration standard.

The FID can operate in two different modes. In the **survey mode**, it can determine the approximate concentration of all detectable volatile organic chemicals in the air. The **gas chromatograph** (GC) **mode** separates and measures individual components. This is done by drawing a sample into the FID's probe which is then carried to the detector by an internal pump.

FLAME IONIZATION DETECTOR (OVA) (con.)

Limitations:

- manufacturer internally calibrates to methane; for other compounds, adjustments and/or calibration charts needed
- only detects organic compounds
- requires high quality hydrogen (transport regulated by DOT)
- lead acid battery loses power in cold weather, affecting readings

In the GC mode, a small sample of ambient air is injected into a chromatographic column and carried through the column by a stream of hydrogen gas. Contaminants with different chemical structures are retained on the column for different lengths of time (known as retention times) and, hence, are detected separately by the flame ionization detector. A strip chart recorder can be used to record the retention times and peaks (concentrations), which are then compared to the retention times of a standard with known chemical constituents.

Limitations of the OVA include the fact that it is internally calibrated by the manufacturer (usually to methane), and therefore, does not give an exact reading for other compounds. The OVA can only detect organic compounds, however, since petroleum products are organic compounds, this poses no major problem.

The OVA needs high-quality hydrogen to operate. Hydrogen transport is regulated by the U.S. Department of Transportation. If the OVA's hydrogen tank is empty, it can be shipped without restriction. Once on-site, however, plans have to be made for the acquisition of high quality hydrogen.

Lead-acid batteries are used by the OVA and they tend to lose power in cold weather which could cause problems with on-site usage.

Finally, OVA's do not detect compounds less than 1 ppm in concentration.

PHOTOIONIZATION DETECTOR (HNu)

Function: detects total organic and some inorganic gases

How it works:

- sample subjected to ultraviolet radiation
- ions produced, meter reads resulting current
- easier to use than the OVA
- calibrated to benzene equivalent (isobutylene)

PHOTOIONIZATION DETECTOR

Photoionization Detectors (PIDs) are one way to detect organic vapors. The HNu system portable photoionizer detects concentrations of organic gases and a few inorganic gases. The basis for detection is the photoionization of gaseous species. The incoming gas molecules are subjected to ultraviolet radiation which ionizes a number of gaseous compounds. Each particle is changed into charged-ion pairs creating a current between two electrodes which can be read by a meter. The HNu measures the total concentration of those organic (and some inorganic) vapors in air that have an ionization potential less than or equal to the energy of the probe.

The HNu consists of two modules connected via a signal-power cord; a readout unit consisting of a meter, a battery, and electronics; and a sensor unit consisting of a light source, a pump, and an ionization chamber.

The photoionization detector is easier to use than the OVA and it has a lower detection limit. The system is usually calibrated to a benzene substitute such as isobutylene and reads benzene directly.

Two other photoionization detector models are the TIP manufactured by photovac and the OVM manufactured by Envirotherm. These two models, unlike the HNu, have the ability to retain readings in memory which can then be down loaded into the computer at a later date.

PHOTOIONIZATION DETECTION (HNu) (con.)

Limitations:

- radio frequency interference may skew readings
- high humidity, temperature differentials "cloud" UV lamp window, depressing readings
- lead acid battery loses power in cold weather, affecting readings

The HNu system does have a number of limitations. It can be susceptible to radio frequency interference from power lines, transformers, high voltage equipment, and radio transmissions. Also, the window of the UV lamp must be cleaned on a regular basis to insure that airborne contaminants are ionized. Finally, the HNu system also uses a lead-acid battery. These batteries lose power in cold weather and can be unreliable. Once the batteries have been severely discharged, they may no longer accept a charge and will need to be replaced. For these reasons, the unit should be placed on the battery charger after every use. The HNu charge circuit has a protector that prevents overcharging.

SITE HEALTH AND SAFETY PLANS

SAFETY PLAN PREPARATION

Planning is the most critical element of UST investigations.

- **Anticipate and prevent hazards to minimize risk to workers and the public.**
- Key to successful site safety = a **site health and safety plan.**

SAFETY PLAN PREPARATION

UST investigations require that all operations be planned ahead of time in order to keep problems to a minimum. Anticipating and preventing potential accidents is the best way to protect workers and the public from injury. The major aspect of planning for any hazardous field activity is the development and implementation of a comprehensive safety plan that considers each specific phase of an operation. This plan identifies all potential hazards, and specifies methods to control these hazards; prescribes work practice, engineering controls and PPE; and defines areas of responsibility.

The plan describes the organizational structure for site operations (most appropriate for use at state-lead cleanup sites) and plans for coordination with existing response organizations including the local fire marshal, police, ambulance, and emergency care facility.

The plan should be prepared by an individual knowledgeable in health and safety and at a minimum, reviewed and approved by personnel knowledgeable in industrial hygiene and health and safety.

SAFETY PLAN PURPOSE

The purpose of a safety plan is to provide guidelines and procedures required to assure the health and safety of those personnel working at sites. While it may be impossible to eliminate all risks associated with site work, the goal is to provide state-of-the-art precautionary and responsive measures aimed at assuring the use of proper occupational health and safety procedures for the protection of on-site personnel, the general public, and the environment.

A written safety plan basically outlines the steps workers should follow when on-site, and eliminates the uncertainties of memory by providing a checklist for inspectors to use when preparing to go on site. Sample checklists are provided in the appendix.

SAFETY PLAN PURPOSE

- Assures systematic attention to health and safety issues
- Specifies procedures to protect on-site personnel, general public, and environment
- Eliminates memory uncertainties; provides checklist for on-site activity

SAFETY PLAN CONTENTS

- Expected field activities
- Potential hazards and control guidelines
- Work practices and engineering controls
- Monitoring and protective equipment required
- Personnel roles and responsibilities
- Emergency procedures and contacts

SAFETY PLAN CONTENTS

NOTES

The safety plan is intended to:

- Provide a systematic consideration of health and safety issues in the preparation and execution of site work and enhance the ability of team members to use their best professional judgement in reducing hazards.

- Describe potential hazards and specify applicable guidelines, standards, and regulations, and appropriate emergency responses to such hazards.

- Prescribe work practices, engineering controls, and personal protection to protect team members.

- Prescribe monitoring equipment to detect and measure potential exposures to hazardous substances.

- Prescribe guidance for changing work practices and personal protection levels in response to changing site conditions.

- Provide a list of emergency contacts.

A sample safety plan is provided in the appendix for your information.

SAFETY PLAN HAZARD ASSESSMENT

Most difficult and critical plan element

Should be conducted by knowledgeable individual

Should consider:

- chemical and physical hazards
- environmental conditions
- interplay between work activities and hazards

SAFETY PLAN HAZARD ASSESSMENT

The most difficult and critical aspect of the safety plan is assessing all possible potential hazards that may arise. If possible, the plan should identify all of the potential hazards and describe methods to control them.

Safety is defined as the practical certainty that harm will not occur. A safety plan based on reliable information will reduce the measure of risk by preventing, or at least, minimizing human exposure to hazards. Note that exposure consists of human contact with a hazard. A **hazard** is defined as any substance, situation, or condition that is capable of doing harm to human health, property and/or the environment. Note that this definition does not say that the hazards will do harm, but merely that is has the capability to do so.

The activities required to accurately assess risks and determine their acceptability can be divided into three interacting elements:

- Recognition: Identifying the substances, situations or conditions that may be hazardous and the characteristics that determine the degree of hazard.
- Evaluation: Comparing the potential impact of the risk to acceptable levels of impact or risk.

SAFETY PLAN HAZARD ASSESSMENT

- Control: Instituting methods to eliminate or reduce the impact of the potential hazards.

The **risk** associated with a potential hazard is defined as the probability of harm to human health, property or the environment. Inspectors need to plan for effective control of both physical and health hazards often encountered at UST facilities. Inspectors are strongly encouraged to use site-specific checklists to ensure control of potential hazards.

While on-site, hazardous conditions may be in a continuous state of flux (particularly vapor-related hazards). As new monitoring results become available, inspectors should evaluate the relative risk on-site and if necessary, make adjustments in work practices or PPE.

HANDLING EMERGENCIES

- Identify/confirm off-site emergency services and capabilities.
- Define rapid evacuation procedures for workers (audible warning signals, etc.).
- Prepare list of emergency equipment available on-site.

HANDLING EMERGENCIES

NOTES

The site specific checklists in the safety plan should identify all nearby emergency services, including fire and rescue services, hospitals, ambulances, medivacs, police departments, public health departments, explosives experts, and hazardous materials response teams.

The checklists should also include a list of emergency equipment available on-site. At a minimum, the checklists should include the following:

- A list of emergency service organizations that may be needed. Arrangements for using emergency organizations should be made prior to the initiation of site activities. Evaluate their capability to handle the sort of emergencies that might occur.
- A list of emergency equipment. This list should include emergency equipment available on site, as well as transportation, fire fighting and equipment to mitigate emergencies, for example, booms and sorbents.
- A list of utility company contacts, such as power, electrical, gas, and telephone.

SITE HEALTH AND SAFETY PLAN FOR UNDERGROUND STORAGE TANK INSPECTIONS

The following is a generic site health and safety plan for underground storage tank inspections. As indicated throughout the plan, selected sections should only be filled out by people with technical expertise in health and safety issues. In addition, State organizations using this plan should set up a system to ensure that: (1) the plan is used properly and (2) staff follow proper safety procedures.

PART I

Part I (Sections I-IV) should be completed by the UST inspector prior to the site visit.

SECTION I. GENERAL SITE INFORMATION

SITE NAME AND ADDRESS:

CONTACT PERSON AND PHONE NUMBER:

SITE IDENTIFICATION NUMBER:

PROPOSED DATE(S) OF SITE WORK:

SECTION II. DESCRIPTION OF INSPECTION ACTIVITY

PURPOSE OF ACTIVITY:

New Tank Installation	( )
Tank Closure	( )
Tank/Pipe Removal	( )
Tank/Pipe Disposal	( )
Petroleum Release Investigation	( )
Tank/Pipe Repair	( )
Leak Detection Testing	( )
Installation of Monitor Wells/Sampling	( )

PROVIDE A BRIEF NARRATIVE DESCRIPTION OF THE PROPOSED INSPECTION ACTIVITIES:

SECTION III. SPECIFIC SITE INFORMATION

SPECIFIC TANK SYSTEM INFORMATION:

Age/Size/Capacity of Tanks and Piping:

Contents of Tank:

Other (Specify):

TYPE OF SITE

CHECK ALL APPROPRIATE:

__Active
__Inactive
__Industrial facility
__Gas station

__TSDF
__R & D Facility
__Military base
___Other (Specify)

RELEASE HISTORY

No evidence of leaks or soil contamination	( )
Suspected or known leaks and soil contamination	( )
Known groundwater contamination	( )

BACKGROUND AND DESCRIPTION OF ANY PREVIOUS INVESTIGATIONS OR INCIDENCE:

BACKGROUND INFORMATION STATUS: ( ) COMPLETE ( ) INCOMPLETE

SECTION IV. POTENTIAL HEALTH AND SAFETY HAZARDS

ANTICIPATED PHYSICAL HAZARDS OF CONCERN: (CHECK ALL THAT APPLY AND DESCRIBE)

___Heat (high ambient temp.)
___Cold
___Noise
___Oxygen depletion
    ___Asphyxiation

___ Excavation
    ___Cave-ins
    ___Falls, trips, slipping

___Handling and transfer of petroleum products
    ___Fire
    ___Explosions

___Heavy equipment
    ___Physical injury and trauma resulting from moving machinery

___General construction
    ___Physical injury and trauma
    ___Electrical Hazards

___Confined space entry
    ___Explosions

___Other (Specify)

ANTICIPATED BIOLOGICAL HAZARDS: (LIST BELOW)

__ Snakes
__ Insects
__ Rodents
__Poisonous plants
__Other

NARRATIVE: (Provide all information which could impact Health and Safety -- e.g., power lines, integrity of dikes, terrain, etc.)

ANTICIPATED CHEMICAL HAZARDS: (LIST BELOW ALL CHEMICALS PRESENT ON SITE; ATTACH MATERIAL SAFETY DATA SHEETS-MSDS)

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

PART II

Section V should only be completed by persons with technical expertise in health and safety.

SECTION V. EVALUATION OF POTENTIAL HAZARDS

CHEMICALS OF CONCERN

Chemical	Highest Observable Concentration (media)	PEL/ TLV	IDLH	Symptoms/ Effects of Acute Exposure

PART III

Sections VI and VII should be completed by the UST inspector prior to the site visit.

SECTION VI. METHODS TO CONTROL POTENTIAL HEALTH AND SAFETY HAZARDS

MONITORING INSTRUMENTATION: (NOTE: MONITORING INSTRUMENTS MUST BE USED FOR ALL OPERATIONS UNLESS APPROPRIATE RATIONALE OR RESTRICTIONS ARE PROVIDED).

____Organic Vapor Analyzer

____Photoionization Detector

____Combustible Gas Indicator (CGI)

___Oxygen Meter

___Hydrogen Sulfide Meter

____Detector Tubes (specify)

____Other, specify (toxic gas, air sampling pumps, etc.)

IF MONITORING INSTRUMENTS ARE NOT USED, SPECIFY RATIONALE OR JUSTIFICATION <u>OR</u> ACTIVITY/AREA RESTRICTIONS.

ACTION LEVELS (breathing zone):

Combustible Gas Indicator

0 - 10%	LEL	No Explosion Hazard
10 -25%	LEL	Potential Explosion Hazard; Notify Site Health and Safety Officer
>25%	LEL	Explosion Hazard; Interrupt Task/Evacuate

ACTION LEVELS (breathing zone): continued

Oxygen Meter

<21.0%	O_2	Oxygen Normal
<21.0%	O_2	Oxygen Deficient; Notify Site Health and Safety Officer
<19.5%	O_2	Oxygen Deficient; Interrupt Task/Evacuate

Photoionization Detector Specify:

( ) 11.7 ev
( ) 10.2 ev
( ) 9.8 ev

Type:

Flame Ionization Detector Specify:

Type:

Detector Tubes Specify:

Type

Type

Type

PERSONAL PROTECTIVE EQUIPMENT: List all applicable items

Minimum personal protective equipment:

1. Hardhat
2. Safety glasses/goggles
3. Steel toed/shank shoes or boots
4. Flame retardant coveralls
5. Hearing protection (muffs or ear plugs)

Is additional PPE required? YES / NO

PERSONAL PROTECTIVE EQUIPMENT continued

Check all additional necessary items:

__ Uncoated tyvek coveralls
__ Saranex tyvek coveralls
__ Rubber boots
__ Overboots
__ Surgical (inner) gloves
__ Butyl/neoprene/viton/nitrile outer gloves

__Full face respirators
type of cartridge:__
__SCBA / SAR
__ELSAs
__Other (specify):

VII. EMERGENCY INFORMATION

Emergency Contact:

Fire/Rescue:

Ambulance:

Police:

Hazardous Waste Material Response Units

Health and Safety Director:

Poison Control Center:

On-site medical facility (clinic): YES / NO

Facility health and safety officer: YES / NO

Name:

Phone number:

Hospital Name and Address:

Directions to hospital (include a map):

PART IV

SECTION VIII. PLAN APPROVAL

Plan prepared by: ____________________ (Date)

Plan approved by: ____________________ (Date)

Plan approved by: ____________________ (Date)

OXYGEN MONITORS, CGIs AND SPECIFIC CHEMICAL MONITORS

I. INTRODUCTION

Many hazards may be present when responding to hazardous materials spills or uncontrolled waste sites. These include oxygen deficient atmospheres, combustible/explosive atmospheres, toxic atmospheres and radiation. There are several types of instrumentation for detecting hazardous atmospheres. This section will discuss combustible gas indicators, oxygen monitors and monitors for specific chemicals.

II. OXYGEN MONITORS

Oxygen monitors are used to evaluate an atmosphere for:

- oxygen content for respiratory purposes. Normal air is 20.8% oxygen. Generally, if the oxygen content decreases below 19.5%, it is considered oxygen deficient and special respiratory protection is needed,

- increased risk of combustion. Generally, concentrations above 25% are considered oxygen-enriched and increase the risk of combustion,

- use of other instruments. Some instruments require sufficient oxygen for operation. For example, some combustible gas indicators do not give reliable results at oxygen concentrations below 10%. Also, the inherent safety approvals for instruments are for normal atmospheres and not for oxygen-enriched ones,

- the presence of contaminants. A decrease in oxygen content can be due to the consumption (by combustion or a reaction such as rusting) of oxygen or the displacement of air by a chemical. If it is due to consumption then the concern is the lack of oxygen. If it is due to displacement then there is something present that could be flammable or toxic. Since oxygen makes up only 20.8% of air, a 1% drop in oxygen means that about 5% air (air being 1 part oxygen and 4 parts nitrogen) has been displaced. This means that 5% or 50,000 ppm (1% = 10,000 ppm) of "something" could be there.

Most indicators have meters which display the oxygen concentration from 0-25%. There are also oxygen monitors available which measure concentrations from 0-5% and 0-100%. The most useful range for hazardous material response is the 0-25% oxygen content readout since decisions involving air-supplying respirators and the use of combustible gas indicators fall into this range.

The oxygen sensor can be on the outside (external) or inside (internal) of the instrument. Internal sensors need a pump - battery operated or hand operated - to draw a sample to it.

OXYGEN MONITORS, CGIs, AND SPECIFIC CHEMICAL MONITORS

Units that combine O_2 meters and combustible gas indicators into one instrument are available from many manufacturers. Also, flashing and audible alarms can be found on many instruments. These alarms go off at a pre-set oxygen concentration to alert the users even if they are not watching the meter. A list of manufacturers of oxygen monitors are found in this manual in section **MANUFACTURERS & SUPPLIERS OF AIR MONITORING EQUIPMENT.**

A. Principle of Operation

Oxygen monitors use an electrochemical sensor to determine the oxygen concentration in air. A typical sensor consists of: two electrodes; a housing containing a basic electrolytic solution; and a semi-permeable Teflon membrane **(FIGURE 1)**.

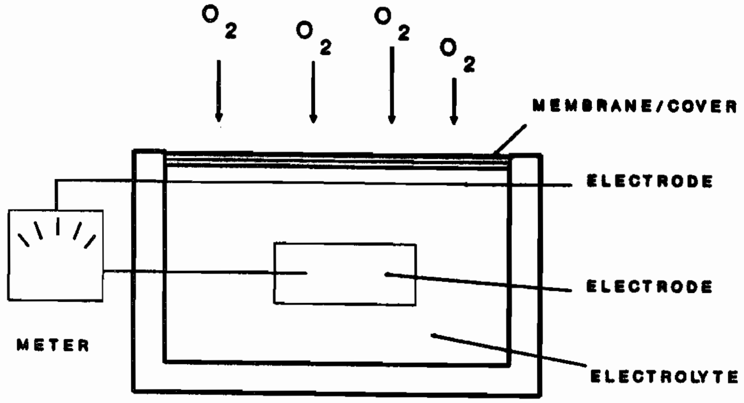


FIGURE 1
SCHEMATIC OF OXYGEN SENSOR

Source: Atmospheric Monitoring for Employee Safety, BioMarine Industries Inc.

Oxygen molecules (O_2) diffuse through the membrane into the solution. Reactions between the oxygen, the solution and the electrodes produce a minute electric current proportional to the oxygen content. The current passes through an electronic circuit which amplifies the signal. The resulting signal is shown as a needle deflection on a meter or as a digital reading.

In some units, air is drawn into the oxygen detector with an aspirator bulb or pump; in other units, the ambient air is allowed to diffuse to the sensor.

* B. Limitations and Considerations

The operation of oxygen monitors depends on the absolute atmospheric pressure. The concentration of atmospheric oxygen is a function of the atmospheric pressure at a given altitude. While the actual percentage of oxygen does not change with altitude, at sea level the weight of the atmosphere above is greater, and more O_2 molecules (and the other components of air) are compressed into a given volume than at higher elevations. As elevation increases, this compression decreases, resulting in fewer air molecules being "squeezed" into a given volume. Consequently, an O_2 indicator calibrated at sea level and operated at an altitude of several thousand feet will falsely indicate an oxygen deficient atmosphere because less oxygen is being "pushed" into the sensor. Therefore, it is necessary to calibrate at the altitude the instrument is used.

The reaction that produces the current in the sensor is non-reversible. Thus, once the sensor is exposed to oxygen, it begins to wear out. The normal life span of a sensor is 6 months to one year. Sensors are shipped in sealed packages which have been purged with nitrogen. The packet should not be opened until the sensor is to be used. Storing the sensor in an oxygen absent atmosphere after opening the package can prolong the sensor life, but may not be practical.

High concentrations of carbon dioxide (CO_2) may shorten the useful life of the oxygen sensor. As a general rule, the unit can be used in atmospheres greater than 0.5% CO_2 only with frequent replacing or rejuvenating of the sensor. Lifetime in a normal atmosphere (0.04% CO_2) can be from 6 months to one year depending on the manufacturer's design. The service life of one sensor is 100 days in 1% CO_2 and 50 days in 5% CO_2.

Strong oxidizing chemicals, like ozone and chlorine, can cause increased readings and indicate high or normal O_2 content when the actual content is normal or even low.

Temperature can affect the response of oxygen indicators. The normal operating range for them is between 32°F and 120°F. Between O°F and 32°F the response of the unit is slower. Below O°F the solution may freeze and damage the sensor. The instrument should be calibrated at the temperature it will be used. High temperature can also shorten the sensor life.

III. COMBUSTIBLE GAS INDICATORS

Combustible gas indicators (CGIs) measure the concentration of a flammable vapor or gas in air, indicating the results as a percentage of the lower explosive limit (LEL) of the calibration gas.

The LEL (or LFL - lower flammable limit) of a combustible gas or vapor is the minimum concentration of the material in air which will propagate flame on contact with an ignition source. The upper explosive limit (UEL) is the maximum concentration. Below the LEL there is insufficient fuel to support combustion. Above the UEL, the mixture is too "rich" to support combustion so ignition is not possible. Concentrations between the LEL and UEL are considered flammable.

CGIs are available in many styles and configurations. The combustible gas sensor can be on the outside (external) or inside (internal) of the instrument. Internal sensors need a pump - battery operated or hand operated - to draw a sample to it. Many units are "combination meters". This means they have an O_2 meter and CGI (and sometimes one or two specific gas indicators) combined in the same instrument. Flashing and audible alarms are options on many units. The alarms go off at a pre-set concentration to warn the instrument operator of potentially hazardous concentrations. Other options such as longer sampling lines, moisture traps and dust filters are also available. Manufacturers of CGIs are listed in Section 8.

A. Principle of Operation

Combustible gas indicators use a combustion chamber containing a filament that combusts the flammable gas. To facilitate combustion the filament is heated or is coated with a catalyst (like platinum or palladium), or both. The filament is part of a balanced resistor circuit called a Wheatstone bridge (**FIGURE 2**). The hot filament combusts the gas on the immediate surface of the element, thus raising the temperature of the filament. As the temperature of the filament increases so does its resistance. This change in resistance causes an imbalance in the Wheatstone bridge. This is measured as the ratio of combustible vapor present compared to the total required to reach the LEL. For example, if the meter reads 50% (or 0.5, depending upon the readout), this means that 50% of the concentration of combustible gas needed to reach a flammable or combustible situation is present. If the LEL for the gas is 5% then the meter would be indicating that a 2.5% concentration is present. Thus, the typical meter indicates concentration up to the LEL of the gas. (See **FIGURE 3a**.)

If a concentration greater than the LEL and lower than the UEL is present, then the meter needle will stay beyond the 100% (1.0) level on the meter. (See **FIGURE 3b**.) This indicates that the ambient atmosphere is readily combustible. When the atmosphere has a gas concentration above the UEL the meter needle may rise above the 100% (1.0) mark and then return to zero. (See **FIGURE 3c**.) This occurs because the gas mixture in the combustion cell is too rich to burn. This permits the filament to conduct a current just as if the atmosphere contained no combustibles at all. Some instruments have a lock mechanism that prevents the needle from returning to zero when it has reached 100%. This mechanism must be reset in an atmosphere below the LEL.

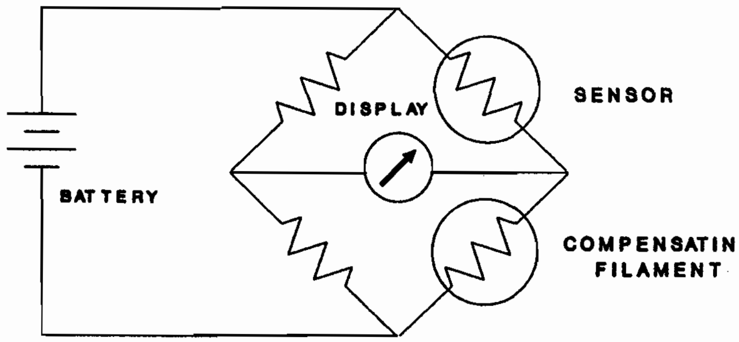


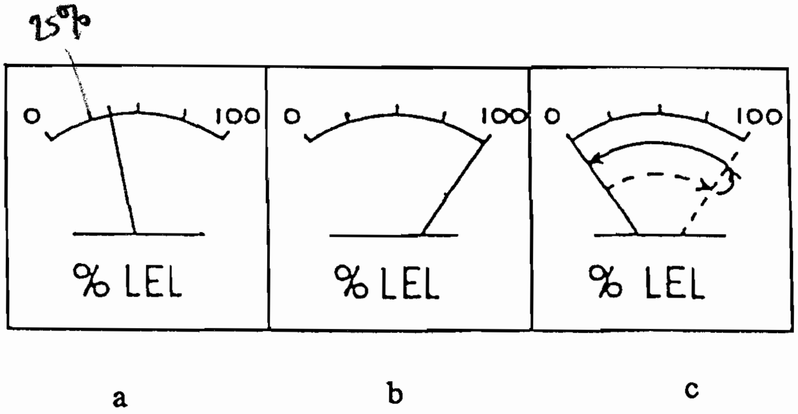
FIGURE 2
WHEATSTONE BRIDGE CIRCUIT

Source: <u>Atmospheric Monitoring for Employee Safety</u>, BioMarine Industries Inc.

B. Limitations and Considerations

The instruments are intended for use only in normal oxygen atmospheres. Oxygen-deficient atmospheres will produce lowered readings. Also, the safety guards that prevent the combustion source from igniting a flammable atmosphere are not designed to operate in an oxygen-enriched atmosphere.

Organic lead vapors (e.g., leaded gasoline), sulfur compounds, and silicone compounds will foul the filament. Acid gases (e.g., hydrogen chloride and hydrogen fluoride) can corrode the filament. Most units have an optional filter that protects the sensor from leaded vapors.



Lower than LEL

Between the LEL and the UEL

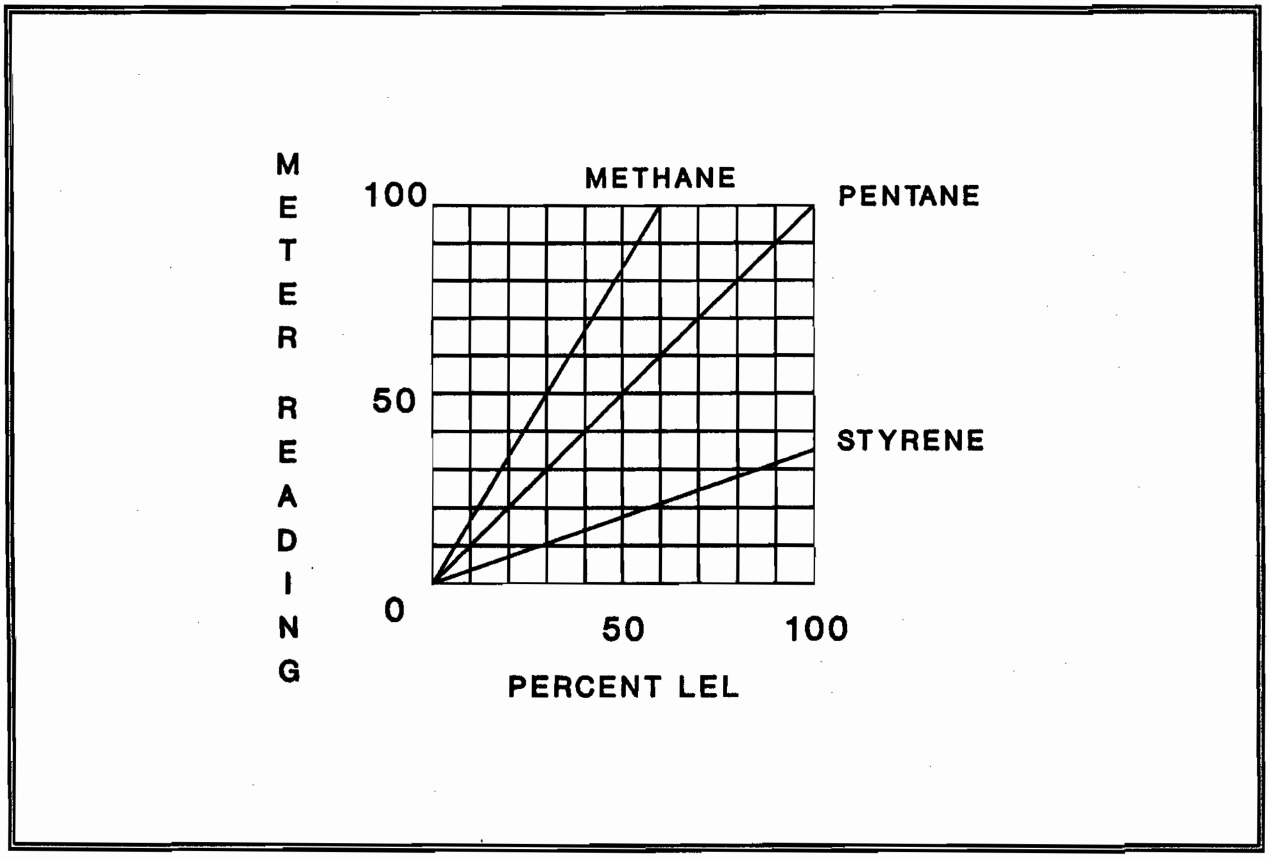
Above the UEL

FIGURE 3
COMPARISON OF METER READINGS TO COMBUSTIBLE GAS CONCENTRATIONS

The response of the instrument is temperature dependent. If the temperature at which the instrument is zeroed differs from the sample temperature, the accuracy of the reading is affected. Hotter temperatures raise the temperature of the filament and produce a higher than actual reading. Cooler temperatures will reduce the reading. The instrument should be calibrated and zeroed at the same temperature that a reading will be taken. Some instruments have a compensating filament (see **FIGURE** 2). This filament is similar to the sensor and is exposed to the same atmosphere, but it does not combust the atmosphere. It compensates for any temperature changes not due to the combustible gas.

There is no differentiation between petroleum vapors and combustible gases. If the flammability of the combined vapors and gases in an atmosphere is the concern, this is not a problem. However, if the instrument is being used to detect the presence of a released flammable liquid - like gasoline - in a sewer system where methane may be present, the operator can't tell if the reading is the contaminant or the methane. A pre-filter can be used to remove the vapors but will not remove the methane. Thus, if readings are made with and without the filter, the user can compare the readings and can conclude that differences in the values indicate that a petroleum vapor (i.e., the contaminant) is present.

Relative response is also a concern. If the CGI is used to monitor a gas/vapor that the unit is not calibrated to, it can give inaccurate results. GRAPH 1 illustrates the effect of relative response.



GRAPH 1
EXAMPLES OF RELATIVE RESPONSE CURVES FOR MSA MODEL 260

Source: Portable Gas Indicator, Model 250 and 260, Response Curves, Mine Safety Appliances Company, Pittsburgh, PA.

IV. TOXIC ATMOSPHERE MONITORS

Along with oxygen concentration and flammable gases or vapors, there is also a concern about chemicals present at toxic concentrations. This usually involves measurements at concentrations lower than would be indicated by oxygen indicators or combustible gas indicators. There is a need to determine if toxic chemicals are present and identify them so the environmental concentration can be compared to exposure guidelines. Toxic atmosphere monitoring is done to:

- identify airborne chemicals and their concentrations,
- evaluate the exposure of workers and the public,
- evaluate the need for and type of personal protective equipment,
- develop controls for exposure in the form of engineered safe guards, work practices, safety plans, and work zones.

There are several different groups of instruments that can be used for these functions. In this manual the following types will be discussed.

- *Colorimetric indicators* include detector tubes, chemical impregnated tape and color changing badges. Further discussion will be found in one of the exercise.
- *Specific chemical sensors* are electronic devices that are designed to respond to a specific chemical. More discussion will follow.
- *Total vapor survey meters* have detectors (e.g. PID or FID) that respond to a variety of chemicals. Additional information can be found in Section 4.
- *Gas chromatographs* are used to help identify what chemicals are present in the atmosphere. Further information will be found in Section 5.

Specific chemical monitors are gas monitors which utilize either electrochemical cells (similar to oxygen sensors) or metal oxide semi-conductors (MOS) for detecting specific chemicals.

A. Principle of Operation

Electrochemical cells (**FIGURE 1**) contain a chemical solution and two or more electrodes. The chemical reacts with the solution or the electrodes. The reaction can be a generation of electrical current or a change in conductivity of the solution. The change in signal is expressed as a needle movement or a digital response on a meter. The selectivity of the sensor depends on the selection of the chemical solution and the electrodes.

There are electrochemical sensors for ammonia, carbon monoxide, carbon dioxide, chlorine, hydrogen chloride, hydrogen cyanide and hydrogen sulfide. Examples of these instruments are Compur's **Monitox®** Personal Monitor Alarms, MDA's **MSTox 8600** series, and National Draeger's **PAC** series of personal monitors.

MOS detectors, also called solid-state sensors, consist of a metal oxide film coating on heated ceramic substrate fused or wrapped around a platinum wire coil. When a gas comes in contact with the metal oxide, it replaces oxygen in the oxide and alters the conductivity of the semiconductor. The change in conductivity can be expressed in a meter readout. The bead is heated to give a constant baseline as oxygen in the air can combine with the oxide. Selectivity can be determined by selecting specific metal oxides and/or using specific temperatures from the heater to prevent chemicals reacting.

There are MOS detectors for ammonia, carbon monoxide, hydrogen chloride, hydrogen cyanide, hydrogen sulfide, methyl chloride, nitrogen oxides and sulfur dioxide. Examples of instruments that use a MOS to detect specific toxic compounds are the Enmet **Tritechtor®** and Biosystem's **Model 100** series.

Specific chemical sensors can be used in a single unit for monitoring just that chemical or can be combined in a unit with a combustible gas indicator and oxygen meter.

B. Limitations and Considerations.

The sensors are not always specific. There can be interferences. For example, many of the carbon monoxide sensors will also respond to hydrogen sulfide. In fact, one manufacturer uses the same sensor for both carbon monoxide and hydrogen sulfide detection. The user must inform the instrument which chemical is being monitored so the readout is in the proper units.

The sensors are designed for temperatures between 32°F and 140°F. Lower temperatures can reduce response time or even freeze the sensor. MOSs are also effected by elevated temperature since the resistance of the sensor changes with temperature. Electrochemical sensors may wear out faster at higher temperatures.

Some of the reactions are non-reversible. The sensors will wear out during use. The life span of an electrochemical sensor is about 6 months to 1 year.

MOSs cannot be operated in an absence of oxygen. They can also be saturated by high concentrations of chemicals.

MOSs need a minimum of 10% humidity. They may also be affected by high humidity. Electrochemical cells can be "dried out" by low humidity atmospheres.

V. CONCLUSION

There are many hazards that can be present at a hazardous materials operation. There are instruments for determining the presence of hazardous situations like combustible atmospheres, oxygen deficient atmospheres and toxic atmospheres. The instruments discussed in this section can only identify certain hazardous situations and should be selected and used accordingly. Additional instrumentation on identifying and evaluating toxic atmospheres will be discussed in the following sections.

EXPOSURE LIMITS AND ACTION LEVELS

TABLE 1
ATMOSPHERIC HAZARD ACTION GUIDES

Monitoring Equipment	Hazard	Level	Action
Combustible Gas Indicator	Explosive	< 10% LEL	Continue monitoring with caution.
		10-25% LEL	Continue monitoring, but with extreme caution, especially as higher levels are encountered.
		≥ 25% LEL	Explosion hazard! Withdraw from area immediately.
Oxygen Concentration		< 19.5%	Monitor wearing SCBA. NOTE: Combustible gas readings not valid in atmospheres < 19.5% oxygen.
		19.5-25%	Continue Monitoring with caution. SCBA not needed based <u>only</u> on oxygen content.
		> 25%	Discontinue monitoring. Fire potential! Consult specialist.
Radiation Survey Instrument	Gamma Radiation	< 1mR/hr	Continue monitoring. Consult a Health Physicist.
		≥ 1 mR/hr	Continue monitoring only upon the advice of a Health Physicist.
Colorimetric Tubes	Organic & inorganic vapors/gases	Depends on chemical	Consult reference manuals for air concentration vs. toxicity data.
Photoionization Detector	Organic vapors/gases	Depends on chemical	Consult reference manuals for air concentration vs. toxicity data.
Flame Ionization Detector	Organic vapors/gases	Depends on chemical	Consult reference manuals for air concentration vs. toxicity data.

<u>NOTE</u>: The correct interpretation of any instrument readout is difficult. If the instrument operator is uncertain of the significance of a reading, especially if conditions could be unsafe, a technical specialist should immediately be consulted. Consideration should be given to withdrawing personnel from the area until approval, by the safety officer, is given to continue operations.