Attachment A

Daily Safety Procedures Acknowledgement Sheet

Daily Health and Safety Tailgate Meeting Check List

Project:	Project #:	Date:
Site Location:		
Scope: (check all that apply) ☐drilling ☐soil sampling ☐gw sampling ☐system maintenance/installation ☐excavation ☐construction/demolition ☐work in public right-of-way ☐other:	Site Safety Officer:	

Time of Tailgate/H&S Meeting:_____

☐Scope of work communicated to all personnel

H&S Topics (check as discussed):

☐HASP on site
☐Site Safety Officer identified
☐Identify hazards
- ☐Confined space
- ☐Oxygen deficiency
- ☐Electrical hazards
- ☐Mechanical hazards (tools & equipment)
- ☐Medical hazards
  - ☐Acoustic
  - ☐Chemical (info. sheets/MSDS)
  - ☐Temperature
  - ☐Lifting
  - ☐Exhaustion (rest/ breaks)
- ☐Physical (i.e., slips/trips/falls)
- ☐Explosive/Flammable
- ☐Biological
- ☐Other:_____

☐Air quality monitoring (use respirators ≥ _____ ppmv)
☐Work zone areas
☐Site security and control measures
☐Evaluate PPE needed (No Level A or B work)

Hard hat:	☐LEVEL D	☐LEVEL C
Safety glasses:	☐LEVEL D	☐LEVEL C
Safety goggles:	☐LEVEL D	☐LEVEL C
Steel-toe boots:	☐LEVEL D	☐LEVEL C
Long pants:	☐LEVEL D	☐LEVEL C
Work gloves:	☐LEVEL D	☐LEVEL C
Nitrile gloves:	☐LEVEL D	☐LEVEL C
Reflective vest:	☐LEVEL D	☐LEVEL C
Tyvek:	☐LEVEL D	☐LEVEL C
Respirator:	☐LEVEL D	☐LEVEL C
Hearing Protection:	☐LEVEL D	☐LEVEL C

Other:_____

☐Emergency Procedures
- ☐Medical treatment, CPR, & first aid
- ☐Hospital location
- ☐Notifications & incident reporting

☐Special project considerations exist(see below)

Other Procedures: (check when action completed)

☐Identify if site will remain operating during work
☐Identify how adverse weather will affect safety
☐All work personnel reportedly medically fit
☐Identify jobs that require special certifications
☐Establish housekeeping protocol
☐Establish tool use guidelines
☐Establish digging/augering safety protocols
☐Establish runoff, dust, and vapor controls
☐Identify emergency shut-down controls
☐Identify underground/aboveground utilities
☐Recent USA markings are present and legible
☐Identify confined space areas
☐Establish decon procedures
☐Establish waste handling and storage procedures
☐Identify vehicle parking areas
☐Establish communication standard
☐Establish smoking rules
☐Identify location of fire extinguishers
☐Identify location of telephones (mobile & fixed)
☐Identify location of first aid kit
☐Identify personnel that are CPR/First Aid trained
☐Establish hot work protocols & permitting
☐Inspect equipment for operational safety
☐Safety barriers/cones/signs are sufficient for job
☐Establish traffic control measures
☐Identify sanitation facilities
☐Identify equipment that requires grounding
☐Establish visitor procedures
☐Establish extra precautions for high profile site
☐Conduct H&S orientation for late arrivals
☐_____
☐_____
☐_____
☐_____
☐_____
☐_____
☐_____
☐_____
☐_____
☐_____

H&S DISCUSSION/COMMENTS/ITEMS REQUIRING FOLLOW-UP:

Signature of Site Safety Officer:

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Daily Health and Safety Tailgate Meeting Sign-In Sheet

Project:	**Project #:**
Date of Tailgate Meeting:	**Time of Meeting:**

SITE WORKERS

I attended this Tailgate Meeting and understand the hazards at this site. All my health and safety concerns as they pertain to the site location and scope of work have been addressed.

	Worker's Name (Print) and Signature	***Company***	***Comments***
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

SITE VISITORS

I have been briefed by the Site Safety Officer about the hazards at this site and understand that I am only allowed to participate as an observer working from areas outside of the work zone and hazardous areas. All my health and safety concerns as they pertain to the site location and my visit have been addressed.

	Visitor's Name (Print) and Signature	***Agency/Company***	***Time of Briefing***
A			
B			
C			
D			

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Attachment B

Material Safety Data Sheets

Health	2
Fire	1
Reactivity	0
Personal Protection	H

Material Safety Data Sheet
Trichloroethylene MSDS

Section 1: Chemical Product and Company Identification

Product Name: Trichloroethylene

Catalog Codes: SLT3310, SLT2590

CAS#: 79-01-6

RTECS: KX4560000

TSCA: TSCA 8(b) inventory: Trichloroethylene

CI#: Not available.

Synonym:

Chemical Formula: C2HCl3

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call: 1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Trichloroethylene	79-01-6	100

Toxicological Data on Ingredients: Trichloroethylene: ORAL (LD50): Acute: 5650 mg/kg [Rat]. 2402 mg/kg [Mouse]. DERMAL (LD50): Acute: 20001 mg/kg [Rabbit].

Section 3: Hazards Identification

Potential Acute Health Effects: Hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), of ingestion, of inhalation.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Classified + (PROVEN) by OSHA. Classified A5 (Not suspected for human.) by ACGIH.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance is toxic to kidneys, the nervous system, liver, heart, upper respiratory tract.
Repeated or prolonged exposure to the substance can produce target organs damage.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Cold water may be used. Do not use an eye ointment. Seek medical attention.

Skin Contact:
After contact with skin, wash immediately with plenty of water. Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Be particularly careful to clean folds, crevices, creases and groin. Cover the irritated skin with an emollient. If irritation persists, seek medical attention. Wash contaminated clothing before reusing.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek medical attention.

Inhalation: Allow the victim to rest in a well ventilated area. Seek immediate medical attention.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek medical attention.

Ingestion:
Do not induce vomiting. Loosen tight clothing such as a collar, tie, belt or waistband. If the victim is not breathing, perform mouth-to-mouth resuscitation. Seek immediate medical attention.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 420°C (788°F)

Flash Points: Not available.

Flammable Limits: LOWER: 8% UPPER: 10.5%

Products of Combustion: These products are carbon oxides (CO, CO2), halogenated compounds.

Fire Hazards in Presence of Various Substances: Not available.

Explosion Hazards in Presence of Various Substances:
Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards: Not available.

Section 6: Accidental Release Measures

Small Spill: Absorb with an inert material and put the spilled material in an appropriate waste disposal.

Large Spill:
Absorb with an inert material and put the spilled material in an appropriate waste disposal. Be careful that the

product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapour/spray. Wear suitable protective clothing In case of insufficient ventilation, wear suitable respiratory equipment If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes

Storage:
Keep container dry. Keep in a cool place. Ground all equipment containing material. Carcinogenic, teratogenic or mutagenic materials should be stored in a separate locked safety storage cabinet or room.

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Splash goggles. Lab coat. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 50 STEL: 200 (ppm) from ACGIH (TLV)
TWA: 269 STEL: 1070 (mg/m3) from ACGIH
Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid.

Odor: Not available.

Taste: Not available.

Molecular Weight: 131.39 g/mole

Color: Clear Colorless.

pH (1% soln/water): Not available.

Boiling Point: 86.7°C (188.1°F)

Melting Point: -87.1°C (-124.8°F)

Critical Temperature: Not available.

Specific Gravity: 1.4649 (Water = 1)

Vapor Pressure: 58 mm of Hg (@ 20°C)

Vapor Density: 4.53 (Air = 1)

Volatility: Not available.

Odor Threshold: 20 ppm

Water/Oil Dist. Coeff.: The product is equally soluble in oil and water; log(oil/water) = 0

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, methanol, diethyl ether, acetone.

Solubility:
Easily soluble in methanol, diethyl ether, acetone.
Very slightly soluble in cold water.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Not available.

Incompatibility with various substances: Not available.

Corrosivity:
Extremely corrosive in presence of aluminum.
Non-corrosive in presence of glass.

Special Remarks on Reactivity: Not available.

Special Remarks on Corrosivity: Not available.

Polymerization: No.

Section 11: Toxicological Information

Routes of Entry: Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
Acute oral toxicity (LD50): 2402 mg/kg [Mouse].
Acute dermal toxicity (LD50): 20001 mg/kg [Rabbit].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified + (PROVEN) by OSHA. Classified A5 (Not suspected for human.) by ACGIH.
The substance is toxic to kidneys, the nervous system, liver, heart, upper respiratory tract.

Other Toxic Effects on Humans: Hazardous in case of skin contact (irritant, permeator), of ingestion, of inhalation.

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans: Passes through the placental barrier in human. Detected in maternal milk in human.

Special Remarks on other Toxic Effects on Humans: Not available.

Section 12: Ecological Information

Ecotoxicity: Not available.

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are more toxic.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:

Section 14: Transport Information

DOT Classification: CLASS 6.1: Poisonous material.

Identification: : Trichloroethylene : UN1710 PG: III

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer, birth defects or other reproductive harm, which would require a warning under the statute: Trichloroethylene
California prop. 65: This product contains the following ingredients for which the State of California has found to cause cancer which would require a warning under the statute: Trichloroethylene
Pennsylvania RTK: Trichloroethylene
Florida: Trichloroethylene
Minnesota: Trichloroethylene
Massachusetts RTK: Trichloroethylene
New Jersey: Trichloroethylene
TSCA 8(b) inventory: Trichloroethylene
CERCLA: Hazardous substances.: Trichloroethylene

Other Regulations: OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).

Other Classifications:

WHMIS (Canada):
CLASS D-1B: Material causing immediate and serious toxic effects (TOXIC).
CLASS D-2B: Material causing other toxic effects (TOXIC).

DSCL (EEC):
R36/38- Irritating to eyes and skin.
R45- May cause cancer.

HMIS (U.S.A.):

Health Hazard: 2

Fire Hazard: 1

Reactivity: 0

Personal Protection: h

National Fire Protection Association (U.S.A.):

Health: 2

Flammability: 1

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Splash goggles.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

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Attachment C

Potential Physical Hazards and Required Control Measures

ATTACHMENT C

Potential Physical Hazards and Required Control Measures

POTENTIAL PHYSICAL HAZARD	REQUIRED CONTROL MEASURE(S)
Objects striking head	Hard hats will be worn during construction, maintenance, and heavy equipment operations. When there is a potential for overhead hazards, hard hats will be worn.
Flying particulates or objects	Safety glasses and/or face shields will be worn during construction, maintenance, and sampling activities. When there is a potential for flying projectiles, such as hand tools, safety glasses will be worn.
Foot hazards	Steel-toed boots will be worn at all times while on-site.
Heat afflictions	Observe work/rest cycles for measured temperature conditions and follow heat stress prevention measures.
Mechanical systems and moving equipment	All cleaning, repairing, and servicing of machines and equipment will be conducted in accordance with Title 8, California Code of Regulations (CCR), Sections 3314 and 3328 and applicable Federal Occupational Safety and Health Administration (OSHA) regulations. Machine guards will be used where appropriate to provide maximum protection for field employees. Access to areas where moving machines and machines with moving parts are located will be controlled and limited to those individuals experienced with those machines or who have received proper safety instruction with respect to the machinery. All major installations or major repair to mechanical systems will be conducted only by a qualified mechanical contractor. Only qualified personnel will make minor adjustments to those systems with prior approval by the Project Manager. Copies of the applicable operation and maintenance manual and manufacturer's operations manuals will be available on-site at all times.
	Loose, ragged, or poorly fitted clothing, dangling jewelry, or rings will not be worn when working around equipment or machinery. Any of these items could become snagged in moving equipment and result in serious injury. All long hair will be contained to prevent it from getting caught in moving equipment.
	Air compressors and pumps are started automatically under some conditions. This equipment will be electrically disconnected and locked out before service or repair.
Equipment failure	All equipment will be inspected and tested before use, and will be maintained in accordance with manufacturer's specifications. Malfunctioning equipment will be tagged and locked until repairs are made.

POTENTIAL PHYSICAL HAZARD	REQUIRED CONTROL MEASURE(S)
Fire	**Open fires and smoking are prohibited**. Instrumentation used in hazardous areas will be rated intrinsically safe for Class I atmospheres. Inspect fire extinguishers daily before work begins.
Noise	Hearing protection will be used as necessary. In general, if a normal conversation cannot be heard, hearing protection is required. If deemed appropriate, the SSO may perform noise level or audio dosimetry testing to determine if noise levels are excessive. Equipment should be maintained so that noise levels are minimized. Avoid high noise levels whenever possible. When high noise levels are unavoidable, such as during heavy equipment operations, wear hearing protection. Take special care when wearing hearing protection around drill rigs and other equipment and in high traffic areas as the ability to verbally communicate a warning is minimized. Maintain visual contact with co-workers.
Thermal burns	Use personal protective equipment (PPE) to protect skin from heated equipment surfaces on equipment. Label hot surfaces that can cause thermal burns.
Construction debris	Miscellaneous obstacles may be present at various site locations. Field employees will be aware of objects underfoot, particularly when walking in grassy areas.
Slips, trips, falls	Minimize the potential for slips, trips, and falls by providing clear footing, clearly identifying any tripping hazards, and maintaining awareness of uneven terrain.
Excavation	**Excavation activities (other than drilling) will are not anticipated during this project.** No entry into any excavation is allowed under this HASP. Excavations will be conducted using proper shoring or sloping in accordance with CAL/OSHA Regulations, Title 8, California Code of Regulations (CCR), Sections 1523, 1539 through 1543, and 5156 and 5192 and applicable federal OSHA regulations. Do not stand adjacent (i.e., within 2 feet) to any unshored or unsloped excavation.
Confined space entry	**Confined space operations are not anticipated for this site.** Confined space operations require the use of the Confined Space Entry Permit and Observer Checklist. No confined space entry will occur without written authorization of the Health and Safety Director.
Underground utility lines	Contact an underground service alert service before excavating to avoid utility line contact.

POTENTIAL PHYSICAL HAZARD	REQUIRED CONTROL MEASURE(S)
Electrical	**Electric work is not anticipated for this site.** Any electrical work on 120-volt or greater power circuits will be performed by a licensed electrical contractor. Qualified personnel may perform testing of power circuits and modifications to control circuits with prior approval from the Project Manager. Only personnel familiar with the particular system may work on that system. All electrical work will be conducted in accordance with Title 8, CCR, Subchapter 5, Electrical Safety Orders and applicable OSHA regulations.
Heavy equipment operation	Seat belts will be provided on all equipment and employees using such equipment will be instructed in their use. All equipment will be equipped with the proper roll-over protection. The rated capacity of the equipment will be readily visible. Only individuals trained in safe operation and authorized by the employer may operate such equipment (Title 8, CCR, Sections 3653, 3660, and 3664). All subcontractors who operate heavy equipment will provide proof of current applicable certification/license.
Excavating equipment	**Excavation work is not anticipated during this project.** Do not approach excavating equipment or the excavation without first notifying the equipment operator of intent to do so. Make direct eye contact with the operator. Do not assume the operator sees you. Any person entering the excavating equipment work area will wear an orange safety vest. Do not stand alongside, behind, or in the operating area of any operating excavating equipment. Be aware of the tail and boom swing-radius of trackhoes, cranes, and other center pivoting equipment. Also be aware of pinch points on articulated equipment such as front-end loaders.
Vehicles	All vehicles will be parked away from operating excavating equipment areas unless necessary to load or unload equipment or samples. No vehicle will enter any operating excavating equipment area without first notifying all excavating equipment operators. Any vehicles in the operating excavating equipment area will have a suitable warning flag or strobe attached to the vehicle.
Overhead utility lines	Maintain a **minimum** of 10 feet of clearance between any field equipment and high voltage lines; lines carrying more than 50,000 volts require additional clearance; electrical arc hazard is increased during high humidity or rainy conditions.
Manual lifting	During any manual material handling tasks, personnel are to lift with the force of the load suspended on their legs and not their backs. Several persons may be needed to lift or handle heavy equipment.

POTENTIAL PHYSICAL HAZARD	REQUIRED CONTROL MEASURE(S)
Weather conditions	Severe thunderstorms, lightning, and local flooding may occur during the rainy season. In case of severe weather, halt all operations and move indoors or into the cab of a truck as soon as possible. Avoid ravines and small arroyos due to the possibility of flooding during heavy rainfall. If there is lightning activity in the vicinity, the SSO at the site will decide when to halt site activities. A rule of thumb is to halt site activities if ground-to-air lightning is present within 1 mile of the site. To gauge the proximity of lightning, count the number of seconds between the lightning strike and the sound of thunder. A span of approximately 7 seconds indicates a 1-mile distance.
Compressed gas cylinders	Such vessels will be secured and used with the manufacturer's recommended valves and fittings. Unused cylinders will be secured and capped. All cylinders will be identified or labeled.
Vehicle traffic	When conducting field activities in roads, streets, and parking lots, mark the area with safety cones, wear orange traffic vests, and turn on the vehicle's emergency flashers. Safety cones should taper gradually and allow cars to change lanes or merge easily. Safety cones should extend past the work area. One field employee should act as an observer and watch the traffic and act as a buddy to the other field employee.
Shoring of Excavations	**Shoring of excavations is not anticipated at this site.** A H&S permit from CAL/OSHA is required when personnel enter an excavation or trench five feet deep or greater. Only a competent and adequately trained inspector will perform excavation and trenching activities. All excavation, trenching and shoring activities will be performed according to subcontractor Standard Operating Procedures. Evaluation of any excavation by England & Associate's supervising competent person may require installation of positive retention shoring devices, each excavation will be evaluated throughout its construction and duration for need of such retention devices.

Attachment D

Line Clearances for boom Type Equipment
(Table 2, 40 CFR § 2946)

TABLE 1

General Clearances Required from Energized Overhead High–Voltage Conductors

Nominal Voltage (Phase to Phase)	*Minimum Required Clearance (Feet)*
600 50,000	6
over 50,000 . . . 345,000	10
over 345,000 . . . 750,000	16
over 750,000 . . . 1,000,000	20

(3) Boom–type lifting or hoisting equipment. The erection, operation or dismantling of any boom–type lifting or hoisting equipment, or any part thereof, closer than the minimum clearances from energized overhead high–voltage lines set forth in Table 2 shall be prohibited.

(4) Storage. The storage of tools, machinery, equipment, supplies, materials, or apparatus under, by, or near energized overhead high–voltage lines is hereby expressly prohibited if at any time during such handling or other manipulation it is possible to bring such tools, machinery, equipment, supplies, materials, or apparatus, or any part thereof, closer than the minimum clearances from such lines as set forth in Table 1.

(c) The specified clearance shall not be reduced by movement due to any strains impressed (by attachments or otherwise) upon the structures supporting the overhead high–voltage line or upon any equipment, fixtures, or attachments thereon.

(d) Any overhead conductor shall be considered to be energized unless and until the person owning or operating such line verifies that the line is not energized, and the line is visibly grounded at the work site.

TABLE 2

Boom–type lifting or hoisting equipment clearances required from energized overhead high–voltage lines

Nominal voltage (Phase to Phase)	*Minimum Required Clearance (Feet)*
600 50,000	10
over 50,000 . . . 75,000	11
over 75,000 . . . 125,000	13
over 125,000 . . . 175,000	15
over 175,000 . . . 250,000	17
over 250,000 . . . 370,000	21
over 370,000 . . . 550,000	27
over 550,000 . . . 1,000,000	42

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. Amendment of subsections (b), (c), repealer of subsections (d), (e) and new subsection (d) filed 8–9–79; effective thirtieth day thereafter (Register 79, No. 32).
2. Editorial correction renumbering former Article 86 to Article 37 filed 11–2–83 (Register 83, No. 45).
3. Amendment filed 12–10–87; operative 1–9–88 (Register 88, No. 1).

§ 2947. Warning Signs Required.

The owner, agent, or employer responsible for the operations of equipment shall post and maintain in plain view of the operator and driver on each crane, derrick, power shovel, drilling rig, hay loader, hay stacker, pile driver, or similar apparatus, a durable warning sign legible at 12 feet reading: "Unlawful To Operate This Equipment Within 10 Feet Of High–Voltage Lines of 50,000 Volts Or Less."

In addition to the above wording, the following statement in small lettering shall be provided on the warning sign: "For Minimum Clearances of High–Voltage Lines In Excess of 50,000 Volts, See California Code of Regulations, Title 8, Article 37, High–Voltage Electrical Safety Orders."

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. Amendment filed 8–9–79; effective thirtieth day thereafter (Register 79, No. 32).
2. Editorial correction filed 11–2–83 (Register 83, No. 45).
3. Amendment filed 12–10–87; operative 1–9–88 (Register 88, No. 1).

§ 2948. Notification to the Operators of High–Voltage Lines and Responsibility for Safeguards.

When any operations are to be performed, tools or materials handled, or equipment is to be moved or operated within the specified clearances of any energized high–voltage lines, the person or persons responsible for the work to be done shall promptly notify the operator of the high–voltage line of the work to be performed and shall be responsible for the completion of the safety measures as required by Section 2946 (b) before proceeding with any work which would impair the aforesaid clearance.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. Editorial correction adding NOTE filed 11–2–83 (Register 83, No. 45).
2. Amendment filed 12–10–87; operative 1–9–88 (Register 88, No. 1).

§ 2949. Special Exemption.

The provisions of the foregoing Sections 2946 through 2948 shall not apply to the construction, reconstruction, maintenance, or operation of any energized overhead high–voltage lines or their supporting structures or appurtenances by qualified electrical workers, authorized by the owner of such lines, nor to work performed in proximity to energized overhead high–voltage lines by qualified persons using approved equipment and work procedures specified in these orders in accordance with Penal Code Section 385D.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. Repealer and new section filed 8–9–79; effective thirtieth day thereafter (Register 79, No. 32). 2. Amendment filed 12–10–87; operative 1–9–88 (Register 88, No. 1).

Article 38. Line Clearance Tree Trimming Operations

(Formerly Article 87)

§ 2950. Application.

This article shall apply to all line clearance tree trimming operations performed in the vicinity of exposed energized overhead conductors and equipment where any part of the employee's body, tools or equipment being used, or parts of trees being worked upon, is likely to come within the distances specified in Section 2946(b)(2).

NOTE: Additional requirements for Tree Work, Maintenance or Removal, are contained in Article 12 of the General Industry Safety Orders, Title 8, California Administrative Code.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. New Article 87 (§§ 2950–2959, not consecutive) filed 10–14–75 as an emergency; effective upon filing (Register 75, No. 42).
2. Certificate of Compliance as to Article 87, except for Sections 2950(c)(2)(A), 2954(f), and 2955(a)(5)(A) filed 1–9–76 (Register 76, No. 2).
3. Amendment of subsection (c)(2)(A) filed 1–9–76 (Register 76, No. 2).
4. Repealer of Article 87 (Sections 2950–2959, not consecutive) and new Article 87 (Sections 2950–2951) filed 8–9–79; effective thirtieth day thereafter (Register 79, No. 32).
5. Amendment filed 4–16–80 as procedural and organizational; effective upon filing (Register 80, No. 16).
6. Editorial correction renumbering former Article 87 to Article 38 filed 11–2–83 (Register 83, No. 45).
7. Amendment filed 12–10–87; operative 1–9–88 (Register 88, No. 1).

§ 2951. Line Clearance Operations.

(a) Prior to commencing line clearance tree trimming operations, the employer shall ensure that an inspection of the work locations is made in order to identify potential hazards and a tail gate briefing is conducted to discuss the work procedures to be followed.

(b) Only qualified line clearance tree trimmers, or trainees under the direct supervision and instruction of qualified line clearance tree trimmers, shall be permitted to perform line clearance tree trimming operations as described in Section 2950. Under no circumstances shall the minimum distance specified in Section 2940.2(b) Table 2940.2 be violated.

5) Buildings which form part of an enclosure shall have no unguarded doors or windows which permit unintentional access to the enclosure. Where the enclosure is adjacent to and below stairways, fire escapes, balconies, or windows, suitable guards shall be installed to prevent persons from making accidental contact with exposed energized parts.

(g) Work Space. Suitable work space shall be provided about exposed energized electrical equipment to permit the safe operation and/or maintenance of such equipment.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. Editorial correction of subsection (f)(4) filed 11-2-83 (Register 83, No. 45). 2. Amendment filed 12-10-87; operative 1-9-88 (Register 88, No. 1).

Appendix A

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. Editorial correction of items (7) and (11) filed 11-2-83 (Register 83, No. 45).
2. Amendment filed 6-2-87; operative 7-2-87 (Register 87, No. 24).
3. Repealer filed 12-7-92; operative 1-6-93 (Register 92, No. 50).

Appendix B

LIVE LINE TOOLS

Insulated parts of Live Line Tools shall have manufacturers' certification to withstand the following minimum tests:

(1) 100,000 volts per foot of length for five minutes when the tool is made of fiberglass; or

(2) 75,000 volts per foot of length for three minutes when the tool is made of wood; or

(3) other tests equivalent to (1) or (2) above as appropriate.

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. Amendment filed 12-10-87; operative 1-9-88 (Register 88, No. 1).

Appendix C

PROTECTIVE EQUIPMENT

Rubber insulating equipment shall meet the provisions of the American National Standard ANSI/ASTM series, which is hereby incorporated by reference, as follows:

ITEM	STANDARD
Rubber Insulating Gloves	D-120-84a
Rubber Insulating Matting	D-178-81
Rubber Insulating Blankets	D-1048-81
Rubber Insulating Hoods	D-1049-83
Rubber Insulating Line Hose	D-1050-80
Rubber Insulating Sleeves	D-1051-81

NOTE: Authority cited: Section 142.3, Labor Code. Reference: Section 142.3, Labor Code.

HISTORY

1. Amendment filed 12-10-87; operative 1-9-88 (Register 88, No. 1).

Article 37. Provisions for Preventing Accidents Due to Proximity to Overhead Lines

(Formerly Article 86)

§ 2946. Provisions for Preventing Accidents Due to Proximity to Overhead Lines.

(a) General. No person, firm, or corporation, or agent of same, shall require or permit any employee to perform any function in proximity to energized high-voltage lines; to enter upon any land, building, or other premises and there engage in any excavation, demolition, construction, repair, or other operation; or to erect, install, operate, or store in or upon such premises any tools, machinery, equipment, materials, or structures (including scaffolding, house moving, well drilling, pile driving, or hoisting equipment) unless and until danger from accidental contact with said high-voltage lines has been effectively guarded against.

(b) Clearances or Safeguards Required. Except where overhead electrical distribution and transmission lines have been de-energized and visibly grounded, the following provisions shall be met:

(1) Over Lines. The operation, erection, or handling of tools, machinery, apparatus, supplies, or materials, or any part thereof, over energized overhead high-voltage lines shall be prohibited.

EXCEPTION: 1: Aircraft over energized overhead high-voltage lines operating in conformance with:

(A) Applicable regulations administered by the Federal Aviation Administration, and/or

(B) Helicopter Operations, Article 35, Construction Safety Orders, California Administrative Code, Title 8.

EXCEPTION: 2: Tower cranes (Hammerhead) installed not closer than the minimum clearances set forth in Table 2, whereon the trolley or boom travel is controlled by limit switches which will prevent carrying a load over energized overhead high-voltage lines or within a horizontal distance closer than the minimum clearances set forth in Table 2.

(2) The operation, erection, handling, or transportation of tools, machinery, materials, structures, scaffolds, or the moving of any house or other building, or any other activity where any parts of the above or any part of an employee's body will come closer than the minimum clearances from energized overhead lines as set forth in Table 1 shall be prohibited.

Operation of boom-type equipment shall conform to the *minimum* clearances set forth in Table 2, except in transit where the boom is lowered and there is no load attached, in which case the distances specified in Table 1 shall apply.

Attachment E

Air Quality Monitoring Log

Work Zone Health and Safety Monitoring Log

Project:	**Project #:**	**Date:**
Site Location:		
Work Zone Monitoring Targets: (check all that apply) ☐VOCs ☐O_2 ☐H_2S ☐CO ☐Particulates ☐Noise ☐Other:	**Monitoring Technician:**	

Monitoring Criteria:

Monitoring Instrument	Calibration Gas/Material	Date/Time Calibration	Calibration Notes

Time	Results of Work Zone Monitoring							Notes
	VOCs (ppmv)	O_2 (%)	H_2S (ppmv)	CO (ppmv)	Particulates (%)	Noise (decib.)	Other:	

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Attachment F

Correction and Calibration Factors for Rae Systems PIDs

TN-106

TECHNICAL NOTE

Correction Factors, Ionization Potentials, and Calibration Characteristics

Correction Factors and Ionization Potentials

RAE Systems PIDs can be used for the detection of a wide variety of gases that exhibit different responses. In general, an organic compound* with ionization potential (IP) lower than that of the lamp photons can be measured. The best way to calibrate a PID to different compounds is to use a standard of the gas of interest. However, correction factors have been determined that enable the user to quantify a large number of chemicals using only a single calibration gas, typically isobutylene. In our PIDs, correction factors can be used in one of three ways:

1) Calibrate the unit with isobutylene in the usual fashion to read in isobutylene equivalents. Manually multiply the reading by the correction factor (CF) to obtain the concentration of the gas being measured.

2) Calibrate the unit with isobutylene in the usual fashion to read in isobutylene equivalents. Call up the correction factor from the instrument memory or downloaded from a personal computer and then call it up. The unit will then read directly in units of the gas of interest.

3) Calibrate the unit with isobutylene, but input an equivalent, "corrected" span gas concentration when prompted for this value. The unit will then read directly in units of the gas of interest.

Example 1:

With the unit calibrated to read isobutylene equivalents, the reading is 10 ppm with a 10.6 eV lamp. The gas being measured is butyl acetate, which has a correction factor of 2.6. Multiplying 10 by 2.6 gives an adjusted butyl acetate value of 26 ppm. Similarly, if the gas being measured were trichloroethylene (CF = 0.52), the adjusted value with a 10 ppm reading would be 5.2 ppm.

Example 2:

With the unit calibrated to read isobutylene equivalents, the reading is 100 ppm with a 10.6 eV lamp. The gas measured is m-xylene (CF = 0.43). After downloading this factor, the unit should read about 43 ppm when exposed to the same gas, and thus read directly in m-xylene values.

Example 3:

The desired gas to measure is ethylene dichloride (EDC). The CF is 0.6 with an 11.7 eV lamp. During calibration with 100 ppm isobutylene, insert 0.6 times 100, or 60 at the prompt for the calibration gas concentration. The unit then reads directly in EDC values.

Conversion to mg/m^3

To convert from ppm to mg/m^3, use the following formula:

$$\text{Conc. mg/m}^3) = \frac{[\text{Conc.(ppmv) x mol. wt. (g/mole)}]}{\text{molar gas volume}}$$

For air at 25 °C (86 °F), the molar gas volume is 24.4 L/mole and the formula reduces to:

$$\text{Conc.(mg/m}^3) = \text{Conc.(ppmv) x mol. wt. (g/mole) x 0.041}$$

For example, if the instrument is calibrated with a gas standard in ppmv, such as 100 ppm isobutylene, and the user wants to display to read in mg/m3 of hexane, whose m.w. is 86 and CF is 4.3, the overall correction factor would be 4.3 x 86 x 0.041 equals 15.2.

Correction Factors for Mixtures

The correction factor for a mixture is calculated from the sum of the mole fractions Xi of each component divided by their respective correction factors CFi:

$$CFmix = 1 / (X_1/CF_1 + X_2/CF_2 + X_3/CF_3 + ... X_i/CF_i)$$

Thus, for example, a vapor phase mixture of 5% benzene and 95% n-hexane would have a CFmix of CFmix = 1 / (0.05/0.53 + 0.95/4.3) = 3.2. A reading of 100 would then correspond to 320 ppm of the total mixture, comprised of 16 ppm benzene and 304 ppm hexane.

For a spreadsheet to compute the correction factor and TLV of a mixture see the appendix at the end of the CF table.

TLVs and Alarm Limits for Mixtures

The correction factor for mixtures can be used to set alarm limits for mixtures. To do this one first needs to calculate the exposure limit for the mixture. The Threshold Limit Value (TLV) often defines exposure limits. The TLV for the mixture is calculated in a manner similar to the CF calculation:

$$TLV\ mix = 1 / (X_1/TLV_1 + X_2/TLV_2 + X_3/TLV_3 + ... X_i/TLV_i)$$

In the above example, the 8-h TLV for benzene is 0.5 ppm and for n-hexane 50 ppm. Therefore the TLV of the mixture is TLVmix = 1 / (0.05/0.5 + 0.95/50) = 8.4 ppm, corresponding to 8.0 ppm hexane and 0.4 ppm benzene. For an instrument calibrated on isobutylene, the reading corresponding to the TLV is:

$$\text{Alarm Reading} = TLVmix / CFmix = 8.4 / 3.2 = 2.6\ \text{ppm}$$

A common practice is to set the lower alarm limit to half the TLV, and the higher limit to the TLV. Thus, one would set the alarms to 1.3 and 2.6 ppm, respectively.

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Calibration Characteristics

a) **Flow Configuration**. PID response is essentially independent of gas flow rate as long as it is sufficient to satisfy the pump demand. Three main flow configurations are used for calibrating a PID:

1) **A pressurized gas cylinder (with flow-matching regulator):** The flow rate from the regulator should match the flow rate of the instrument
2) **A collapsible gas bag:** The instrument will draw the calibration gas from the bag at its normal flow rate, as long as the bag valve is large enough. The bag should be filled with enough gas to allow at least one minute of flow (~ 0.5 L for a MiniRAE).
3) **The T method:** The T method uses a T junction with gas flow higher than the pump draw. The gas supply is connected to one end of the T, the instrument inlet is connected to a second end of the T, and excess gas flow escapes through the third, open end of the T.

The first method is most efficient in terms of gas usage, while the bag and T methods give slightly more accurate results because they match the pump flow better

b) **Pressure**. Pressures deviating from atmospheric pressure affect the readings by altering gas concentration and pump characteristics. It is best to calibrate with the instrument and calibration gas at the same pressure as each other and the gas to be analyzed. (Note that the cylinder pressure is not relevant because the regulator reduces the pressure to ambient.) If the instrument is calibrated at atmospheric pressure in one of the flow configurations described above, then 1) pressures slightly above ambient are acceptable but high pressures can damage the pump and 2) samples under vacuum may give low readings if air leaks into the sample train.

c) **Temperature**. Because temperature effects gas density and concentration, the temperature of the calibration gas and instrument should be as close as possible to the ambient temperature where the unit will be used. We recommend that the temperature of the calibration gas be within the instrument's operating range of 14°-104° F (-10°- 40° C). Also, during actual measurements, the instrument should be kept at the same or higher temperature than the sample temperature to avoid condensation in the unit.

d) **Matrix**. The matrix gas of the calibration compound and VOC sample is significant. Some common matrix components, such as methane and water vapor can affect the VOC signal. PIDs are most commonly used for monitoring VOCs in air, in which case the preferred calibration gas matrix is air. For a MiniRAE, methane, methanol, and water vapor reduce the response by about 20% when their concentration is 15,000 ppm and by about 40% at 30,000 ppm. Despite earlier reports of oxygen effects, RAE PID responses are independent of oxygen concentration, and calibration gases in a pure nitrogen matrix can be used. CO2 up to 50,000 ppm (5%) also has no effect.

e) **Concentration**. Although RAE Systems PIDs have electronically linearized output, it is best to calibrate in a concentration range close to the actual measurement range. For example, 100 ppm standard gas for anticipated vapors of 0 - 250 ppm, and 500 ppm standard for expected concentrations of 250 - 1000 ppm.

f) **Filters**. Filters affect flow and pressure conditions and therefore all filters to be used during sampling should also be in place during calibration. Using a water trap (hydrophobic filter) greatly reduces the chances of drawing water aerosols or dirt particles into the instrument. Regular filter replacements are recommended because dirty filters can adsorb VOCs and cause slower response time and shifts in calibration.

* Some inorganic compounds do not follow this trend. For example, hydrogen peroxide and nitrogen dioxide give no response using photon energies well above those of their reported ionization potentials.

Table Abbreviations:

CF = Correction Factor (multiply by reading to get corrected value for the compound when calibrated to isobutene)
NR = No Response
IP = Ionization Potential (values in parentheses are not well established)
C = Confirmed Value; all others are preliminary or estimated values and are subject to change

Disclaimer:

Actual readings may vary with age and cleanliness of lamp, relative humidity, and other factors. For accurate work, the instrument should be calibrated regularly under the operating conditions used.

Updates:

The correction factors in this table were measured in dry air. The values that are indicated by a "plus" sign in the "C" columns are confirmed values; all others are preliminary and subject to change. Watch for updates of this table on the Internet at http://www.raesystems.com

IP data are taken from the CRC Handbook of Chemistry and Physics, 73rd Edition, D.R. Lide (Ed.), CRC Press (1993) and NIST Standard Ref. Database 19A, NIST Positive Ion Energetics, Vers. 2.0, Lias, et.al., U.S. Dept. Commerce (1993).

Compound Name	Synonym/Abreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IP (eV)
Acetaldehyde		75-07-0	C_2H_4O			5.5	+			10.23
Acetic Acid	Ethanoic Acid	64-19-7	$C_2H_4O_2$	NR	+	22	+	2.6	+	10.66
Acetic Anhydride	Ethanoic Acid Anhydride	108-24-7	$C_4H_6O_3$	NR	+	6.1	+	2.0	+	10.14
Acetone	2-Propanone	67-64-1	C_3H_6O	1.2	+	1.1	+	1.4	+	9.71
Acetonitrile	Methyl cyanide; Cyanomethane	75-05-8	C_2H_3N					100		12.19
Acetylene	Ethyne	74-86-2	C_2H_2					2		11.40
Acrolein	Propenal	107-02-8	C_3H_4O	42	+	3.9	+	1.4	+	10.10
Acrylic Acid	Propenoic Acid	79-10-7	$C_3H_4O_2$			12	+	2.0	+	10.60
Acrylonitrile	Propenenitrile	107-13-1	C_3H_3N			NR	+	1.2	+	10.91
Allyl alcohol		107-18-6	C_3H_6O			2.4	+	1.7		9.67
Allyl chloride	3-Chloropropene	107-05-1	C_3H_5Cl			4.3		0.7		9.9
Ammonia		7664-41-7	H_3N	NR	+	9.7	+	5.7	+	10.16
Amyl alcohol	1-Pentanol	75-85-4	$C_5H_{12}O$			5				10.00
Aniline	Aminobenzene	62-53-3	C_7H_7N	0.50	+	0.5	+	0.5	+	7.72
Anisole	Methoxybenzene	100-66-3	C_7H_8O			0.8				8.21
Benzaldehyde		100-52-7	C_7H_6O					1		9.49
Benzene		71-43-2	C_6H_6	0.55	+	0.53	+	0.6	+	9.25
Benzonitrile	Cyanobenzene	100-47-0	C_7H_5N			1.6				9.62
Benzyl chloride	α-Chlorotoluene; Chloromethylbenzene	100-44-7	C_7H_7Cl			2		0.7		
Bromobenzene		108-86-1	C_6H_5Br			0.6		0.5		8.98
Bromoform	Tribromomethane	75-25-2	$CHBr_3$	NR	+	2.5	+	0.5	+	10.48
Bromopropane, 1-	n-Propyl bromide	106-94-5	C_3H_7Br	150	+	1.5	+	0.6	+	10.18
Butadiene	1,3-Butadiene, Vinyl ethylene	106-99-0	C_4H_6			1.0	+	1.1		9.07
Butadiene diepoxide, 1, 3-	1,2,3,4-Diepoxybutane	298-18-0	$C_4H_6O_2$	25	+	3.5	+	1.2		~10
Butane		106-97-8	C_4H_{10}					1.2		10.53
Butanol, 1-	Butyl alcohol	71-36-3	$C_4H_{10}O$	70	+	4.7	+	1.4	+	9.99
Butene, 1-	1-Butylene	106-98-9	C_4H_8			0.9				9.58
Butoxyethanol, 2-	Butyl Cellosolve; Ethylene glycol monobutyl ether	111-76-2	$C_6H_{14}O_2$	1.8	+	1.2	+	0.6	+	<10
Butyl acetate, n-		123-86-4	$C_6H_{12}O_2$			2.6	+			10
Butyl acrylate, n-	Butyl 2-propenoate, acrylic acid butyl ester	141-32-2	$C_7H_{12}O_2$			1.6	+	0.6	+	
Butylamine		109-73-9	$C_4H_{11}N$			7				8.71
Butyl cellosolve	see 2-Butoxyethanol	111-76-2								
Butyl mercaptan	1-Butanethiol	109-79-5	$C_4H_{10}S$			0.5				9.14
Carbon disulfide		75-15-0	CS_2			1.2	+	0.3		10.07
Carbon tetrachloride	Tetrachloromethane	56-23-5	CCl_4	NR	+	NR	+	1.7	+	11.47
Chlorine		7785-50-5	Cl_2					1.0	+	11.48
Chloro-1,3-butadiene, 2-	Chloroprene	126-99-8	C_4H_5Cl			3				
Chlorobenzene		108-90-7	C_6H_5Cl	0.44	+	0.40	+	0.39	+	9.06
Chloro-1,1 difluoroethane, 1-	(R-142B)	75-68-3	$C_2H_3ClF_2$			NR		NR		12.0
Chlorodifluoro methane	HCFC-22; R-22	75-45-6	$CHClF_2$	NR		NR		NR		12.2
Chloroethane	Ethyl chloride	75-00-3	C_2H_5Cl	NR	+	NR	+	1.1	+	10.97
Chloroethanol	Ethylene chlorohydrin	107-07-3	C_2H_5ClO							10.52
Chloroethyl methyl ether, 2-	Methyl 2-chloroethyl ether	627-42-9	C_3H_7ClO			3				
Chloroform	Trichloromethane	67-66-3	$CHCl_3$	NR	+	NR	+	3.5	+	11.37
Chlorotoluene, o-	o-Chloromethylbenzene	95-49-8	C_7H_7Cl			0.5		0.6		8.83
Chlorotoluene, p-	p-Chloromethylbenzene	106-43-4	C_7H_7Cl					0.6		8.69
Crotonaldehyde	*trans*-2-Butenal	123-73-9	C_4H_6O	1.5	+	1.1	+	1.0	+	9.73
Cumene	Isopropylbenzene	98-82-8	C_9H_{12}	0.58	+	0.5	+	0.4	+	8.73

Compound Name	Synonym/Abreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IP (eV)
Cyanogen bromide		506-68-3	CNBr	NR		NR		NR		11.84
Cyanogen chloride		506-77-4	CNCl	NR		NR		NR		12.34
Cyclohexane		110-82-7	C_6H_{12}	3.3	+	1.4	+	0.64	+	9.86
Cyclohexanol	Cyclohexyl alcohol	108-93-0	$C_6H_{12}O$					1.1		9.75
Cyclohexanone		108-94-1	$C_6H_{10}O$	1.0	+	0.9	+	0.7	+	9.14
Cyclohexene		110-83-8	C_6H_{10}			0.8	+			8.95
Cyclohexylamine		108-91-8	$C_6H_{13}N$			1.2				8.62
Cyclopentane		287-92-3	C_5H_{10}					0.6		10.51
Decane		124-18-5	$C_{10}H_{22}$	4.0	+	1.4	+	0.4	+	9.65
Diacetone alcohol	4-Methyl-4-hydroxy-2-pentanone	123-42-2	$C_6H_{12}O_2$			0.7				
Dibromoethane, 1,2-	EDB, Ethylene dibromide, Ethylene bromide	106-93-4	$C_2H_4Br_2$	NR	+	1.7	+	0.6	+	10.37
Dichlorobenzene, o-	1,2-Dichlorobenzene	95-50-1	$C_6H_4Cl_2$	0.54	+	0.47	+	0.38	+	9.08
Dichlorodifluoromethane	CFC-12	75-71-8	CCl_2F_2			NR	+	NR	+	11.75
Dichloroethane, 1,1-	1,1-DCA	75-34-3	$C_2H_4Cl_2$							11.06
Dichloroethane, 1,2-	EDC; 1,2-DCA; Ethylene dichloride	107-06-2	$C_2H_4Cl_2$			NR	+	0.6	+	11.04
Dichloroethene, 1,1-	1,1-DCE; Vinylidene chloride	75-35-4	$C_2H_2Cl_2$			0.9				9.79
Dichloroethene, c-1,2-	c-1,2-DCE; *cis*-Dichloroethylene	156-59-2	$C_2H_2Cl_2$			0.8				9.66
Dichloroethene, t-1,2-	t-1,2-DCE; *trans*-Dichloroethylene	156-60-5	$C_2H_2Cl_2$			0.5	+	0.3	+	9.65
Dichloro-1-fluoroethane, 1,1- (R-141B)		1717-00-6	$C_2H_3Cl_2F$	NR	+	NR	+	2.0	+	
Dichloromethane	see Methylene chloride									
Dichloropropane, 1,2-		78-87-5	$C_3H_6Cl_2$					0.7		10.87
Dichloro-1-propene, 2,3-		78-88-6	$C_3H_4Cl_2$	1.9	+	1.3	+	0.7	+	<10
Dichloro-1,1,1-trifluoroethane, 2,2- (R-123)		306-83-2	$C_2HCl_2F_3$	NR	+	NR	+	10.1	+	11.5
Diesel Fuel #1		68334-30-5	m.w. 226			0.9	+			
Diesel Fuel #2		68334-30-5	m.w. 216			0.7	+	0.4	+	
Diethylamine		109-89-7	$C_4H_{11}N$			1	+			8.01
Diethylaminopropylamine, 3-		104-78-9	$C_7H_{18}N_2$			1.3				
Diethylmaleate		141-05-9	$C_8H_{12}O_4$			4				
Diisopropylamine		108-18-9	$C_6H_{15}N$	0.84	+	0.74	+	0.5	+	7.73
Dimethylacetamide,N,N-	DMA	127-19-5	C_4H_9NO	0.87	+	0.8	+	0.6	+	8.81
Dimethylamine		124-40-3	C_2H_7N			1.5				8.23
Dimethyl disulfide	DMDS	624-92-0	$C_2H_6S_2$	0.2	+	0.20	+	0.2	+	7.4
Dimethylformamide,N,N-	DMF	68-12-2	C_3H_7NO			0.8				9.13
Dimethylhydrazine, 1,1-	UDMH	57-14-7	$C_2H_8N_2$			0.8	+	0.8	+	7.28
Dimethyl sulfate		77-78-1	$C_2H_6O_4S$	~23		~20	+	2.3	+	
Dioxane, 1,4-		123-91-1	$C_4H_8O_2$			1.1				9.19
DS-108F Wipe Solvent	Ethyl lactate/Isopar H/Propoxypropanol ~7:2:1	97-64-3/64742-48-9/1569-01-3	m.w. 118	3.3	+	1.6	+	0.7	+	
Epichlorohydrin	Chloromethyloxirane; 1-chloro2,3-epoxypropane, ECH	106-89-8	C_3H_5ClO	~20	+	8.5	+	1.4	+	10.2
Ethane		74-84-0	C_2H_6			NR	+	15	+	11.52
Ethanol	Ethyl alcohol	64-17-5	C_2H_6O			12	+	8		10.47
Ethanolamine (Not Recommended)	MEA, Monoethanolamine	141-43-5	C_2H_7NO			~4	+	~3	+	8.96
Ethene	Ethylene	74-85-1	C_2H_4			10	+	3		10.51
Ethoxyethanol, 2-	Ethylene glycol monoethyl ether	110-80-5	$C_4H_{10}O_2$			3.5				9.6
Ethyl acetate		141-78-6	$C_4H_8O_2$			4.8	+			10.01

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IP (eV)
Ethyl acrylate		140-88-5	$C_5H_8O_2$			2.4	+	1.0	+	<10.3
Ethylamine		75-04-7	C_2H_7N			0.8				8.86
Ethylbenzene		100-41-4	C_8H_{10}	0.52	+	0.5	+	0.5	+	8.77
Ethylene glycol	1,2-Ethanediol	107-21-1	$C_2H_6O_2$			16	+	6	+	10.16
Ethylene oxide	Oxirane, Epoxyethane	75-21-8	C_2H_4O			19	+	3	+	10.57
Ethyl ether	Diethyl ether	60-29-7	$C_4H_{10}O$			1.1	+			9.51
Ethyl formate		109-94-4	$C_3H_6O_2$					1.9		10.61
Ethyl hexyl acrylate, 2-	Acrylic acid 2-ethylhexyl ester	103-11-7	$C_{11}H_{20}O_2$			1.1	+	0.5	+	
Ethyl (S)-(-)-lactate	Ethyl lactate, Ethyl (S)-(-)-hydroxypropionate, see also DS-108F	687-47-8, 97-64-3	$C_5H_{10}O_3$	13	+	3.2	+	1.6	+	~10
Ethyl mercaptan	Ethanethiol	75-08-1	C_2H_6S			0.6				9.29
Ethyl sulfide	Diethyl sulfide	352-93-2	$C_4H_{10}S$			0.5	+			8.43
Formaldehyde	Formalin	50-00-0	CH_2O					0.6		10.87
Furfural	2-Furaldehyde	98-01-1	$C_5H_4O_2$			0.9	+	0.8	+	9.21
Gasoline #1		8006-61-9	m.w. 72			0.9	+			
Gasoline #2, 92 octane		8006-61-9	m.w. 93	1.3	+	1.0	+	0.5	+	
Glutaraldehyde	1,5-Pentanedial, Glutaric dialdehyde	111-30-8	$C_5H_8O_2$	1.1	+	0.8	+	0.6	+	
Halothane	2-Bromo-2-chloro-1,1,1-trifluoroethane	151-67-7	$C_2HBrClF_3$					0.6		11.0
HCFC-123 see 2,2-Dichloro-1,1,1-trifluoroethane, R-123										
HCFC-141B see 1,1-Dichloro-1-fluoroethane										
HCFC-142B see 1-Chloro-1,1-difluoroethane										
Heptane, n-		142-82-5	C_7H_{16}	45	+	2.8	+	0.60	+	9.92
Hexamethyldisilazane, 1,1,1,3,3,3-	HMDS	999-97-3	$C_6H_{19}NSi_2$			0.2	+	0.2	+	~8.6
Hexane, n-		110-54-3	C_6H_{14}	300		4.3	+	0.5	+	10.13
Hexene, 1-		592-41-6	C_6H_{12}			0.8				9.44
Hydrazine		302-01-2	H_4N_2			2.6	+	2.1	+	8.1
Hydrogen	Synthesis gas	1333-74-0	H_2	NR	+	NR	+	NR	+	15.43
Hydrogen peroxide		7722-84-1	H_2O_2	NR	+	NR	+	NR	+	10.54
Hydrogen sulfide		7783-06-4	H_2S	NR	+	3.3	+	1.5	+	10.46
Iodine		7553-56-2	I_2	0.1	+	0.1	+	0.1	+	9.40
Iodomethane	Methyl iodide	74-88-4	CH_3I	0.21	+	0.22	+	0.26	+	9.54
Isobutane	2-Methylpropane	75-28-5	C_4H_{10}			100	+	1.2	+	10.57
Isobutanol	2-Methyl-2-propanol	78-83-1	$C_4H_{10}O$	19	+	3.8	+	1.5		10.02
Isobutene	Isobutylene, Methyl butene	115-11-7	C_4H_8	1.00	+	1.00	+	1.00	+	9.24
Isobutyl acrylate	Isobutyl 2-propenoate, acrylic acid Isobutyl ester	106-63-8	$C_7H_{12}O_2$			1.5	+	0.60	+	
Isoflurane	1-Chloro-2,2,2-trifluoroethyl difluoromethyl ether		$C_3H_2ClF_5O$							
Isooctane	2,2,4-Trimethylpentane	540-84-1	C_8H_{18}			1.4				9.86
Isopar G Solvent	Photocopier diluent		m.w. 148			0.8	+			
Isopar M Solvent	Isoparaffinic hydrocarbons	64742-47-8	m.w. 191			0.7	+	0.4	+	
Isophorone		78-59-1	$C_9H_{14}O$					3		9.07
Isoprene	2-Methyl-1,3-butadiene	78-79-5	C_5H_8	0.69	+	0.6	+	0.60	+	8.85
Isopropanol	Isopropyl alcohol	67-63-0	C_3H_8O	500	+	6.0	+	2.7		10.12
Isopropyl acetate		108-21-4	$C_5H_{10}O_2$			2.5				9.99
Isopropyl ether	Diisopropyl ether	108-20-3	$C_6H_{14}O$			0.8				9.20
Jet fuel JP-4	Jet B, Turbo B, wide-cut aviation fuel	m.w. 115				1.0	+	0.4	+	
Jet fuel JP-5	Jet 5, Kerosene type aviation fuel	m.w. 167				0.6	+	0.5	+	
Jet fuel JP-8	Jet A-1, Kerosene type aviation fuel	m.w. 165				0.6	+	0.3	+	
Kerosene	C10-C16 petro.distillate - see Jet Fuels									

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IP (eV)
Mesitylene	1,3,5-Trimethylbenzene	108-67-8	C_9H_{12}	0.36	+	0.35	+	0.3	+	8.41
Methane	Natural gas	74-82-8	CH_4	NR	+	NR	+	NR	+	12.51
Methanol	Methyl alcohol	67-56-1	CH_4O	NR	+	NR	+	2.5	+	10.85
Methoxyethanol, 2-	Methyl cellosolve, ethylene glycol monomethyl ether	109-86-4	$C_3H_8O_2$	4.8	+	2.4	+	1.4	+	10.1
Methoxyethoxyethanol, 2-	2-(2-Methoxyethoxy) ethanol; diethylene glycol monomethyl ether	111-77-3	$C_7H_{16}O_3$	2.3	+	1.2	+	0.9	+	<10
Methyl acetate		79-20-9	$C_3H_6O_2$	NR	+	6.6	+	1.4	+	10.27
Methyl acrylate	Methyl 2-propenoate, acrylic acid methyl ester	96-33-3	$C_4H_6O_2$			3.7	+	1.2	+	(9.9)
Methylamine	Aminomethane	74-89-5	CH_5N			1.0				8.97
Methyl bromide	Bromomethane	74-83-9	CH_3Br	110	+	1.7	+	1.3	+	10.54
Methyl t-butyl ether	MTBE; *tert*-Butyl methyl ether	1634-04-4	$C_5H_{12}O$			0.9	+			9.24
Methyl cellosolve	see 2-Methoxyethanol									
Methyl chloride	Chloromethane	74-87-3	CH_3Cl	NR	+	NR	+	0.74	+	11.22
Methylcyclohexane		107-87-2	C_7H_{14}	1.6	+	0.97	+	0.53	+	9.64
Methylene chloride	Dichloromethane	75-09-2	CH_2Cl_2	NR	+	NR	+	0.89	+	11.32
Methyl ethyl ketone	MEK, 2-Butanone	78-93-3	C_4H_8O	0.86	+	0.9	+	1.1	+	9.51
Methylhydrazine	Monomethylhydrazine, Hydrazomethane	60-34-4	$C_2H_6N_2$	1.4	+	1.2	+	1.3	+	7.7
Methyl isobutyl ketone	MIBK; 4-Methyl-2-pentanone	108-10-1	$C_6H_{12}O$	1.3	+	1.1	+	0.83	+	9.30
Methyl isocyanate	CH_3NCO	624-83-9	C_2H_3NO	NR	+	4.6	+	1.5		10.67
Methyl mercaptan	Methanethiol	74-93-1	CH_4S			0.6				9.44
Methyl methacrylate		80-62-6	$C_5H_8O_2$	2.7	+	1.5	+	1.2	+	9.7
Methyl propyl ketone	MPK, 2-Pentanone	107-87-9	$C_5H_{12}O$			0.9	+	0.8	+	9.38
Methyl-2-pyrrolidinone, N-	NMP; N-methylpyrrolidone; 1-methyl-2-pyrrolidinone; 1-methyl-2-pyrrolidone	872-50-4	C_5H_9NO	1.0	+	0.8	+	0.9	+	9.17
Methyl salicylate	Methyl 2-hydroxybenzoate	119-36-8	$C_8H_8O_3$			2				
Methylstyrene, α-	2-Propenylbenzene	98-83-9	C_9H_{10}			0.5				8.18
Methyl sulfide	DMS, Dimethyl sulfide	75-18-3	C_2H_6S	0.49	+	0.44	+	0.46	+	8.69
Mineral spirits	Stoddard Solvent, see also Viscor 120B	8020-83-5	m.w. 144			0.71	+	0.39	+	
Mineral Spirits - Viscor 120B 156-207C	Calibration Fluid, b.p.	8052-41-3	m.w. 142	1.0	+	0.7	+	0.3	+	
Naphthalene	Mothballs	91-20-3	$C_{10}H_8$	0.45	+	0.4	+	0.40	+	8.13
Nitric oxide		10102-43-9	NO			5.2	+	2.8	+	9.26
Nitrobenzene		98-95-3	$C_6H_5NO_2$	2.6	+	1.9	+	1.6	+	9.81
Nitroethane		79-24-3	$C_2H_5NO_2$					3		10.88
Nitrogen dioxide		10102-44-0	NO_2			NR	+	NR	+	9.75
Nitromethane		75-52-5	CH_3NO_2					4		11.02
Nitropropane, 2-		79-46-9	$C_3H_7NO_2$					2.6		10.71
Nonane		111-84-2	C_9H_{20}			2				9.72
Octane, n-		111-65-9	C_8H_{18}	13.2	+	1.6	+			9.82
Pentane		109-66-0	C_5H_{12}	80	+	8.4	+	0.7	+	10.35
Peracetic acid	Peroxyacetic acid; acetyl hydroperoxide	79-21-0	$C_2H_4O_3$	NR	+	NR	+	2.3	+	
Peracetic/Acetic acid mix	Peroxyacetic acid; acetyl hydroperoxide	79-21-0	$C_2H_4O_3$			50	+	2.5	+	
Perchloroethene	PCE; Perchloroethylene, Tetrachloroethylene	127-18-4	C_2Cl_4	0.69	+	0.67	+	0.31	+	9.32 ✓

Compound Name	Synonym/Abreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IP (eV)
PGME	Propylene glycol methyl ether, 1-Methoxy-2-propanol	107-98-2	$C_6H_{12}O_3$	2.4	+	1.5	+	1.1	+	
PGMEA	Propylene glycol methyl ether acetate, 1-Methoxy-2-acetoxypropane	108-65-6	$C_6H_{12}O_3$	1.65	+	1.0	+	0.8	+	
Phenol	Hydroxybenzene	108-95-2	C_6H_6O	1.0	+	1.0	+	0.9	+	8.51
Phosphine			PH_3			2	+	1.4		9.87
Photocopier Toner	Isoparaffin mix					0.5	+	0.3	+	
Picoline, 3-	3-Methylpyridine	108-99-6	C_6H_7N			0.9				9.04
Pinene, α-		2437-95-8	$C_{10}H_{16}$			0.3	+	0.5		8.07
Pinene, β-		18172-67-3	$C_{10}H_{16}$	0.38	+	0.4	+	0.4	+	~8
Piperylene, isomer mix	1,3-Pentadiene	504-60-9	C_5H_8	0.76	+	0.7	+	0.6	+	8.6
Propane		74-98-6	C_3H_8			NR	+	1.8	+	10.95
Propanol, n-	Propyl alcohol	71-23-8	C_3H_8O			6		1.7		10.22
Propene	Propylene	115-07-1	C_3H_6			1.7	+			9.73
Propionaldehyde	Propanal	123-38-6	C_3H_6O			1.9				9.95
Propyl acetate, n-		109-60-4	$C_5H_{10}O_2$			3.5				10.04
Propylene oxide	Methyloxirane	16088-62-3	C_3H_6O			6.5		2		10.22
Propyleneimine	2-Methylaziridine	75-55-8	C_3H_7N	1.5	+	1.3	+	1.0	+	9.0
Pyridine		110-86-1	C_5H_5N	0.78	+	0.7	+	0.7	+	9.25
RR7300 (PGME/PGMEA)	70:30 PGME:PGMEA (1-Methoxy-2-propanol:1-Methoxy-2-acetoxypropane)	107-98-2	$C_4H_{10}O_2$/$C_6H_{12}O_3$			1.4	+	1.0	+	
Stoddard Solvent - see Mineral Spirits		8020-83-5								
Styrene		100-42-5	C_8H_8	0.45	+	0.40	+	0.4	+	8.43
Sulfur dioxide		7446-09-5	SO_2			NR	+	NR	+	12.32
Tetrachloroethane, 1,1,1,2-		630-20-6	$C_2H_2Cl_4$					1.3		~11.1
Tetrachloroethane, 1,1,2,2-		79-34-5	$C_2H_2Cl_4$	NR	+	NR	+	0.60	+	~11.1
Tetraethyllead	TEL	78-00-2	$C_8H_{20}Pb$	0.4		0.3		0.2		~11.1
Tetraethyl orthosilicate	Ethyl silicate, TEOS	78-10-4	$C_8H_{20}O_4Si$			0.7	+	0.2	+	~9.8
Tetrafluoroethane, 1,1,1,2-	HFC-134A	811-97-2	$C_2H_2F_4$			NR		NR		
Tetrafluoromethane	CFC-14, Carbon tetrafluoride	75-73-0	CF_4			NR	+	NR	+	>15.3
Tetrahydrofuran	THF	109-99-9	C_4H_8O	1.9	+	1.7	+	1.0	+	9.41
Therminol	Dowtherm, 3:1 Diphenyl oxide : Biphenyl			0.90	+	0.7	+			
Toluene	Methylbenzene	108-88-3	C_7H_8	0.54	+	0.50	+	0.51	+	8.82
Tolylene-2,4-diisocyanate	TDI; 4-Methyl-1,3-phenylene-2,4-diisocyanate	584-84-9	$C_9H_6N_2O_2$	1.4	+	1.4	+	2.0	+	
Trichloroethane, 1,1,1-	1,1,1-TCA; Methyl chloroform	71-55-6	$C_2H_3Cl_3$			NR	+	1	+	11
Trichloroethane, 1,1,2-	1,1,2-TCA	79-00-5	$C_2H_3Cl_3$	NR	+	NR	+	0.9	+	11.0
Trichloroethene	TCE; Trichoroethylene	79-01-6	C_2HCl_3	0.62	+	0.54	+	0.43	+	9.47
Trichlorotrifluoroethane, 1,1,2-	CFC-113	76-13-1	$C_2Cl_3F_3$			NR		NR		11.99
Triethylamine		121-44-8	$C_6H_{15}N$			1.3				7.50
Trifluoroethane, 1,1,2-		430-66-0	$C_2H_3F_3$					34		12.9
Trimethylamine		75-50-3	C_3H_9N			0.9				7.82
Trimethylbenzene, 1,3,5- - see Mesitylene		108-67-8								
Turpentine	Pinenes (85%) + other diisoprenes	8006-64-2	$C_{10}H_{16}$			0.4				

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IP (eV)
Undecane		1120-21-4	$C_{11}H_{24}$			2				9.56
Vinyl acetate		108-05-4	$C_4H_6O_2$			1.2				9.19
Vinyl bromide	Bromoethylene	593-60-2	C_2H_3Br			0.4				9.80
Vinyl chloride	Chloroethylene; VCM	75-01-4	C_2H_3Cl			2.0	+	0.6	+	9.99
Vinyl-2-pyrrolidinone, 1-	NVP, N-vinylpyrrolidone, 1-ethenyl-2-pyrrolidinone	88-12-0	C_6H_9NO	1.0	+	0.8	+	0.9	+	
Viscor 120B - see Mineral Spirits - Viscor 120B Calibration Fluid										
Xylene, m-	1,3-Dimethylbenzene	108-38-3	C_8H_{10}	0.50	+	0.43	+	0.40	+	8.56
Xylene, o-	1,2-Dimethylbenzene	95-47-6	C_8H_{10}	0.57	+	0.59	+	0.69		8.56
Xylene, p-	1,4-Dimethylbenzene	106-42-3	C_8H_{10}			0.45	+	0.62	+	8.44
None				1		1		1		
Undetectable				1E+6		###		###		

Appendix I:
Automatic Calculation of Correction Factors, TLVs and Alarm Limits for Mixtures

Compound	CF 9.8 eV	CF 10.6 eV	CF 11.7eV	Mol. Frac	Conc. ppm	TLV ppm
Benzene	0.55	0.53	0.6	0.01	1	0.5
Toluene	0.54	0.5	0.51	0.06	10	50
Hexane, n-	300	4.3	0.54	0.06	10	50
Octane, n-	13.2	1.8	0	0.28	50	300
Styrene	0.45	0.4	0.42	0.06	10	20
Acetone	1.2	1.1	1.4	0.28	50	750
Isopropanol	500	6	2.7	0.28	50	400
None	1	1	1	0.00	0	1
Mixture Value:	2.1	1.4	#DIV/0!	1.00	181 ppm	58 ppm
TLV Alarm Setpoint when Calibrated to Isobutylene:	27 ppm	40 ppm	#DIV/0! ppm			