MultiRAE Plus

Multi-Gas Monitor with VOC Detection and LEL Model # PGM-50
March 2010

NOTE: Guides are to be used by trained personnel only and DO NOT replace the manufacturer's operations or technical manuals. These guides were developed by field personnel for utilization by EPA and their contractors and are helpful in quick start-up and operations. Various limitations have been identified through the experience of the development group. Different makes, models, and updates to this equipment may change the limitations. It is recommended that calibration, maintenance, and use be recorded in a log book. If you have any changes or revisions please email one of the following: stevenson.peter@epa.gov, boykin.michael@epa.gov, chong.margaret@epa.gov, kroone.janice@epa.gov, zintak.leonard@epa.gov.

Uses:

The MultiRAE Plus is a multi-gas monitor for continuous monitoring of toxic gases, oxygen and combustible gases. It monitors organic vapors with a built-in photo-ionization detector (PID) (10.6 eV lamp standard), combustible gases (LEL) with a catalytic bead sensor, oxygen concentration with a electrochemical sensor, and inorganic toxic compounds with up to two electrochemical sensors. The MultiRAE Plus may be used in confined space, emergency response, industrial hygiene, and many other monitoring applications. It can be used as a personal monitor, hand-held survey/sniffer instrument, or as a continuous area monitor. Applications include leak detection, spill delineation, remediation, confined space entry, initial entry into unknown situations/assessments, perimeter monitoring, decontamination, soil and water head space analysis, and indoor air quality.

Limitations:

- Gas concentrations exceeding the upper limit of detection of the instrument (refer to table, Manual page 1-3) will not be properly detected. Any up-scale reading followed by a declining or erratic reading may indicate a gas concentration beyond the upper scale limit which may be hazardous.
- Ambient conditions: -4° to 113° Fahrenheit and 0% to 95% relative humidity (non-condensing)
- Instrument not tested in explosive gas/air atmosphere having an oxygen concentrations greater than 21%.
- The internal and external filters should be inspected and replaced as necessary.
- Some sensors are cross-sensitive to many chemicals. See attachment 3, RAE TN-114.
- Not compound specific, PID calibrated to isobutylene. Other compounds have different response factors.
- If the ionization potential of a compound is higher than the lamp energy, the compound will not be detected.
- As the unit ages, the PID lamp energy may decrease, so compounds near the lamp energy may not be detected.
- PID lamp requires periodic cleaning depending on operating conditions.
- Detection of chemical warfare agents are unreliable, even if calibrated.

Quick Start-up and Operation:

- Assemble regulators and tubing on cylinders of calibration gases and fill Tedlar bags for instrument calibrations. Alternately, calibration gas can be used directly provided a demand flow regulator or a fixed flow regulator at 0.5 - 1.0 l/min is used.
- **NOTE:** NEVER operate the Monitor without an inlet filter. Replace filters weekly in normal operatioin and more often if used in heavily contaminated or dusty areas.
- Unplug instrument from charger.
- Press and release the [Mode] key to turn instrument on. The unit takes approximately 90 seconds to warm up, check all sensors, and display the sensor configuration and alarm limits.
- After 90 sec. warm-up, the MultiRAE will ask to perform fresh air calibration. If programmed to do so, why you are in clean, ambient air or if MultiRAE is connected to zero air, press the [Y/+] key. **Note: If not programmed, instrument will go directly to monitoring mode.** The sensor will be zeroed.
- Display shows sensors name and readings, if there is no alarm, and the sensor readings are in right range (TOX1 and TOX2=0, VOC=0, LEL=0 and OXY =20.9), the MultiRAE is ready for use.
- Press [Y/+] key to test the alarm buzzer.
- Instruments response times for different gases vary from 15 second to 150 seconds. Allow sufficient time before recording the reading.
- To turn the instrument off, press and hold the [Mode] key until the pump stops running and "Off" is displayed.

Calibration/Operational Test:

To perform functional bump test, allow the instrument to warm up and stabilize for at least 3 minutes. Oxygen should read 20.9% and other values should be 0.0. If readings are not zero, perform a fresh air calibration (described below). Connect 4-gas mixture and turn on valve. After 40 seconds readings should fall within the following ranges:

CO	40-60 ppm	H_2S	17-33 ppm
LEL	40-60%	OXY	19.7-22.2%

If readings are out of range, calibrate instrument as described below.

If different sensors are installed, use manufacturers recommended calibration gas.

To calibrate monitor, enter programming mode by pressing the [N/-] and [MODE] keys simultaneously for 3 seconds. Display will change to "Calibrate Monitor?"

Select [Y/+] to calibrate unit. Display will ask "Fresh air calibration?" In fresh air conditions, press [Y/+], unit will proceed to zero the various parameters.

When zeroing has been completed, the display will read "Multiple sensor calibration?" Select [Y/+], unit will identify parameters and ask "OK?." Select [Y/+]. Display will prompt you to apply gas and will count down from 60 during calibration process. Display will then indicate the calibration results for the various parameters and prompt you to turn the gas off.

The monitor will then display “Single Sensor Calibration?” Select [N/-] if multiple sensor calibration performed. You would use this option for calibration of a single gas sensor. Use [MODE] to toggle to the desired sensor to calibrate. Follow display prompts as for the multiple gas calibration.

The display will offer additional programming options. Press [Y+] or [N/-] to select desired option.

Additional Operation Information:

- Use [N/-] key to answer “no” to a question, decrease a number, or toggle the backlight on or off.

- Use the [Y/+] keys to answer “yes” to a question, increase a number, test the alarm, or acknowledge the alarm condition.

- **Press** [MODE] to scroll through parameters and/or options. Display will show the peak reading, minimum reading, STEL, TWA, and operational conditions such as battery, and calibration gases. The options to start or stop datalogging, communicate with the personal computer (PC), or print readings are also accessed through this menu. RAE ProRAE Suite Version 3.0 software and a computer cable are included for datalogging to a laptop computer.

- To enter programming menu press the [N/-] and [MODE] keys simultaneously for 3 seconds. Press [MODE] key to access desired feature, such as alarm levels, span gas, or datalogging options. Use [Y/+] and [N/-] keys to select options.

- For a quick verification of the PID function, use a source of volatile organic compounds, such as a Sharpie® to check the photo-ionization sensor

- **Alarm Signals**: The MultiRAE Plus has both audible and LED visual alarms to alert the user to 10 different instrument conditions. The alarm condition is also indicated in the instrument display. High Alarm: 3 beeps/flashes per second; Low Alarm: 2 beeps/flashes; STEL and TWA exceeded: 1 beep/flash. For details, refer to the instrument manual, pages 2-18 and 2-19.

- **PID Lamp Verification:** The PID Lamp Type (9.8, **10.6 eV** or 11.7 eV) can be checked in the Sensor Configuration Submenu (Manual pages 4-37 and 4-45). The lamp voltage must be known to evaluate whether a given chemical could be detected with the currently installed PID lamp. Refer to attachment 1, Correction Factors, Ionization Energies (RAE Systems Technical Notes TN-106,158) attachment 2, RAE Systems PID Response or (www.raesystems.com) for details.

Principles of Operation:

The MultiRAE Plus uses one to five different sensors to measure a variety of gases. A discharge ultra-violet (UV) lamp is used as the high energy photon source for the PID sensor, which will detect a broad range of organic vapors. Up to two electrochemical toxic gas sensors can be installed in the monitor to measure inorganic toxic gases (CO, H_2 S, SO_2, NO, NO_2, Cl_2, HCN, NH_3, PH_3). A catalytic bead sensor is used to measure combustible gases (LEL) and an electrochemical sensor is used to measure oxygen concentration.

A small diaphragm pump inside the monitor draws air into the sensor manifold and distributes it to all sensors. A microcomputer chip controls the operation of the alarm buzzer, LED, pump and light sensor. It measures the sensor readings and calculates the gas concentrations based on calibration to known standard gases. The data is stored in memory and can be sent to a PC for record keeping and presentation (data logging capability). A 2-line LCD display shows all the readings. The user interacts with the monitor through three keys on the front panel keypad.

Health Effects:

Refer to Material Safety Data Sheets for details.

Detection Limits:

Oxygen: 0.1-30%; Combustible Gas: 1-100% LEL; VOCs: 0.1-2000 ppm; Carbon Monoxide: 1-500 ppm; Hydrogen Sulfide: 1-100 ppm; Sulfur Dioxide: 0.1-20 ppm; Nitric Oxide 1-250 ppm; Nitrogen Dioxide: 0.1-20 ppm; Chlorine: 0.1-10 ppm; Hydrogen Cyanide: 1-100 ppm; Ammonia: 10-50 ppm; Phosphine: 0-5 ppm.

Routine Maintenance:

Frequency	Action	Manual Reference
Daily	• Perform Bump Test or Calibrate • Recharge battery after use	Operating Guide and Manual Section 3-2
Weekly (during use)	• Change inlet filter. Change more frequently in dusty or highly contaminated environments	Operating Guide and Manual Page 4-3
Monthly	• Recharge battery if unused in last month	Page 4-3
Every 6 Months	• Clean lamp, if needed	Page 5-3
	• Replace battery, if needed • Replace lamp, if needed	Page 5-3

- Cleaning procedures for the lamp are provided in Section 6 of the Operator's Manual.
- If the instrument does not respond acceptably to a calibration check after the lamp is cleaned the lamp should be replaced.
- The battery replacement process is described in Section 4-1of the Manual.

Alarm Levels:

Default Factory Alarm Settings					
Sensor Type	**Low Alarm**	**High Alarm**			IDLH
LEL	10.0%	20%			
	Deficiency	**Enrichment**			
Oxygen	19.5%	23.5%			
	Low Alarm	**High Alarm**	**STEL**	**TWA**	
VOC	50 ppm	100 ppm	25	10 ppm	-
Carbon Monoxide	35 ppm	200 ppm	100 ppm	35 ppm	1,200 ppm
Hydrogen Sulfide	10 ppm	20 ppm	10 ppm	10 ppm	100 ppm

Notes:
LEL lower explosive limit
ppm parts per million
STEL short-term exposure limit
TWA time weighted average
IDLH immediately dangerous to life or health concentrations

Action Levels:

Analyte	Action Level	Response	Action Taken
Oxygen (O_2)	19.5 %	≤ 19.5 % (oxygen deficiency)	• Evacuate site • Consult Site Safety Officer (SSO) • Level "B" Personal Protective Equipment (PPE)
	23.0 %	≥ 23.00 % (oxygen enrichment potential fire hazard)	• Evacuate site • Consult SSO before re-entry
LEL	>10%	Leave Area	
Unknown VOCs	Readings above background <500 units	Use SCBA	• Level "B" PPE minimum

Alarm Levels:

Default Factory Alarm Settings				
Sensor Type	**Low Alarm**	**High Alarm**		
LEL	10.0%	20%		
	Deficiency	**Enrichment**		
Oxygen	19.5%	23.5%		
	Low Alarm	**High Alarm**	**STEL**	**TWA**
VOC	50 ppm	100 ppm	25	10 ppm
Carbon Monoxide	35 ppm	200 ppm	100 ppm	35 ppm
Hydrogen Sulfide	10 ppm	20 ppm	10 ppm	10 ppm

Notes: LEL lower explosive limit
ppm parts per million
STEL short-term exposure limit
TWA time weighted average

Battery Information and Charging Schedule:

Rechargeable, nickel-cadmium (NICAD) or Lithium-ion (Li-ion) battery pack, or 4 AA alkaline battery adapter. The factory-supplied rechargeable NICAD battery is designed to last for 10 hours of normal operation (no back light, no alarms) under best conditions. Li-ion batteries are expected to last up to 20 hours. As the battery becomes older, and/or under cold ambient temperatures, battery capacity will be reduced significantly. NICAD batteries are especially prone to build up a memory if not discharged deeply as noted below. Fresh alkaline batteries will provide approximately 12-14 hours of operation under ideal conditions.

- The battery charger should remain attached to the instrument until it is ready for use in the field (the Li-ion battery will drain slowly even when the monitor is off).
- Connect the AC adapter to the DC jack on the MultiRAE Plus monitor.

- When the MultiRAE Plus charger is being attached, the display will ask whether a deep discharge cycle is required. Occasional deep discharging is required to remove memory effects from the NICAD (but not the Li-ion) battery and maintain charge capacity. Select [Y/+] or [N/-]. Deep discharging adds up to 8 hours to the charging cycle. The charging cycle will automatically follow the deep discharge. A completely discharged MultiRAE Plus monitor will charge to full capacity within 10 hours. Recommend deep discharge once a month.

- While charging, the display will indicate the charging status and battery voltage and the instrument LED will be red. Once the battery is fully charged, the LED will change to green.

Note: It is recommended that due to the many types of rechargeable battery configurations, that Equipment Managers verify proper battery charging and operation through monthly equipment operation until battery is discharged prior to recharging.

Main Inventory of Items/Accessories:

- MultiRAE Plus PGM-50
- Rubber Boot
- Wrist Strap
- Belt Clip
- Water Trap Filter and Tygon® or Teflon® Tubing
- 4 "AA" Batteries

Replacement of Auxiliary Equipment/Supplies:

Replacement supplies will be purchased from equipment manufacturer or other vendor as needed.

Contact Information (Technical Support):

http://www.raesystems.com

The website provides several Technical and Application Notes on the use of PIDs for various applications, maintenance, correction factors, compound ionization energies and calibration characteristics. A 30-minute training video is also available.

RAE Systems Technical Support Team: Monday through Friday, 7:00am - 5:00pm PST
1-888-723-4800 (toll free)
1-408-585-3546
tech@raesystems.com

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Sunnyvale, CA 94089
phone: (408) 752-0723 **(for after-hours, life-critical support, select Option 9).**
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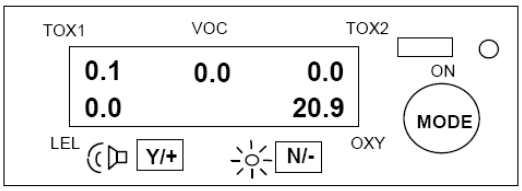
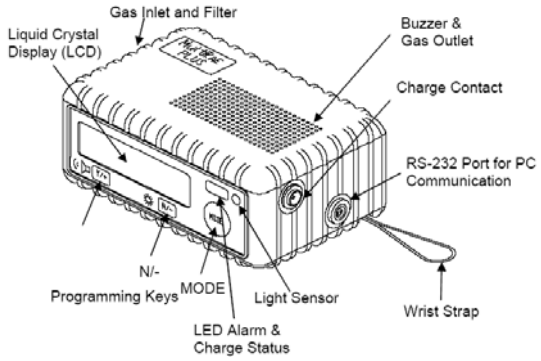
Instrument Panel:





Part Type	Part Description
AC Adapter	Black transformer
Protective Case	Yellow rubber protective boot
Carrying case	Black plastic instrument/accessory case
Alkaline Battery Adapter	Thin black case for 4 AA batteries
Operating guide	Laminated Quick reference guide
Instruction Manual	Short Form O&M Manual
Compact Disk	Training CD Windows CD on instrument use
Calibration Adapter	6-inch tubing with fittings for gas regulator
Inlet probe	3-inch Teflon tubing with fitting for unit
Water traps	Replaceable clear plastic filters
Compact Disk	ProRAE-Suite Version 3 software
Cable	Computer cable with 9-pin female connector
Tool kit	Phillips screwdriver and 2 wrenches
Calibration Gas	Mixture of H_2S, CO, CH_4, O_2, N_2 gases
Gas regulator	Victor model PR160 1-L/min flow rate

RAE Systems Technical Note
CORRECTION FACTORS, IONIZATION ENERGIES*, AND CALIBRATION CHARACTERISTICS

Correction Factors and Ionization Energies

RAE Systems PIDs can be used for the detection of a wide variety of gases that exhibit different responses. In general, any compound with ionization energy (IE) 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 monitor 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 download it from a personal computer and then call it up. The monitor 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.

* *Some inorganic compounds like H_2O_2 and NO_2 give weak response at photon energies well above those of their ionization energies. The term " ionization" energy replaces the old term "ionization potential."*

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. No data is presented for the PID/FID CF. Similarly, if the gas being measured were trichloroethylene (CF = 0.54), the adjusted value with a 10 ppm reading would be 5.4 ppm. There PID/FID conversion factor is 1 therefore the response by FID would be 10 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 approximately 43 ppm when exposed to the same gas, and thus read directly in m-xylene values. Look at the PID/FID conversion factor of m-xylene (CF=3.4) using the PID converts to approximately 340 ppm using the FID.

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: Conc. (mg/m^3) = [Conc.(ppmv) x mol. wt. (g/mole)] molar gas volume (L) For air at 25 ºC (77 ºF), the molar gas volume is 24.4 L/mole and the formula reduces to: Conc.(mg/m^3) = 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/m^3 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: $CFmix = 1 / (X_1/CF_1 + X_2/CF_2 + X_3/CF_3 + ... Xi/CFi)$ 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 / ($X_1/TLV_1 + X_2/TLV_2 + X_3/TLV_3 + ... Xi/TLVi$) 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: Alarm Reading = TLVmix / CFmix = 8.4 / 3.2 = 2.6 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.

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. Four main flow configurations are used for calibrating a PID: **1) a pressurized gas cylinder (Fixed-flow regulator):** The flow rate of the regulator should match the flow demand of the instrument pump or be slightly higher. **2) A pressurized gas cylinder (Demand-flow regulator):** A demand-flow regulator better matches pump speed differences, but results in a slight vacuum during calibration and thus slightly high readings. **3) 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 (~ 0.6 L for a MiniRAE, ~0.3 L for MultiRAE). **4) The T (or open tube) 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. To prevent ambient air mixing, a long tube should be connected to the open end, or a high excess rate should be used. Alternatively, the instrument probe can be inserted into an open tube slightly wider than the probe. Excess gas flows out around the probe. The first two cylinder methods are the 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 sample gas. (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 temperature specification (typically 14c-113c F or -10c- 45c 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 with 10.6 eV lamps are independent of oxygen concentration, and calibration gases in a pure nitrogen matrix can be used. H_2 and CO_2 up to 5 volume % also have 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.

Table Abbreviations:

CF =Correction Factor (multiply by reading to get corrected value for the compound when calibrated to isobutylene)
NR =No Response
IE =Ionization Energy (values in parentheses are not well established)
C =Confirmed Value; all others are preliminary or estimated values and are subject to change
ne =Not Established ACGIH 8-hr. TWA
C## =Ceiling value, given where 8-hr.TWA is not available

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. The correction factors in this table were measured in dry air at room temperature.

Updates:

The values in this are subject to change as more or better data become available. Watch for updates of this table on the Internet at **http://www.raesystems.com**

IE 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 IonEnergetics, Vers. 2.0, Lias, *et al* U.S. Department of Commerce
(1993). Exposure limits (8-h TWA and Ceiling Values) are from the 1997 ACGIH TLVs and BEIs, Threshold Limit Values
for Chemical Substances and Physical Agents and Biological Exposure Indices. ACGIH, Cincinnati, OH 1997.

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Attachment 2
RAE SYSTEMS PID RESPONSE (Note: bold indicates "lab validated")

Compound Name	Synonym/ Abbreviation	CAS No.	Formula	Lamp			IE(eV)	TWA	FID-PID Conversion Factor (as CH4)	FID Response Factor (Lab)
				9.80	STD 10.6	11.70				
Acetaldehyde		75-07-0	C2H4O	NR	**6.0**	**3.30**	**10.23**	C25	12.0	
Acetic Acid	Ethanoic Acid	64-19-7	C2H4O2	NR	**22.0**	**2.60**	**10.66**	10	44.0	
Acetic Anhydride	Ethanoic Acid Anhydride	108-24-7	C4H6O3	NR	**6.0**	**2.00**	**10.14**	5		
Acetone	2-Propanone	67-64-1	C3H6O	1.20	**1.1**	**1.40**	**9.71**	500	3.3	1.8
Acetonitrile	Methyl cyanide, Cyanomethane	75-05-8	C2H3N			100	12.19	40	NR	
Acetylene	Ethyne	74-86-2	C2H2			2.00	11.40	ne	NR	
Acrolein	Propenal	107-02-8	C3H4O	42	**3.9**	**1.40**	**10.10**	0.10	11.7	
Acrylic Acid	Propenoic Acid	79-10-7	C3H4O2		12.0	**2.00**	**10.60**	2		
Acrylonitrile	Propenenitrile	107-13-1	C3H3N		NR	**1.20**	**10.91**	2	NR	
Allyl alcohol		107-18-6	C3H6O		2.4	**1.70**	9.67	2	7.2	
Allyl chloride	3-Chloropropene	107-05-1	C3H5Cl		4.3	0.70	9.90	1	~12	
Ammonia		7664-41-7	H3N	NR	**9.7**	**5.70**	**10.16**	25		
Amyl acetate	mixture of isomers n-Pentyl acetate & 2-Methyl-1-butylacetate	628-63-7	C7H14O2	11.0	**2.3**	**0.95**	**<9.9**	100		
Amyl alcohol	1-Pentanol	75-85-4	C5H12O		5.0		10.00	ne		
Aniline	Aminobenzene	62-53-3	C7H7N	0.5	**0.48**	**0.47**	**7.72**	2	18.0	
Anisole	Methoxybenzene	100-66-3	C7H8O		0.8		8.21	ne		
Arsine	Arsenic trihydride	7784-42-1	AsH3		1.9		9.89	0.05		
Benzaldehyde		100-52-7	C7H6O			1.00	9.49	ne		
Benzene		71-43-2	C6H6	0.55	**0.53**	**0.60**	**9.25**	0.50	3.20	4.3
Benzonitrile	Cyanobenzene	100-47-0	C7H5N		1.6		9.62	ne		
Benzyl alcohol	ß-Hydroxytoluene, Hydroxymethylbenzene, Benzene methanol	100-51-6	C7H8O	1.4	**1.1**	**0.90**	**8.26**	ne		
Benzyl chloride	ß-Chlorotoluene,	100-44-7	C7H7Cl	0.7	**0.6**	**0.50**	**9.14**	1	4.20	
	Chloromethylbenzene									
Benzyl formate	Formic acid benzyl	104-57-4	C8H8O2	0.9	**0.73**	**0.66**		ne		
Boron trifluoride		2095581	BF3	NR	NR	NR	15.50	C1		
Bromine		7726-95-6	Br2	NR	**1.3**	**0.74**	**10.51**	0.1		
Bromobenzene		108-86-1	C6H5Br		0.6	0.50	8.98	ne		
2-Bromoethyl methyl ether		6482-24-2	C3H7OBr		0.84		~10	ne		
Bromoform	Tribromomethane	75-25-2	CHBr3	NR	**2.5**	**0.50**	**10.48**	0.5	2.50	
Bromopropane,1-	n-Propyl bromide	106-94-5	C3H7Br	150	**1.5**	**0.60**	**10.18**	ne	4.50	
Butadiene	1,3-Butadiene, vinyl ethylene	106-99-0	C4H6	0.8	0.85	**1.10**	9.07	2		
Butadiene diepoxide,1,3-	1,2,3,4-Diepoxybutane	298-18-0	C4H6O2	25	**3.5**	**1.20**	~10	ne	3.40	
Butane	106-97-8	C4H10			67.0	**1.20**	10.53	800		

Attachment 2
RAE SYSTEMS PID RESPONSE (Note: bold indicates "lab validated")

Compound Name	Synonym/ Abbreviation	CAS No.	Formula	Lamp			IE(eV)	TWA	FID-PID Conversion Factor (as CH4)	FID Response Factor (Lab)
				9.80	STD 10.6	11.70				
Butanol, 1-	Butyl alcohol, n-Butanol	71-36-3	C4H10O	70	**4.7**	**1.40**	**9.99**	20		
Butanol, t-	tert-Butanol, t-Buty alcohol	75-65-0	C4H10O	6.9	**2.9**		9.90	100		
Butene, 1-	1-Butylene	106-98-9	C4H8		0.9		9.58	ne		
Butoxyethanol, 2-	Butyl Cellosolve, Ethylene, glycol monobutyl ether	111-76-2	C6H14O2	1.8	**1.2**	**0.60**	**<10**	25		
Butyl acetate, n-	123-86-4	C6H12O2			2.6		10.00	150		
Butyl acrylate, n-	Butyl 2-propenoate, Acrylic acid butyl ester	141-32-2	C7H12O2		1.6	**0.60**		10		
Butylamine, n-	109-73-9	C4H11N		1.1	**1.1**	**0.70**	**8.71**	C5		
Butyl cellosolve	see 2-Butoxyethanol	111-76-2								
Butyl	75-91-2	C4H10O2		2.0	**1.6**		<10	1		
Butyl mercaptan	1-Butanethiol	109-79-5	C4H10S	0.55	**0.52**		9.14	0.5	2.10	
Carbon disulfide	75-15-0	CS2		4	**1.2**	**0.44**	10.07	10		
Carbon tetrachloride	Tetrachloromethane	56-23-5	CCl4	NR	**NR**	**1.70**	**11.47**	5	NR	0.4
Carbonyl sulfide	Carbon oxysulfide	463-58-1	COS					11.18		
Cellosolve	see 2-Ethoxyethanol									
CFC-14	see Tetrafluoromethane									
CFC-113	see 1,1,2-Trichloro-1,2,2-trifluoroethane									
Chlorine		7782-50-5	Cl2			1.00	**11.48**	0.5		
Carbon tetrachloride	Tetrachloromethane	56-23-5	CCl4	NR	**NR**	**1.70**	**11.47**	5		
Chlorine dioxide		10049-04-4	ClO2	NR	**NR**	**NR**	**10.57**	0.1		
Chloro-1,3-		126-99-8	C4H5Cl		3.0			10		
2-Chloroprene										
Chlorobenzene	Monochlorobenzene	108-90-7	C6H5Cl	0.44	**0.4**	**0.39**	**9.06**	10	2.40	4.0
Chloro-1,1-difluoroethane, 1-		75-68-3	C2H3ClF2		NR	NR	12.00	ne		
(R-142B)										
Chlorodifluoromethane	HCFC-22, R-22	75-45-6	CHClF2	NR	NR	NR	12.20	1000		
Chloroethane	Ethyl chloride	75-00-3	C2H5Cl	NR	**NR**	**1.10**	**10.97**	100	NR	
Chloroethanol	Ethylene chlrohydrin	107-07-3	C2H5ClO				10.52	C1		
Chloroethyl ether, 2-	bis(2-chloroethyl) ether	111-44-4	C4H8Cl2O	8.6	**3.0**			5		
2-Methyl 2-chloroethyl ether										
Chloroform	Trichloromethane	67-66-3	CHCl3	NR	**NR**	**3.50**	**11.37**	10	NR	0.5
Chloropicrin		76-06-2	CCl3NO2	NR	**~400**	**7.00**	**?**	0.1		
Chlorotoluene, o-	o-Chloromethylbenzene	95-49-8	C7H7Cl		0.5	0.60	8.83	50		
Chlorotoluene, p-	p-Chloromethylbenzene	106-43-4	C7H7Cl			0.60	8.69	ne		

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				9.80	STD 10.6	11.70				
Chlorotrimethylsilane		75-77-4	C3H9ClSi	NR	NR	0.82	**10.83**	ne		
Crotonaldehyde	trans-2-Butenal	123-73-9	C4H6O	1.5	**1.1**	**1.00**	**9.73**	2		
		4170-30-3								
Cumene	Isopropylbenzene	98-82-8	C9H12	0.58	**0.54**	**0.40**	**8.73**	50	4.90	
Cyanogen bromide		506-68-3	CNBr	NR	NR	NR	11.84	ne		
Cyanogen chloride		506-77-4	CNCl	NR	NR	NR	12.34	C0.3		
Cyclohexane		110-82-7	C6H12	3.3	**1.4**	**0.64**	**9.86**	300	8.40	
Cyclohexanol	Cyclohexyl alcohol	108-93-0	C6H12O			1.10	9.75	50		
Cyclohexanone		108-94-1	C6H10O	1.0	**0.9**	**0.70**	**9.14**	25		
Cyclohexene		110-83-8	C6H10		0.8		8.95	300		
Cyclohexylamine		108-91-8	C6H13N		1.2		8.62	10		
Cyclopentane 85%		287-92-3	C5H10	NR	**15.0**	**1.10**	10.33	600		
2,2-dimethylbutane 15%										
Cyclopropylamine	Aminocyclpropane	765-30-0	C3H7N	1.1	**0.9**	**0.90**		ne		
Decane		124-18-5	C10H22	4.0	**1.4**	**0.35**	**9.65**	ne		
Diacetone alcohol	4-Methyl-4-hydroxy-2-pentanone	123-42-2	C6H12O2		0.7			50		
Dibromochloromethane	Chlorodibromomethane	124-48-1	CHBr2Cl	NR	**5.3**	**0.70**	**10.59**	ne		
Dibromoethane, 1,2-	EDB, Ethylene dibromide, Ethylene bromide	106-93-4	C2H4Br2	NR	**1.7**	**0.60**	**10.37**	ne	3.40	
Dichlorobenzene, o-	1,2-Dichlorobenzene	95-50-1	C6H4Cl2	0.54	**0.47**	**0.38**	**9.08**	25	2.80	
Dichlorodifluoromethane	CFC-12	75-71-8	CCl2F2		NR	**NR**	**11.75**	1000		
Dichlorodimethylsilane		75-78-5	C2H6Cl2Si	NR	NR	1.10	**>10.7**	ne		
Dichloroethane, 1,2-	EDC, 1,2-DCA, Ethylene dichloride	107-06-2	C2H4Cl2		NR	**0.60**	**11.04**	10	NR	1.5
Dichloroethene, 1,1-	1,1-DCE, Vinylidene chloride	75-35-4	C2H2Cl2		0.82	**0.80**	**9.79**	5		
Dichloroethene, c-1,2-	c-1,2-DCE,	156-59-2	C2H2Cl2		0.8		9.66	200		
	cis-Dichloroethylene								~1.6	
Dichloroethene, t-1,2-	t-1,2-DCE,	156-60-5	C2H2Cl2		0.45	**0.34**	**9.65**	200		
	trans-Dichloroethylene								0.90	
Dichloro-1-fluoroethane, 1,1-		1717-00-6	C2H3Cl2F	NR	**NR**	**2.00**		ne		
R-141B										
Dichloromethane	see Methylene chloride									
Dichloropentafluoropropane		442-56-	C3HCl2F5	NR	**NR**	**25.00**		ne		
Dichloropropane,		78-87-5	C3H6Cl2			0.70	10.87	75	NR	
Dichloro-1-propene, 1,3-		542-75-6	C3H4C12	1.3	**0.96**		<10	1		

Attachment 2
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				9.80	STD 10.6	11.70				
Dichloro-1-propene, 2,3-		78-88-6	C3H4Cl2	1.9	**1.3**	**0.70**	**<10**	ne		
Dichloro-1,1,1-	R-123	306-83-2	C2HCl2F3	NR	**NR**	**10.10**	**11.50**	ne		
trifluoroethane, 2,2-										
Dichloro-2,4,6-	DCTFP	1737-93-5	C5Cl2F3N	1.1	**0.9**	**0.80**		ne		
trifluoropyridine, 3,5-										
Dichlorvos	Vapona; O,O-dimethyl Odichlorovinyl, phosphate	62-73-7	C4H7Cl2O4P		0.9		<9.4	0.1		
Dicyclopentadiene	DCPD, Cyclopentadiene, dimer	77-73-6	C10H12	0.57	**0.48**	**0.43**	**8.80**	5		
Diesel Fuel		68334-30-5	m.w. 226		0.9			11		
Diesel Fuel #2 (Automotive)		68334-30-5	m.w. 216		0.7	**0.40**		11		
Diethylamine		109-89-7	C4H11N		1.0		8.01	5		
Diethylaminopropylamine, 3-		104-78-9	C7H18N2		1.3			ne		
Diethylbenzene	See Dowtherm J									
Diethylmaleate		141-05-9	C8H12O4		4.0			ne		
Diethyl sulfide	See Ethyl sulfide									
Diisopropylamine		108-18-9	C6H15N	0.84	**0.74**	**0.50**	**7.73**	5		
Diketene	Ketene dimmer	674-82-8	C4H4O2	2.6	**2.0**	**1.40**	**9.60**	0.5		
Dimethylacetamide, N,N-	DMA	127-19-5	C4H9NO	0.87	**0.8**	**0.80**	**8.81**	10		
Dimethylamine		124-40-3	C2H7N		1.5		8.23	5		
Dimethyl carbonate	Carbonic acid dimethyl ester	616-38-6	C3H6O3	NR	**~70**	**1.70**	**~10.5**	ne		
Dimethyl disulfide	DMDS	624-92-0	C2H6S2	0.20	**0.2**	**0.21**	**7.40**	ne		
Dimethylethylamine	DMEA	598-56-1	C4H11N	1.10	**1.0**	**0.90**	**7.74**	~3		
Dimethylformamide, N,N-	DMF	68-12-2	C3H7NO		0.8		9.13	10	~2.4	
Dimethylhydrazine, 1,1-	UDMH	57-14-7	C2H8N2		0.8	**0.80**	**7.28**	0.01		
Dimethyl	DMMP, methyl phosphonic	756-79-6	C3H9O3P	NR	**4.3**	**0.74**	**10.00**	ne		
Methylphosphonate	acid dimethyl ester									
Dimethyl sulfate		77-78-1	C2H6O4S	~23	~20	**2.30**		0.1		
Dimethyl sulfide	see Methyl sulfide									
Dimethyl sulfoxide	DMSO, Methyl sulfoxide	67-68-5	C2H6OS		1.4		9.10	ne		
Dioxane, 1,4-		123-91-1	C4H8O2		1.3		9.19	25	~5.2	
Dioxolane, 1,3-	Ethylene glycol formal	646-06-0	C3H6O2	4.0	**2.3**	**1.60**	**9.90**	20		
Dowtherm A	see Therminol7									
Dowtherm J		25340-17-4	C10H14		0.5					

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				9.80	STD 10.6	11.70				
(97% Diethylbenzene)										
DS-108F Wipe	Ethyl lactate/Isopar H/	97-64-3	m.w. 118	3.3	**1.6**	**0.70**		ne		
	Propoxypropanol ~7:2:1	64742-48-9								
		1569-01-3								
Epichlorohydrin	ECH Chloromethyloxirane,	106-89-8	C2H5ClO	~200	**8.5**	**1.40**	**10.20**	0.5	17.00	
	1-chloro2,3-epoxypropane									
Ethane		74-84-0	C2H6		NR	**15.00**	**11.52**	ne	NR	
Ethanol	Ethyl alcohol	64-17-5	C2H6O		10	**3.10**	**10.47**	1000	24.00	
Ethanolamine	MEA,	141-43-5	C2H7NO	5.6	**1.6**		8.96	3		
Ethene	Ethylene	74-85-1	C2H4		9.0	**4.50**	**10.51**	ne	0.77	
Ethoxyethanol, 2-	Ethyl cellosolve, Ethylene glycol monoethyl ether	110-80-5	C4H10O2		1.3		9.60	5	~5.2	
Ethyl acetate		141-78-6	C4H8O2		4.6		10.01	400	18.40	2.0
Ethyl acrylate		140-88-5	C5H8O2		2.4	**1.00**	**<10.3**	5	12.00	
Ethylamine		75-04-7	C2H7N		0.8		8.86	5		
Ethylbenzene		100-41-4	C8H10	0.52	**0.52**	**0.51**	**8.77**	100	4.20	
Ethylene glycol	1,2-Ethanediol	107-21-1	C2H6O2		16	**6.00**	**10.16**	C100		
Ethylene glycol dimethyl	1,2-Dimethoxyethane,	110-71-4	C4H10O2	1.1	0.86	0.70	9.20	ne		
Ether	Monoglyme									
Ethylene oxide	Oxirane, Epoxyethane	75-21-8	C2H4O		13	**3.50**	**10.57**	1		
Ethyl ether	Diethyl ether	60-29-7	C4H10O		1.1		9.51	400		
Ethyl 3-ethoxypropionate	EEP	763-69-9	C7H14O3	1.2	**0.75**			ne		
Ethyl formate		109-94-4	C3H6O2			1.90	10.61	100		
Ethyl hexyl acrylate, 2-	Acrylic acid, 2-ethylhexyl ester	103-11-7	C11H20O2		1.1	**0.50**		ne		
Ethyl (S)-(-)-lactate	Ethyl lactate, Ethyl (S)-(-)-	687-47-8	C5H10O3	13	**3.2**	**1.60**	**~10**	ne		
see also DS-108F	hydroxypropionate	97-64-3								
Ethyl mercaptan	Ethanethiol	75-08-1	C2H6S	0.6	**0.56**		9.29	0.5		
Ethyl sulfide	Diethyl sulfide	352-93-2	C4H10S		0.5		8.43	ne		
Formaldehyde	Formalin	50-00-0	CH2O	NR	**NR**	**1.60**	**10.87**	C0.3		
Formamide		75-12-7	CH3NO		6.9	**4.00**	10.16	10		
Formic acid		64-18-6	CH2O2	NR	**NR**	**9.00**	**11.33**	5		
Furfural	2-Furaldehyde	98-01-1	C5H4O2		0.92	**0.80**	**9.21**	2		
Furfuryl alcohol		98-00-0	C5H6O2		0.8		<9.5	10		
Gasoline #1		8006-61-9	m.w. 72		0.9			300	~8	

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				9.80	STD 10.6	11.70				
Gasoline #2, 92 octane		8006-61-9	m.w. 93	1.3	**1.0**	**0.50**		300		
Glutaraldehyde	1,5-Pentanedial,	111-30-8	C5H8O2	1.1	**0.8**	**0.60**		C0.0		
	Glutaric dialdehyde							5		
Halothane	2-Bromo-2-chloro-1,1,1-trifluoroethane	151-67-7	C2HBrClF3			0.60	11.00	50		
HCFC-22	see Chlorodifluoromethane									
HCFC-123	see 2,2-Dichloro-1,1,1-trifluoroethane									
HCFC-141B	see 1,1-Dichloro-1-fluoroethane									
HCFC-142B	see 1-Chloro-1,1-difluoroethane									
HCFC-134A	see 1,1,1,2-Tetrafluoroethane									
HCFC-225	see Dichloropentafluoropropane									
Heptane, n-		142-82-5	C7H16	45	**2.8**	**0.60**	**9.92**	400	18.20	
Hexamethyldisilazane,	HMDS	999-97-3	C6H19NSi2		0.2	**0.20**	**~8.6**			
1,1,1,3,3,3-										
Hexane, n-		110-54-3	C6H14	350	**4.3**	**0.54**	**10.13**	50	25.80	4.7
Hexanol, 1-	Hexyl alcohol	111-27-3	C6H14O	9.0	**2.5**	**0.55**	**9.89**	ne		
Hexene, 1-		592-41-6	C6H12		0.8		9.44	30		
Hydrazine		302-01-2	H4N2	>8	**2.6**	**2.10**	**8.10**	0.01		
Hydrazoic acid	Hydrogen azide		HN3				10.7			
Hydrogen	Synthesis gas	1333-74-0	H2	NR	**NR**	**NR**	**15.43**	ne		
Hydrogen cyanide	Hydrocyanic acid	74-90-8	HCN	NR	**NR**	**NR**	**13.60**	C4.7		
Hydrogen peroxide		7722-84-1	H2O2	NR	**NR**	**NR**	**10.54**	1		
Iodine		7553-56-2	I2	0.1	**0.1**	**0.10**	**9.40**	C0.1		
Iodomethane	Methyl iodide	74-88-4	CH3I	0.21	**0.22**	**0.26**	**9.54**	2		
Isoamyl acetate	Isopentyl acetate	123-92-2	C7H14O2	10.1	2.1	1.00	<10	100		
Isobutane	2-Methylpropane	75-28-5	C4H10		100.0	**1.20**	**10.57**	ne		
Isobutanol	2-Methyl-1-propanol	78-83-1	C4H10O	19	**3.8**	**1.50**	10.02	50		
Isobutene	Isobutylene, Methyl butane	115-11-7	C4H8	1.0	**1.0**	**1.00**	**9.24**	ne	4.00	
Isobutyl acetate		110-19-0	C6H12O2		2.6			150		
Isobutyl acrylate	Isobutyl 2-propenoate,	106-63-8	C7H12O2		1.5	**0.60**		ne		
	Acrylic acid Isobutyl ester									
Isoflurane	1-Chloro-2,2,2-trifluoroethyl, difluoromethyl ether,	26675-46-7	C3H2ClF5O				~11.7	ne		
Isooctane	2,2,4-Trimethylpentane	540-84-1	C8H18		1.2		9.86	ne		

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				9.80	STD 10.6	11.70				
Isopar E Solvent	Isoparaffinic hydrocarbons	64741-66-8	m.w. 121	1.7	**0.8**			ne		
Isopar G Solvent	Photocopier diluent	64742-48-9	m.w. 14		0.8			ne		
Isopar K Solvent	Isoparaffinic hydrocarbons	64742-48-9	m.w. 156	0.9	**0.5**	**0.27**		ne		
Isopar L Solvent	Isoparaffinic hydrocarbons	64742-48-9	m.w. 163	0.9	**0.5**	**0.28**		ne		
Isopar M Solvent	Isoparaffinic hydrocarbons	64742-47-8	m.w. 191		0.7	**0.40**		ne		
Isopentane	2-Methylbutane	78-78-4	C5H12		8.2			ne		
Isophorone		78-59-1	C9H14O			3.00	9.07	C5		
Isoprene	2-Methyl-1,3-butadiene	78-79-5	C5H8	0.69	**0.63**	**0.60**	**8.85**	ne	3.20	
Isopropanol	Isopropyl alcohol, 2-propanol, IPA	67-63-0	C3H8O	500	**6.0**	**2.70**	10.12	400	18.00	1.6
Isopropyl acetate		108-21-4	C5H10O2		2.6		9.99	250		
Isopropyl ether	Diisopropyl ether	108-20-3	C6H14O		0.8		9.20	250		
Jet fuel JP-4	Jet B, Turbo B,	8008-20-6	m.w. 115		1	**0.40**		ne		
	Wide cut type aviation fuel	64741-42-0								
Jet fuel JP-5	Jet 5, Kerosene type	8008-20-6	m.w. 167		0.6	**0.50**		15		
	aviation fuel	64747-77-1								
Jet fuel JP-8	Jet A-1, Kerosene type	8008-20-6	m.w. 165		0.6	**0.30**		15		
	aviation fuel	64741-77-1								
Jet fuel A-1 (JP-8)	Kerosene type aviation fuel	8008-20-6	m.w. 145		0.67			15		
		64741-77-1								
Limonene, D-	(R)-(+)-Limonene	5989-27-5	C10H16		0.33		~8.2	ne		
Kerosene		8008-20-6								
C10-C16 petro.distillate										
B see Jet Fuels										
MDI B										
see 4,4'-Methylenebis										
(phenylisocyanate)										
Mesitylene	1,3,5-Trimethylbenzene	108-67-8	C9H12	0.36	**0.35**	**0.30**	**8.41**	25		
Methane	Natural gas	74-82-8	CH4	NR	**NR**	**NR**	**12.61**	ne	NR	1.0
Methanol	Methyl alcohol, carbinol	67-56-1	CH4O	NR	**NR**	**2.50**	**10.85**	200	NR	0.6
Methoxyethanol, 2-	Methyl cellosolve, Ethylene	109-86-4	C3H8O2	4.8	**2.4**	**1.40**	**10.10**	5	7.20	
	glycol monomethyl ether									

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				9.80	STD 10.6	11.70				
Methoxyethoxyethanol, 2-	2-(2-Methoxyethoxy) ethanol, Diethylene glycol, monomethyl ether	111-77-3	C7H16O	2.3	**1.2**	**0.90**	**<10**	ne		
Methyl acetate		79-20-9	C3H6O2	NR	**6.6**	**1.40**	**10.27**	200		
Methyl acrylate	Methyl 2-propenoate, acrylic, acid methyl ester	96-33-3	C4H6O2		3.7	**1.20**	**-9.90**	2		
Methylamine		74-89-5	CH5N		1.2		8.97	5		
Aminomethane										
Methyl bromide		74-83-9	CH3Br	110	**1.7**	**1.30**	**10.54**	1	1.70	
Bromomethane										
Methyl t-butyl ether	MTBE, tert-Butyl methyl ether	1634-04-4	C5H12O		0.9		9.24	40	4.50	3.2
Methyl cellosolve										
see 2-Methoxyethanol										
Methyl chloride	Chloromethane	74-87-3	CH3Cl	NR	**NR**	**0.74**	**11.22**	50	NR	
Methylcyclohexane		107-87-2	C7H14	1.6	**0.97**	**0.53**	**9.64**	400		
Methylene	MDI, Mondur M		C15H10N2O2					0.005		
bis(phenylisocyanate),4,4'-			Very slow ppb level							
Methylene chloride	Dichloromethane	75-09-2	CH2Cl2	NR	**NR**	**0.89**	**11.32**	25	NR	0.9
Methyl ether	Dimethyl ether	115-10-6	C2H6O	4.8	**3.1**	**2.50**	**10.03**	ne		
Methyl ethyl ketone	MEK, 2-Butanone	78-93-3		0.86	**0.9**	**1.10**	**9.51**	200	3.40	2.2
Methylhydrazine	Monomethylhydrazine, Hydrazomethane	60-34-4	C2H6N2	1.4	**1.2**	**1.30**	**7.70**	0.01		
Methyl isobutyl ketone	MIBK, 4-Methyl-2-pentanone	108-10-1	C6H12O	0.9	**0.8**	**0.60**	**9.30**	50	4.80	
Methyl isothiocyanate	CH3NCS	551-61-6	C2H3NS	0.5	**0.45**	**0.40**	**9.25**	ne		
Methyl mercaptan	Methanethiol	74-93-1	CH4S	0.65	0.54	0.66	9.44	0.50		
Methyl methacrylate		80-62-6	C5H8O2	2.7	**1.5**	**1.20**	**9.70**	100	7.50	
Methyl nonafluorobutyl	HFE-7100DL	163702-08-7,	C5H3F9O		NR	**~35**		ne		
Ether		163702-07-6								
Methyl-1,5-pentane-	Dytek-A amine, 2-Methyl	15520-10-2	C6H16N2		~0.6		<9.0	ne		
diamine, 2- (coats lamp)	pentamethylenediamine									
Methyl propyl ketone	MPK, 2-Pentanone	107-87-9	C5H12O		0.93	**0.79**	**9.38**	200		

Attachment 2
RAE SYSTEMS PID RESPONSE (Note: bold indicates "lab validated")

Compound Name	Synonym/ Abbreviation	CAS No.	Formula	Lamp			IE(eV)	TWA	FID-PID Conversion Factor (as CH4)	FID Response Factor (Lab)
				9.80	STD 10.6	11.70				
Methyl-2-pyrrolidinone, N-	NMP, N-Methylpyrrolidone, 1-Methyl-2-pyrrolidinone, 1-Methyl-2-pyrrolidone	872-50-4	C5H9NO	1.0	**0.8**	**0.90**	**9.17**	ne		
Methyl salicylate	Methyl 2-hydroxybenzoate	119-36-8	C8H8O3	1.3	**0.9**	**0.90**	**~9**	ne		
Methylstyrene, ß-	2-Propenylbenzene	98-83-9	C9H10		0.5		8.18	50		
Methyl sulfide	DMS, Dimethyl sulfide	75-18-3	C2H6S	0.49	**0.44**	**0.46**	**8.69**	ne		
Mineral spirits	Stoddard Solvent, Varsol 1,	8020-83-5	m.w. 144		0.70	**0.39**		100		
	White Spirits	8052-41-3								
		68551-17-7								
Mineral Spirits -		8052-41-3	m.w. 142	1.0	**0.7**	**0.30**	**100.00**			
Viscor 120B Calibration Fluid,										
b.p. 156-207EC										
Monoethanolamine										
see Ethanolamine										
Mustard	HD, Bis(2-chloroethyl) sulfide	505-60-2	C4H8Cl2S		0.6			0.0005		
		39472-40-7								
		68157-62-0								
Naphtha - see VM & P Naptha										
Naphthalene	Mothballs	91-20-3	C10H8	0.45	**0.42**	**0.40**	**8.13**	10		
Nickel carbonyl (in CO)	Nickel tetracarbonyl	13463-39-3	C4NiO4		0.18		<8.8	0.001		
Nitric oxide	10102-43-9	NO		~6	5.2	**2.80**	**9.26**	25		
Nitrobenzene		98-95-3	C6H5NO2	2.6	**1.9**	**1.60**	**9.81**	1		
Nitroethane		79-24-3	C2H5NO2			3.00	10.88	100		
Nitrogen dioxide		10102-44-0	NO2	23	**16.0**	**6.00**	**9.75**	3		
Nitrogen trifluoride		7783-54-2	NF3	NR	NR	NR	13.00	10		
Nitromethane		75-52-5	CH3NO2			4.00	11.02	20		
Nitropropane, 2-		79-46-9	C3H7NO2			2.60	10.71	10		
Nonane		111-84-2	C9H20		1.4		9.72	200	~13	
Norpar 12	n-Paraffins, mostly C10-C13	64771-72-8	m.w. 161	3.2	**1.1**	**0.28**		ne		
Norpar 13	n-Paraffins, mostly C13-C14	64771-72-8	m.w. 189	2.7	**1.0**	**0.30**		ne		
Octane, n-		111-65-9	C8H18	13	**1.8**		9.82	300	14.40	
Pentane		109-66-0	C5H12	80	**8.4**	**0.70**	**10.35**	600	42.00	
Peracetic acid	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	C2H4O3	NR	**NR**	**2.30**		ne		

Attachment 2
RAE SYSTEMS PID RESPONSE (Note: bold indicates "lab validated")

Compound Name	Synonym/ Abbreviation	CAS No.	Formula	Lamp			IE(eV)	TWA	FID-PID Conversion Factor (as CH4)	FID Response Factor (Lab)
				9.80	STD 10.6	11.70				
Peracetic/Acetic acid mix	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	C2H4O3		50.0	**2.50**		ne		
Perchloroethene	PCE, Perchloroethylene, Tetrachloroethylene	127-18-4	C2Cl4	0.69	**0.57**	**0.31**	**9.32**	25	1.10	1.3
PGME	Propylene glycol methyl ether,	107-98-2	C6H12O3	2.4	**1.5**	**1.10**		100		
	1-Methoxy-2-propanol									
PGMEA	Propylene glycol methyl ether	108-65-6	C6H12O3	1.65	**1.0**	**0.80**		ne		
	acetate, 1-Methoxy-2-									
	acetoxypropane, 1-Methoxy-									
	2-propanol acetate									
Phenol	Hydroxybenzene	108-95-2	C6H6O	1.0	**1.0**	**0.90**	**8.51**	5		
Phosgene	Dichlorocarbonyl	75-44-5	CCl2O	NR	**NR**	**8.50**	**11.20**	0.1		
Phosgene in Nitrogen	Dichlorocarbonyl	75-44-5	CCl2O	NR	**NR**	**6.80**	**11.20**	0.1		
Phosphine		7803-51-2	PH3	28	3.9	**1.10**	**9.87**	0.3		
Photocopier Toner	Isoparaffin mix				0.5	**0.30**		ne		
Picoline, 3-	3-Methylpyridine	108-99-6	C6H7N		0.9		9.04	ne		
Pinene, ß-		2437-95-8	C10H16		0.31	**0.47**	8.07	ne		
Pinene, Γ-		18172-67-3	C10H16	0.38	**0.37**	**0.37**	**~8**	100		
Piperylene, isomer mix	1,3-Pentadiene	504-60-9	C5H8	0.76	**0.69**	**0.64**	**8.60**	100		
Propane		74-98-6	C3H8		NR	**1.80**	**10.95**	2500	NR	
Propanol, n-	Propyl alcohol	71-23-8	C3H8O		5.0	1.70	10.22	200		
Propene	Propylene	115-07-1	C3H6	1.5	**1.4**	**1.60**	**9.73**	ne		
Propionaldehyde	Propanal	123-38-6	C3H6O		1.9		9.95	ne	~5.7	
Propyl acetate, n-	1-Aminopropane	109-60-4	C5H10O2		3.5		10.04	200		
Propylene carbonate		108-32-7	C4H6O3		62.0	**1.00**	**10.50**	ne		
Propylene glycol	1,2-Propanediol	57-55-6	C3H8O2	18	5.5	**1.60**	**<10.2**	ne		
Propylene oxide	Methyloxirane	75-56-9	C3H6O	~240	6.6	**2.90**	**10.22**	20	19.50	
		16088-62-3								
		15448-47-2								
Propyleneimine	2-Methylaziridine	75-55-8	C3H7N	1.5	**1.3**	**1.00**	**9.00**	2		
Propyl mercaptan, 2-	2-Propanethiol, Isopropyl	75-33-2	C3H8S	0.64	**0.66**		9.15	ne		
	mercaptan									
Pyridine		110-86-1	C5H5N	0.78	**0.7**	**0.70**	**9.25**	5		
Pyrrolidine (coats lamp)	Azacyclohexane	123-75-1	C4H9N	2.1	**1.3**	**1.60**	**~8.0**	ne		

Attachment 2
RAE SYSTEMS PID RESPONSE (Note: bold indicates "lab validated")

Compound Name	Synonym/ Abbreviation	CAS No.	Formula	Lamp			IE(eV)	TWA	FID-PID Conversion Factor (as CH4)	FID Response Factor (Lab)
				9.80	STD 10.6	11.70				
RR7300 (PGME/PGMEA)	70:30 PGME:PGMEA (1- Methoxy-2-propanol:1-	107-98-2	C4H10O2 / C6H12O		1.4	**1.00**		ne		
	Methoxy-2-acetoxypropane)									
Sarin	GB, Isopropyl	107-44-8	C4H10FO2P		~3					
	Methylphosphonofluoridate	50642-23-4								
Stoddard Solvent -	see Mineral Spirits	8020-83-5								
Styrene		100-42-5	C8H8	0.45	**0.4**	**0.40**	**8.43**	20	3.20	
Sulfur dioxide		9/5/7446	SO2		NR	**NR**	**12.32**	2		
Sulfur hexafluoride		2551-62-4	SF6	NR	NR	NR	15.30	1000		
Sulfuryl fluoride	Vikane	2699-79-8	SO2F2	NR	NR	NR	13.00	5		
Tabun	Ethyl N, N- Dimethyl-phosphoramidocyanidate	77-81-6	C5H11N2O2P		0.8			15ppt		
Tetrachloroethane, 1,1,1,2-		630-20-6	C2H2Cl4				~11.1	ne		
Tetrachloroethane, 1,1,2,2-		79-34-5	C2H2Cl4	NR	**NR**	**0.60**	**~11.1**	1	NR	
Tetrachlorosilane		10023-04-7	SiCl4	NR	NR	15.00	**11.79**	ne		
Tetraethyllead	TEL	78-00-2	C8H20Pb	0.4	0.3	0.20	~11.1	0.01		
Tetraethyl	Ethyl silicate, TEOS	78-10-4	C8H20O4		0.7	**0.20**	**~9.8**	10		
Tetrafluoroethane, 1,1,1,2-	HFC-134A	811-97-2	C2H2F4		NR	NR		ne		
Tetrafluoroethene	TFE, Tetrafluoroethylene, Perfluoroethylene	116-14-3	C2F4		~15		10.12	ne		
Tetrafluoromethane	CFC-14, Carbon tetrafluoride	75-73-0	CF4		NR	NR	**>15.3**	ne		
Tetrahydrofuran	THF	109-99-9	C4H8O	1.9	**1.7**	**1.00**	**9.41**	200	6.80	2.5
Tetramethyl orthosilicate		681-84-5	C4H12O4Si	10	**1.9**		~10	1		
Methyl silicate,										
TMOS										
Therminol VP-17	Dowtherm,3:1 Diphenyl oxide:	101-84-8	C12H10O		0.4			ne		
	Biphenyl	92-52-4	C12H10							
Toluene Methylbenzene		108-88-3	C7H8	0.54	**0.5**	**0.51**	**8.82**	50		
Tolylene-2,4-diisocyanate	TDI, 4-Methyl-1,3-phenylene-2,4-diisocyanate	584-84-9	C9H6N2O2	1.4	**1.4**	**2.00**		0.002		
Trichlorobenzene, 1,2,4-	1,2,4-TCB	120-82-1	C6H3Cl3	0.7	**0.46**		9.04	C5		
Trichloroethane, 1,1,1-	1,1,1-TCA, Methyl chloroform	71-55-6	C2H3Cl3		NR	**1.00**	**11.00**	350	NR	1.6

Attachment 2
RAE SYSTEMS PID RESPONSE (Note: bold indicates "lab validated")

Compound Name	Synonym/ Abbreviation	CAS No.	Formula	Lamp			IE(eV)	TWA	FID-PID Conversion Factor (as CH4)	FID Response Factor (Lab)
				9.80	STD 10.6	11.70				
Trichloroethane, 1,1,2-	1,1,2-TCA	79-00-5	C2H3Cl3	NR	**NR**	**0.90**	**11.00**	10	NR	
Trichloroethene TCE,	Trichoroethylene	79-01-6	C2HCl3	0.62	**0.54**	**0.43**	**9.47**	50	1.00	
Trichloromethylsilane	Methyltrichlorosilane	75-79-6	CH3Cl3Si	NR	NR	1.80	**11.36**	ne		
Trichlorotrifluoroethane, 1,1,2-	CFC-113	76-13-1	C2Cl3F3		NR	NR	11.99	1000		
Triethylamine	TEA	121-44-8	C6H15N	0.95	**0.9**	**0.65**	**7.30**	1		
Triethyl borate	TEB; Boric acid triethyl ester, Boron ethoxide	150-46-9	C6H15O3B		2.2	**1.10**	**~10**	ne		
Triethyl phosphate	Ethyl phosphate	78-40-0	C6H15O4P	~50	**3.1**	**0.60**	**9.79**	ne		
Trifluoroethane, 1,1,2-		430-66-0	C2H3F3			34.00	12.90	ne		
Trimethylamine		75-50-3	C3H9N		0.9		7.82	5	2.70	
Trimethylbenzene, 1,3,5- -	see Mesitylene	108-67-8						25		
Trimethyl borate	TMB; Boric acid trimethyl ester, Boron methoxide	121-43-7	C3H9O3B		5.1	**1.20**	**10.10**	ne		
Trimethyl phosphate	Methyl phosphate	512-56-1	C3H9O4P		8.0	**1.30**	**9.99**	ne		
Trimethyl phosphate	Methyl phosphite	121-45-9	C3H9O3P		1.1		**8.50**	2		
Turpentine	Pinenes (85%) + other	8006-64-2	C10H16	0.4	**0.3**		~8	100		
	diisoprenes									
Undecane		1120-21-4	C11H24		2.0		9.56	ne		
Varsol B see Mineral Spirits										
Vinyl actetate		108-05-4	C4H6O2	1.5	**1.2**	**1.00**	**9.19**	10	4.80	
Vinyl bromide	Bromoethylene	593-60-2	C2H3Br		0.4		9.80	5	0.80	
Vinyl-1-cyclohexene, 4-	Butadiene dimer, 4-Ethenylcyclohexene	100-40-3	C8H12	0.6	**0.56**		9.83	0.10		
Vinylidene chloride										
see 1,1-Dicholorethene										
Vinyl-2-pyrrolidinone, 1-	NVP, N-vinylpyrrolidone, ethenyl-2-pyrrolidinone	1-88-12-0	C6H9NO	1.0	**0.8**	**0.90**		ne		
Viscor 120B -	see Mineral Spirits -									
Viscor 120B Calibration Fluid										
V. M. & P. Naphtha	Ligroin; Solvent naphtha;	64742-89-8	m.w. 111		~1			300		
	Varnish maker's & painter's naptha	(C8-C9)								
Xylene, m-	1,3-Dimethylbenzene	108-38-3	C8H10	0.5	**0.43**	**0.40**	**8.56**	100	3.40	
Xylene, o-	1,2-Dimethylbenzene	95-47-6	C8H10	0.57	**0.59**	**0.69**	8.56	100	4.70	3.6

Attachment 2
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Compound Name	Synonym/ Abbreviation	CAS No.	Formula	Lamp			IE(eV)	TWA	FID-PID Conversion Factor (as CH4)	FID Response Factor (Lab)
				9.80	STD 10.6	11.70				
Xylene, p-	1,4-Dimethylbenzene	106-42-3	C8H10		0.45	**0.62**	**8.44**	100	3.60	
None				1	1	1				
Undetectable				1E+06	1E+06	1E+06				
Therminol7 is a registered Trademark ® of Solutia, Inc.										

Attachment 2
RAE SYSTEMS PID RESPONSE (Note: bold indicates "lab validated")

Appendix I:

Example of Automatic Calculation of Correction Factors, TLVs and Alarm Limits for Mixtures

(Calculations performed using Excel version of this database, available on request)

Compound	**CF 9.8 eV**	**CF 10.6 eV**	**CF 11.7eV**	**Mol. Frac**	**Conc ppm**	**TLV ppm**	**STEL ppm**
Benzene	0.55	0.53	0.60	0.01	1	0.5	2.5
Toluene	0.54	0.50	0.51	0.06	10	50.0	150.0
Hexane, n-	300.00	4.30	0.54	0.06	10	50.0	150.0
Heptane, n-	45.00	2.80	0.60	0.28	50	400.0	500.0
Styrene	0.45	0.40	0.42	0.06	10	20.0	40.0
Acetone	1.20	1.10	1.40	0.28	50	750.0	1000.0
Isopropanol	500.00	6.00	2.70	0.28	50	400.0	500.0
None	1.00	1.00	1.00	0.00	0	1.0	
Mixture Value:	2.10	1.50	0.89	1.00	181	56.0	172.0
TLV Alarm Setpoint when Calibrated to Isobutylene:	26.00 ppm	37.00 ppm	62.00 ppm				
STEL Alarm Setpoint, same Calibration	86.00 ppm	115.00 ppm	193.00 ppm				