Correction Factors, Ionization Energies, And Calibration Characteristics For AreaRAE Plus/Pro

Correction Factors & Ionization Energies*

Photoionization Detector sensors (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 instrument with a PID sensor 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.

** The term “ionization energy” is more scientifically correct and replaces the old term “ionization potential.” High-boiling (“heavy”) compounds may not vaporize enough to give a response even when their ionization energies are below the lamp photon energy. Some inorganic compounds like H_2O_2 and NO_2 give weak response even when their ionization energies are well below the lamp photon energy.*

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 = 0.54), the adjusted value with a 10 ppm reading would be 5.4 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:

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

For air at 25°C (77°F), the molar gas volume is 24.4 L/mole and the formula reduces to:

$$\text{Conc.(mg/m3)} = \text{Conc.(ppmv) x mol. wt. (g/mole) x } 0.041$$

For example, if the instrument is calibrated with a gas standard in ppmv, such as 100 ppm isobutylene, and the user wants the 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:

$$CFmix = 1 / (X_1/CF_1 + X_2/CF_2 + X_3/CF_3 + \ldots Xi/CFi)$$

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:

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:

$$TLV\ mix = 1 / (X_1/TLV_1 + X_2/TLV_2 + X_3/TLV_3 + \ldots Xi/TLVi)$$

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. 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. 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. 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 MiniRAE3000+, ~0.3 L for MultiRAE).
4. 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, 14° to 113° F, or -10° to 45° 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 MiniRAE3000+, 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 Honeywell 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 to 250 ppm, and 500 ppm standard for expected concentrations of 250 to 1,000 ppm. The correction factors in this table were typically measured at 50 to 100 ppm and apply from the ppb range up to about 1,000 ppm. Above 1,000 ppm the CF may vary and it is best to calibrate with the gas of interest near the concentration of interest.

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.

G. Instrument Design. High-boiling ("heavy") or very reactive compounds can be lost by reaction or adsorption onto materials in the gas sample train, such as filters, pumps and other sensors. Multi-gas meters, including MultiRAE and AreaRAE Plus/Pro have the pump and other sensors upstream of the PID and are prone to these losses. Compounds possibly affected by such losses are shown in green in the table, and may give slow response, or in extreme cases, no response at all. In many cases the multi-gas meters can still give a rough indication of the relative concentration, without giving an accurate, quantitative reading. The 3GPID+ series instruments have inert sample trains and therefore do not exhibit significant loss; nevertheless, response may be slow for the very heavy compounds and additional sampling time up to a minute or more should be allowed to get a stable reading.

DISCLAIMER

TN-106A is a general guideline for Correction Factors (CF) for use with PID instruments manufactured by Honeywell. The CF may vary, depending on instrument and operation conditions. For the best accuracy, it is recommended to calibrate the instrument to target gas. Actual readings may vary with age and cleanliness of lamp, relative humidity, and other factors, as well. For accurate work, the instrument should be calibrated regularly under the operating conditions used. The factors in this table on the following pages were measured in dry air (40 to 50% RH) at room temperature, typically at 50 to 100 ppm. CF values may vary above about 1,000 ppm.

IMPORTANT!

Even though the same sensor may be used in different instruments (MultiRAE Series and ToxiRAE Pro, for example), the firmware and design of the instruments are different, The CF are therefore customized for best performance within the specific instrument, as confirmed by our lab tests.
Note: These CF are specific to the instruments cited in these notes, and do not apply to instruments not manufactured by Honeywell. In addition, these lamps and sensors should not be used in instruments by other manufacturers because their performance cannot be guaranteed.

Updates

The values in this table on the following pages are subject to change as more or better data become available. Watch for updates of this table on the Internet.

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 Ion Energetics, Vers. 2.0, Lias, et.al., U.S. Dept. Commerce (1993). Equations for exposure limits for mixtures of chemicals were taken from the 1997 TLVs and BEIs handbook published by the ACGIH (1997).

TABLE ABBREVIATIONS

CF = Correction Factor (multiply by reading to get corrected value for the compound when calibrated to isobutylene)
ND = Not Detectable
NCF = No Correction Factor
MW = Molecular weight
CAS No. = CAS Registry Number
IE = Ionization Energy

Note: The term "ionization energy" is more scientifically correct and replaces the old term "ionization potential." High-boiling ("heavy") compounds may not vaporize enough to give a response even when their ionization energies are below the lamp photon energy. Some inorganic compounds like H_2O_2 and NO_2 give weak response even when their ionization energies are well below the lamp photon energy.

Note: The Correction Factors shown here are included in the Correction Factor Library in firmware version V1.10 for the AreaRAE Plus/Pro.

Compound Name	IE (eV)	Formula	CAS No.	Molecular Weight (g/mol)	CF 9.8eV	CF 10.6eV
Acetaldehyde	10.23	C2H4O	75-07-0	44.1	ND	6
Acetic Acid	10.66	C2H4O2	64-19-7	60.1	ND	22
Acetic Anhydride	10.14	C4H6O3	108-24-7	102.1	ND	6.1
Acetone	9.71	C3H6O	67-64-1	58.1	1.2	1.08
Acetone cyanohydrin	11.1	C4H7NO	75-86-5	85.1	ND	ND
Acetylene	12.9	C2H2	74-86-2	26	ND	ND
Acrolein	10.1	C3H4O	107-02-8	56.1	42	3.9
Acrylic Acid	10.6	C3H4O2	79-10-7	72.06	ND	12
Acrylonitrile	10.91	C3H3N	107-13-1	53.1	ND	ND
Allyl alcohol	9.67	C3H6O	107-18-6	58.1	4.5	2.4
Ammonia	10.16	NH3	7664-41-7	17	ND	11.1
Amyl acetate	<9.9	C7H14O2	628-63-7	130.2	11.3	2.2
Aniline	7.72	C7H7N	62-53-3	93.1	6.5	1.2
Anisole	8.21	C7H8O	100-66-3	108.1	0.89	0.58
Arsine	9.89	AsH3	7784-42-1	77.9	ND	1.9
Benzene	9.25	C6H6	71-43-2	78.1	0.55	0.48
Benzyl alcohol	8.26	C7H8O	100-51-6	108.1	2.8	2.2
Benzyl chloride	9.14	C7H7Cl	100-44-7	126.6	0.7	0.6
Benzyl formate	9.32	C8H8O2	104-57-4	136.1	0.9	0.73
Bromine	10.51	Br2	7726-95-3	159.8	ND	1.3
Bromobenzene	9.00	C6H5Br	108-86-1	157.02	NCF	0.31
Bromoethyl methyl ether, 2-	~10	C3H7OBr	6482-24-2	139	ND	0.84
Bromoform	10.48	CHBr3	75-25-2	252.7	71	2.7
Bromopropane, 1-	10.18	C3H7Br	106-94-5	123	150	1.5

Compound Name	IE (eV)	Formula	CAS No.	Molecular Weight (g/mol)	CF 9.8eV	CF 10.6eV
Butadiene	9.07	C4H6	106-99-0	54.1	0.8	0.73
Butadiene diepoxide, 1, 3-	~10	C4H6O2	298-18-0	86.1	25	3.5
Butane	10.53	C4H10	106-97-8	58.1	ND	ND
Butane, n-	10.53	C4H10	106-97-8	58.1	ND	ND
Butanol, 1-	9.99	C4H10O	71-36-3	74.1	70	4.7
Butanol, t-	9.9	C4H10O	75-65-0	74.1	6.9	2.9
Butoxyethanol, 2-	<10	C6H14O2	111-76-2	118.2	1.8	1.2
Butyl acetate, n-	10	C6H12O2	123-86-4	116.2	ND	2.33
Butyl acrylate, n-	~9.6	C7H12O2	141-32-2	128.2	ND	1.6
Butylamine, n-	8.71	C4H11N	109-73-9	73.1	1.1	1.1
Butyl hydroperoxide, t-	<10	C4H10O2	75-91-2	90.1	2	1.6
Butyl mercaptan	9.14	C4H10S	109-79-5	90.2	0.55	0.52
Carbon disulfide	10.07	CS2	75-15-0	76.1	4	1.2
Carbon monoxide	14.01	CO	630-08-0	28	ND	ND
Carbon tetrachloride	11.47	CCl4	56-23-5	153.8	ND	ND
Chlorine	11.48	Cl2	7782-50-5	70.9	ND	ND
Chlorobenzene	9.06	C6H5Cl	108-90-7	112.6	0.6	0.5
Chloroethane	10.97	C2H5Cl	75-00-3	64.5	ND	ND
Chloroethyl ether, 2-	10.05	C4H8Cl2O	111-44-4	143	8.6	3
Chloroform	11.37	CHCl3	67-66-3	119.4	ND	ND
Chloro-2-methylpropene, 3-	9.76	C4H7Cl	563-47-3	90.6	1.4	1.2
Chloropicrin		CCl3NO2	76-06-2	164.4	ND	ND
Chlorotrifluoroethene	9.76	C2ClF3	79-38-9	116.5	6.7	3.9
Chlorotrimethylsilane	10.83	C3H9ClSi	75-77-4	108.6	ND	ND
Cresol, m-	8.29	C7H8O	108-39-4	108.1	0.57	0.5
Crotonaldehyde	9.73	C4H6O	123-73-9	70.1	1.5	1.1
Cumene	8.73	C9H12	98-82-8	120.2	0.58	0.54
Cyclohexane	9.86	C6H12	110-82-7	84.2	3.3	1.4
Cyclohexanol	8.75	C6H12O	108-93-0	100.1	1.5	0.94
Cyclohexanone	9.14	C6H10O	108-94-1	98.1	1	0.9
Cyclohexene	8.95	C6H10	110-83-8	82.1	ND	0.8
Cyclohexylamine	8.40	C6H13N	108-91-8	99.17	NCF	6.1
Cyclopentane	10.52	C5H10	287-92-3	70.1	ND	15
Cyclopropylamine		C3H7N	765-30-0	57.1	3	1.3
Decane	9.65	C10H22	124-18-5	142.3	4	1.4
Dibromochloromethane	10.59	CHBr2Cl	124-48-1	208.3	ND	5
Dibromo-3-chloropropane, 1, 2-		C3H5Br2Cl	96-12-8	236.3	ND	1.7
Dibromoethane, 1, 2-	10.37	C2H4Br2	106-93-4	187.9	ND	1.7
Dichlorobenzene, o-	9.08	C6H4Cl2	95-50-1	147	1.5	0.7

Compound Name	IE (eV)	Formula	CAS No.	Molecular Weight (g/mol)	CF 9.8eV	CF 10.6eV
Dichlorodimethylsilane	>10.7	C2H6Cl2Si	75-78-5	129.1	ND	ND
Dichloroethane, 1, 2-	11.04	C2H4Cl2	107-06-2	99	ND	ND
Dichloroethene, 1, 1-	9.79	C2H2Cl2	75-35-4	96.9	ND	0.82
Dichloroethene, t-1, 2-	9.65	C2H2Cl2	156-60-5	96.9	ND	0.45
Dichloro-1-fluoroethane, 1, 1-		C2H3Cl2F	1717-00-6	117	ND	ND
Dichloromethane	11.33	CH2Cl2	75-09-2	85	ND	ND
Dichloropentafluoropropane		C3HCl2F5	442-56-0	202.9	ND	ND
Dichloro-1-propene, 1, 3-	<10	C3H4Cl2	542-75-6	111	1.3	0.96
Dichloro-1-propene, 2, 3-	<10	C3H4Cl2	78-88-6	111	1.9	1.3
Dichloro-1,1,1-trifluoroethane,2,2-	11.5	C2HCl2F3	306-83-2	152.9	ND	ND
Dichloro-2,4,6-trifluoropyridine,3,5-		C5Cl2F3N	1737-93-5	202	1.1	1.5
Dichlorvos	<9.4	C4H7Cl2O4P	62-73-7	221	ND	0.9
Dicyclopentadiene	8.8	C10H12	77-73-6	132.2	1.5	0.64
Diesel Fuel #2, whole		------	68334-30-5	216	1.3	0.7
Diethylamine	8.01	C4H11N	109-89-7	73.1	ND	3.5
3-(Diethylamino)propylamine		C7H18N2	104-78-9	130.23	NCF	8.6
Diglyme		C6H14O3	111-96-6	134.2	0.64	0.54
Diisopropylamine	7.73	C6H15N	108-18-9	101.2	0.84	0.74
Diketene	9.6	C4H4O2	674-82-8	84.1	2.6	2
Dimethylacetamide, N, N-	8.81	C4H9NO	127-19-5	87.1	0.87	0.8
Dimethyl carbonate	~10.5	C3H6O3	616-38-6	90.1	ND	ND
Dimethyl disulfide	7.4	C2H6S2	624-92-0	94.1	0.2	0.2
Dimethylethylamine	7.74	C4H11N	598-56-1	73.1	1.1	1
Dimethylformamide, N, N-	9.13	C3H7NO	68-12-2	73.1	0.7	0.7
Dimethylhydrazine, 1, 1-	7.28	C2H8N2	57-14-7	60.1	ND	0.78
Dimethyl methylphosphonate	10	C3H9O3P	756-79-6	124.1	ND	4.3
Dimethyl sulfate		C2H6O4S	77-78-1	126.1	23	20
Dimethyl sulfoxide	9.1	C2H6OS	67-68-5	78.1	ND	1.4
Dioxolane,1,3-	9.9	C3H6O2	646-06-0	74.1	4	2.3
DS-108F Wipe Solvent		------	97-64-3	118	3.3	1.6
Epichlorohydrin	10.2	C2H5ClO	106-89-8	92.5	ND	8.5
Ethane	11.52	C2H6	74-84-0	30.1	ND	ND
Ethanol	10.47	C2H6O	64-17-5	46.1	ND	11.2
Ethanolamine	8.96	C2H7NO	141-43-5	61.1	ND	40.1
Ethene	10.51	C2H4	74-85-1	28.1	ND	9
Ethyl acetate	10.01	C4H8O2	141-78-6	88.1	ND	5.3
Ethyl acrylate	<10.3	C5H8O2	140-88-5	100.1	ND	2.4
Ethylbenzene	8.77	C8H10	100-41-4	106.2	0.76	0.63
Ethylenediamine	8.6	C2H8N2	107-15-3	60.1	ND	6.7

Compound Name	IE (eV)	Formula	CAS No.	Molecular Weight (g/mol)	CF 9.8eV	CF 10.6eV
Ethylene glycol	10.16	C2H6O2	107-21-1	62.1	ND	16
Ethylene glycol dimethyl ether	9.2	C4H10O2	110-71-4	90.1	1.8	1.2
Ethylene oxide	10.57	C2H4O	75-21-8	44.1	ND	13
Ethyl ether	9.51	C4H10O	60-29-7	74.1	ND	1.1
Ethyl 3-ethoxypropionate		C7H14O3	763-69-9	146.2	1.2	0.75
Ethyl hexyl acrylate,2-		C11H20O2	103-11-7	184.3	ND	1.1
Ethylidenenorbornene	<8.8	C9H12	16219-75-3	120.2	0.43	0.39
Ethyl (S)-(-)-lactate	~10	C5H10O3	687-47-8	118.1	13	3.2
Ethyl mercaptan	9.29	C2H6S	75-08-1	62.1	0.6	0.56
Ethyl sulfide	8.43	C4H10S	352-93-2	90.2	ND	0.51
Formaldehyde	10.87	CH2O	50-00-0	30	ND	ND
Formamide	10.16	CH3NO	75-12-7	45	ND	6.9
Formic acid	11.33	CH2O2	64-18-6	46	ND	ND
Furfural	9.21	C5H4O2	98-01-1	96.1	2.5	1.4
Furfuryl alcohol	<9.5	C5H6O2	98-00-0	98.1	ND	0.8
Gasoline		------	8006-61-9	93	1.3	1
Glutaraldehyde		C5H8O2	111-30-8	100.1	1.1	0.8
Heptane,n-	9.92	C7H16	142-82-5	100.2	45	2.8
Hexamethyldisilazane,1,1,1,3,3,3-	~8.6	C6H19NSi2	999-97-3	161.4	2.2	1.5
Hexamethyldisiloxane	9.5	C6H18OSi2	107-46-0	162.38	NCF	0.62
Hexane,n-	10.13	C6H14	110-54-3	86.2	ND	4.4
Hexanol,1-	9.89	C6H14O	111-27-3	102.2	9	2.5
Histoclear		------	5989-27-5	136	0.5	0.4
Hydrazine	8.1	H4N2	302-01-2	32.1	8	3
Hydrogen	15.43	H2	1333-74-0	2	ND	ND
Hydrogen iodide	10.39	HI	10034-85-2	127.9	ND	0.6
Hydrogen sulfide	10.45	H2S	6/4/7783	34.1	ND	3.2
Iodine	9.4	I2	7553-56-2	253.8	0.1	0.1
Iodomethane	9.54	CH3I	74-88-4	141.9	0.21	0.22
Isoamyl acetate	<10	C7H14O2	123-92-2	130.2	10.1	2.1
Isobutane	10.57	C4H10	75-28-5	58.1	ND	ND
Isobutanol	10.02	C4H10O	78-83-1	74.1	19	3.8
Isobutylene	9.24	C4H8	115-11-7	56.1	1	1
Isobutyl acrylate		C7H12O2	106-63-8	128.2	ND	1.5
Isopar E Solvent		------	64741-66-8	121	1.7	0.8
Isopar G Solvent		------	64742-48-9	148	ND	0.79
Isopar K Solvent		------	64742-48-9	156	0.85	0.53
Isopar L Solvent		------	64742-48-9	163	0.86	0.52
Isopar M Solvent		------	64742-47-8	191	ND	0.66

Compound Name	IE (eV)	Formula	CAS No.	Molecular Weight (g/mol)	CF 9.8eV	CF 10.6eV
Isoprene	8.85	C5H8	78-79-5	68.1	0.69	0.63
Isopropanol	10.12	C3H8O	67-63-0	60.1	ND	4.8
Jet A		---	80008-20-6	150	3.5	1.2
Jet fuel JP-4		------	------	115	ND	1
Jet fuel JP-5		------	------	167	ND	0.6
Jet fuel JP-8		------	------	165	ND	0.94
Jet fuel TS		------	------	165	0.9	0.6
Limonene,D-	~8.2	C10H16	5989-27-5	136.2	ND	0.33
Mesitylene	8.41	C9H12	108-67-8	102.2	0.36	0.35
Methane	12.61	CH4	74-82-8	16	ND	ND
Methanol	10.85	CH4O	67-56-1	32	ND	ND
Methoxyethanol,2-	10.1	C3H8O2	109-86-4	76.1	4.8	2.4
Methoxyethoxyethanol,2-	<10	C7H16O3	111-77-3	120.2	2.3	1.2
Methyl acetate	10.27	C3H6O2	79-20-9	74.1	ND	6.6
Methyl acrylate	9.9	C4H6O2	96-33-3	86.1	ND	3.7
Methyl bromide	10.54	CH3Br	74-83-9	94.9	110	1.7
Methyl t-butyl ether	9.24	C5H12O	1634-04-4	88.2	ND	0.91
Methyl chloride	11.22	CH3Cl	74-87-3	50.5	ND	ND
Methylaniline, N-	7.32	C7H9N	100-61-8	107.15	NCF	2
Methylcyclohexane	9.64	C7H14	107-87-2	98.2	1.6	0.97
Methylene chloride	11.22	CH2Cl2	75-09-2	84.9	ND	ND
Methyl ether	10.03	C2H6O	115-10-6	46.1	4.8	3.1
Methyl ethyl ketone	9.51	C4H8O	78-93-3	72.1	1.1	1.2
Methylhydrazine	7.7	C2H6N2	60-34-4	58.1	17.2	6.1
Methyl isobutyl ketone	9.3	C6H12O	108-10-1	100.2	0.9	0.8
Methyl isocyanate	10.67	C2H3NO	624-83-9	57.1	ND	4.6
Methyl isothiocyanate	9.25	C2H3NS	551-61-6	73.1	0.5	0.45
Methyl mercaptan	9.44	CH4S	74-93-1	48.1	0.65	0.54
Methyl methacrylate	9.7	C5H8O2	80-62-6	100.12	2.7	1.5
Methyl propyl ketone	9.38	C5H12O	107-87-9	86.1	ND	0.93
3-Methylpyridine	9.0	C6H7N	108-99-6	93.13	NCF	0.8
Methyl-2-pyrrolidinone,N-	9.17	C5H9NO	872-50-4	99.1	9.7	2.7
Methyl salicylate	~9	C8H8O3	119-36-8	152.1	1.3	0.9
Methyl sulfide	8.69	C2H6S	75-18-3	62.1	0.49	0.44
Mineral spirits		------	8020-83-5	144	1	0.71
Naphthalene	8.13	C10H8	91-20-3	128.2	0.45	0.42
Nickel carbonyl in CO	<8.8	C4O4Ni	13463-39-3	170.8	ND	0.17
Nitric oxide	9.26	NO	10102-43-9	30	ND	6.3
Nitrobenzene	9.81	C6H5NO2	98-95-3	123.1	11.1	4.9

Compound Name	IE (eV)	Formula	CAS No.	Molecular Weight (g/mol)	CF 9.8eV	CF 10.6eV
Nitrogen dioxide	9.75	NO2	10102-44-0	46	23	16
Norpar 12		------	64771-72-8	161	3.2	1.1
Norpar 13		------	64771-72-8	189	2.7	1
Octane,n-	9.82	C8H18	111-65-9	114.2	13.2	2.19
Octene,1-	9.43	C8H16	111-66-0	112.2	0.9	0.75
Octamethyltrisiloxane	10.04	C8H24O2Si3	107-51-7	236.53	NCF	0.19
Pentane	10.35	C5H12	109-66-0	72.2	ND	8.5
Peracetic acid		C2H4O3	79-21-0	76.1	ND	ND
Perchloroethene	9.32	C2Cl4	127-18-4	168.5	0.69	0.57
PGME		C4H12O2	107-98-2	90.1	5.1	1.9
PGMEA		C6H12O3	108-65-6	132.2	1.65	1
Phenol	8.51	C6H6O	108-95-2	94.1	11.6	7
Phosgene	11.2	CCl2O	75-44-5	98.9	ND	ND
Phosphine	9.87	PH3	7803-51-2	34	28	3.5
Pinene,a-	8.07	C10H16	2437-95-8	136.2	ND	0.31
Pinene,b-	~8	C10H16	18172-67-3	136.2	0.38	0.37
Piperylene,isomer mix	8.6	C5H8	504-60-9	68.1	0.76	0.69
Propane	10.95	C3H8	74-98-6	44.1	ND	ND
Propandiol 1,2-		C3H8O2	57-55-6	76.1	NCF	8.1
Propanol	10.22	C3H8O	71-23-8	60.09	NCF	5.9
Propene	9.73	C3H6	115-07-1	42.1	1.5	1.4
Propylamine,n-	8.78	C3H9N	107-10-8	59.1	1.1	1.1
Propyl mercaptan,2-	9.21	C3H8S	75-33-2	76.2	0.64	0.66
Propylene carbonate	10.5	C4H6O3	108-32-7	102.1	ND	ND
Propylene glycol	<10.2	C3H8O2	57-55-6	76.1	ND	8.1
Propylene oxide	10.22	C3H6O	16088-62-3	58.1	ND	6.6
Propyleneimine	9	C3H7N	75-55-8	57.1	1.5	1.25
Pyridine	9.25	C5H5N	110-86-1	79.1	1	0.9
Pyrrolidine (coats lamp)	~8	C4H9N	123-75-1	71.1	2.1	1.3
Styrene	8.43	C8H8	100-42-5	104.1	0.45	0.6
Tetrachloroethane,1,1,2,2-	11.1	C2H2Cl4	79-34-5	167.9	ND	ND
Tetrachlorosilane	11.79	SiCl4	100026-04-7	169.9	ND	ND
Tetraethyl orthosilicate	~9.8	C8H20O4Si	78-10-4	208.3	ND	0.71
Tetrahydrofuran	9.41	C4H8O	109-99-9	72.1	1.9	1.7
Tetramethyl orthosilicate	~10	C4H12O4Si	681-84-5	152.2	20.3	20.3
Therminol VP-1		------	------	165.8	ND	0.4
Toluene	8.82	C7H8	108-88-3	92.1	0.54	0.53
Tolylene-2,4-diisocyanate		C9H6N2O2	584-84-9	174.2	1.4	1.4
Trichlorobenzene,1,2,4-	9.04	C6H3Cl3	120-82-1	181.5	3.6	1.2

Compound Name	IE (eV)	Formula	CAS No.	Molecular Weight (g/mol)	CF 9.8eV	CF 10.6eV
Trichloroethane,1,1,1-	11	C2H3Cl3	71-55-6	133.4	ND	ND
Trichloroethane,1,1,2-	11	C2H3Cl3	79-00-5	133.4	ND	ND
Trichloroethene	9.47	C2HCl3	79-01-6	131.4	0.62	0.54
Trichloromethylsilane	11.36	CH3Cl3Si	75-79-6	149.5	ND	ND
Triethylamine	7.3	C6H15N	121-44-8	101.2	13.9	1.9
Triethyl borate	~10	C6H15O3B	150-46-9	146	ND	2.2
Triethyl phosphate	9.79	C6H15O4P	78-40-0	140.1	50	3.1
Trimethyl borate	10.1	C3H9O3B	121-43-7	103.9	ND	5.1
Trimethyl phosphate	9.59	C3H9O4P	512-56-1	140.1	ND	14.9
Trimethyl phosphite	8.5	C3H9O3P	121-45-9	124.1	ND	2.15
Turpentine	~8	C10H16	8006-64-2	136.2	0.7	0.4
Vinyl actetate	9.19	C4H6O2	108-05-4	86.1	1.5	1.2
Vinyl chloride	9.99	C2H3Cl	75-01-4	62.5	ND	2
Vinyl-1-cyclohexene,4-	9.83	C8H12	100-40-3	108.2	0.6	0.56
Vinyl-2-pyrrolidinone,1-		C6H9NO	88-12-0	111.1	1	0.8
Xylene,m-	8.56	C8H10	108-38-3	106.2	0.5	0.44
Xylene,o-	8.56	C8H10	95-47-6	106.2	0.56	0.46
Xylene,p-	8.44	C8H10	106-42-3	106.2	0.48	0.39
1233zd		C3H2ClF3	2730-43-0	130.5	NCF	NCF
1234ze		C3H2F4	29118-24-9	114	NCF	NCF