PLATFORM
ZERO INCIDENTS

BEST PRACTICE
GAS MEASUREMENT

Version 1

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ABOUT PLATFORM ZERO INCIDENTS

The Platform Zero Incidents (PZI) is an initiative of the inland shipping industry. As the name suggests, PZI aims at 0 (zero) accidents in the inland shipping industry. PZI wants to achieve this by:

- Being a Platform in which near misses and incidents are shared among its members.
- Preventing repetition of near misses/incidents by developing best practices and stimulating their use, based on research and analysis of near-miss/incident (trends).
- Building lasting relationships with stakeholders.
- Raising awareness and responsibility for safety within the industry.
- Being the center of expertise in the field of preventing safety and environmental incidents in the inland shipping industry.

This publication helps to achieve PZI's mission and vision. The document has been developed by and for the inland shipping industry.

It can be used for various purposes, such as:

- Reference for crewmembers and fleet managers.
- Training of crewmembers.
- Input for safety meetings on board.
- Lesson material for educational institutions.
- As a basis for procedures and work instructions.

Aan deze publicatie hebben meegewerkt:

Harald Buil	QHSSE-Manager & Safety Advisor - Vario Shipping
Willem Klop	Marine Superintendent & Safety Advisor - Interstream Barging
Kevin van Cauter	HSSEQ Officer - Naval Inland Navigation
Kristel Steeds	Program Manager - Platform Zero Incidents
Erik Soeteman	QHSSE Advisor - Platform Zero Incidents

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1. INTRODUCTION

This document does not replace current systems or documents that are already available on board.

You can use the document as a reference, but also for familiarization with the barge and/or to train your crew members. You can also handle the document during safety meetings with your crew

It can increase safety awareness on board and thus prevent the risk of accidents.

If you have suggestions to further improve this document, please contact Platform Zero Incidents.

Platform Zero Incidents
www.platformzeroincidents.nl
info@platformzeroincidents.nl
@PZI_tweets
+31 (0) 6 21 698 648

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2. WHY DO WE MEASURE?

When transporting goods, an environment can arise that is harmful to people and/or the environment. It is therefore important that it is clear what the composition of the environment is and what measures can possibly be taken to prevent unsafe situations.

Legislation includes measures to limit the dangers. The ADN describes some legal obligations regarding the degassing and measuring of tanks and the environment of the living area. In addition, the employer is obliged to not let an employee work in a potentially dangerous environment (ARBO-besluit). It is important to determine what a hazardous environment is based on the established statutory limit values.

Degassing
Degassing is an event where potentially toxic or (slightly) flammable gases enter the outside air. To provide security for the crew and the surrounding area, measurements must be carried out in order to take any necessary measures.

Entering Confined Space
In confined spaces (a space with limited openings for entry and exit, unfavorable ventilation, not designed for continuous staffing, or is entered irregularly), gases that are poisonous or sensitive to fire may be present. Before entering a confined space, it must first be established whether the tank can be accessed and what safety equipment is required to do this safely.

Signaling
It is important for the surrounding of the barge that proper signaling is maintained. Measurements are also required for this.

Repairs and Site Visit
Measurements are also important before repairs are carried out or visiting the yard. For the above situations, see the procedures of the owner/office.

Seemingly Safe
An environment may seem safe, but in reality, it is not safe. This is called false safety. For example, when work has been done in a confined space and someone wants to enter the space again after a break. It may seem safe because in the meantime 'nothing has happened', but in reality, the mixture of gases may have changed inside the space. Or, for example, when the environment is not toxic, but has a shortage of oxygen. It is therefore important to continue to measure, even if it seems safe.

3. WHAT DO WE MEASURE?

You usually do not see them, but they are everywhere: gases. You inhale a gas mixture that we call "air", you cook food on the gas stove and drink a glass of soda in which carbon dioxide (CO2) bubbles up.

The term ‘gas’ comes from the word chaos. Gas is a cloud of molecules that move randomly and chaotically and that constantly collide with each other and the environment. Gases fill every available volume and due to the particularly high speed at which gases move, they quickly mix with the atmosphere in which they are released.

Gases can have lighter, heavier or roughly the same density as air. Gases can have an odor but can also be odorless. Gases can have a color but can also be colorless. If you cannot see, smell or touch it, it does not mean that it is not there. In order to determine which and how many gases there are in a space, we have to measure.

If we are talking about measuring, we want to know how much of a certain type of gas is present in a room to determine whether there are any risks. The three major dangers that gases entail are:

Danger of poisoning – Toxic Gases

Danger of fire and/or explosion – Flammable Gases

Danger of Suffocation - Oxygen deficiency

Now that we know that measurements are important, we will go deeper into what is measured in this chapter.

3.1. Toxicity

Toxicity is often referred to in 'degree of toxicity'. This concerns whether the substances in the air are present in such a way that they are toxic to humans. The effect already occurs when exposed to even very low concentrations that are inhaled, swallowed or absorbed by the skin. In order to know whether working safely in a space and how long work can be done safely, it is important to look up the limit value in, for example, the Chemical Data Sheet book. This value is indicated by the MAC value (Maximum Accepted Concentration).

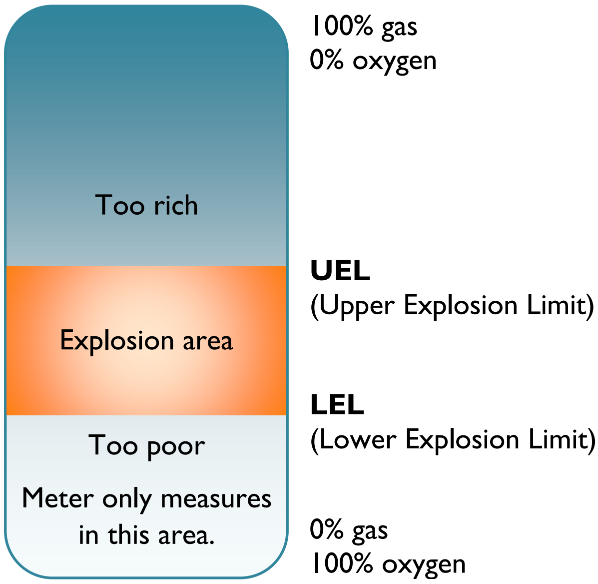
3.2. Explosion Danger

Explosion hazard occurs when a combustible substance is present in the air. This means that a combination of a combustible substance and oxygen is present. This can occur in gases, mists and substances.

The mixing ratio of gas/vapor and oxygen in which a flammable mixture is formed, is not the same for every gas. In the literature the explosion limit is indicated by the abbreviation L.E.L. (LEL), from "Lower Explosive Limit". In addition to the LEL value, there is also a maximum gas concentration: UEL value (Upper Explosive Limit).

A LEL sensor indicates the number of percentages from the lower explosion limit (% LEL; Lower Explosion Limit).

Usually it is thought that an explosion only occurs if direct fire is present. Ignition sources such as hot surfaces, mechanical sparks, or electrical installations and electrical equipment are often overlooked.



3.3. Oxygen (O_2)

People need oxygen to be able to breathe. Our (outside) air consists of approximately 20.9% oxygen. With a higher oxygen percentage (for example 23%), substances can be ignited more quickly. At a lower percentage (for example, below 19.5%) it can cause respiratory problems and in extreme cases suffocation leading to death.

But beware, an acceptable percentage of oxygen does not mean that the air is safe. After all, what does the remaining air consist of?

3.4. Stikstof (N_2)

Despite the fact that our 'air' consists of almost 21% oxygen and 78% nitrogen, an increase in nitrogen (or decrease of oxygen) is very dangerous for humans, as a result of which it can suffocate. The danger of nitrogen is that this gas is completely odorless and colorless and of course expels oxygen. Nitrogen is a fraction heavier than air and will therefore slowly sink under the air in a tank. A 'nitrogen blanket' is meant to expel the oxygen from the tank and thereby minimize the risk of explosion.

In measurements, we often speak of a nitrogen measurement, for example when flushing cargo tanks prior to loading. What is meant by this, is that we try to determine the oxygen content in a nitrogen environment.

3.5. Hydrogen Sulphide (H_2S)

Hydrogen sulphide (H_2S) is a colorless gas at atmospheric pressure and room temperature with a smell of rotten eggs. The gas is heavier than air. At high concentrations of hydrogen sulphide (dangerous!) one can no longer rely on smell perception, because after a few minutes this substance can no longer be smelled by temporary paralysis of the olfactory nerve. H_2S reacts violently with oxidants. H_2S is flammable and with air or oxygen it forms an explosive mixture (LEL 4.3 Vol-%).

3.6. Carbon Monoxide (CO)

Carbon monoxide (CO) is an odorless but toxic and combustible gas. CO is released by, among other things, incineration, rust formation, scalding and decay processes. The substance impedes oxygen absorption in the body.

CO is often located in ballast tanks, anchor chain containers, cofferdams, etc. these spaces should certainly be measured for the presence of CO before they are entered and/or hot work is carried out.

When transporting edible oils, and in particular crude unrefined oils (eg, crude palm oil) and wheat, CO occurs regularly.

4. KNOWLEDGE OF THE GAS AND PROPERTIES

Each gas has specific properties. In the previous chapter, a number of common gases have already been named with some properties, these are called physical properties. For example, how easy it dissolves in water, how heavy it is, how easily it ignites, etc. The properties can be found in the chemistry chart book.

Example physical properties Methanol:

Boiling point, °C	65
Melting point, °C	-98
Flash point, °C	11
Auto-ignition temperature, °C	382
Explosive properties/limits, volume% in air	5.5-44
Minimum ignition energy, mJ	0.14
Specific conduction, pS/m	$1.5*10^5$
Vapor pressure in mbar at 20 °C	128
Relative vapor density (air = 1)	1.1
Relative density at 20 °C of saturated vapor/air mixture (air = 1)	1.01
Relative density (water = 1)	0.8
Solubility in water, g/100 ml	Fully
Log P octanol/water	-0.7

4.1. Flash Point

The flash point of a chemical is the lowest temperature at which the substance can ignite when it comes into contact with an ignition source. The flash point should not be confused with the auto-ignition temperature. That is the temperature at which a vapor/air mixture spontaneously ignites.

The flash point is characteristic of the chance that a spark or hot object will cause a fire.

Het vlampunt van een chemische stof is de laagste temperatuur waarbij de stof tot ontbranding kan komen wanneer hij in contact komt met een ontstekingsbron. Het vlampunt moet niet worden verward met de zelfontbrandingstemperatuur. Dat is de temperatuur waarbij een damp/lucht-mengsel spontaan tot ontbranding komt.

4.2. Auto-ignition

The auto-ignition temperature is the lowest temperature at which, at a pressure of 1 atmosphere and an average oxygen content in the air, a substance ignites spontaneously and also continues to burn.

4.3. Relative Vapor Density

The density of the gases is compared with the density of air. If a gas is heavier than air it drops down. If a gas is lighter, it rises upwards (think of a helium balloon). And there are gases that have about the same weight as air. These will float. The weight of gases is shown in vapor density.

Air has the density of 1.0, so;

A vapor density < 1.0 will rise up

A vapor density > 1.0 will drop down

4.4. Sources for Physical Properties

On the basis of the information from the Chemical Data Sheet book, workplace instructions and/or an MSDS, the captain determines which measures must be taken to control the risks. Consider, for example, the personal protective equipment to be used and the measures to be taken in the event of accidents. It is important that we know the physical properties so that we know where to measure and on which values we should pay attention.

Chemical Data Sheet

It is emphasized that the chemistry chart mentions the hazardous properties of the substance and that this does not automatically reveal the extent of the risks when using the substance. Risks when working with chemical products are not only dependent on the hazardous properties of the product, but also on prevailing working conditions. In this context, consideration should be given in particular to the risk of exposure of the employee to a vapor or mist, to a liquid or to a solid substance, and in particular to powders.

The Chemical Data Sheet book has been developed for laboratory technicians working in a laboratory environment. The working conditions there are different than we have on board.

Workplace instructions

A work instruction is similar to a Chemistry Chart. The substance and hazard properties are also mentioned here. However, a workplace instructions is written in line with the working conditions on board. The advantage is also that, for example, the measuring tube of different brands to be used is indicated, as well as the PID lamp to be used with the corresponding correction factor.

MSDS

An MSDS or material safety data sheet is a structured document with information about the risks of a hazardous substance, and recommendations for its safe use.

It is therefore very important that an MSDS is requested. The producer/supplier also has the duty to provide the MSDS. A MSDS can often also be requested via a freight broker. When searching for MSDS online, there is always a risk that it is not appropriate or incorrect.

The sections from an MSDS are:

S1 - Identification of substance and organization
S2 - Hazard(s) identification
S3 - Composition/information on ingredients
S4 - First-aid measures
S5 - Fire-fighting measures
S6 - Accidental release measures
S7 - Handling and storage
S8 - Exposure controls/personal protection
S9 - Physical and chemical properties
S10 - Stability and reactivity
S11 - Toxicological information
S12 - Ecological information
S13 - Disposal considerations
S14 - Transport information
S15 - Regulatory information

5. HOW DO WE MEASURE?

5.1. PPM, mg/m³ and Volume Percent

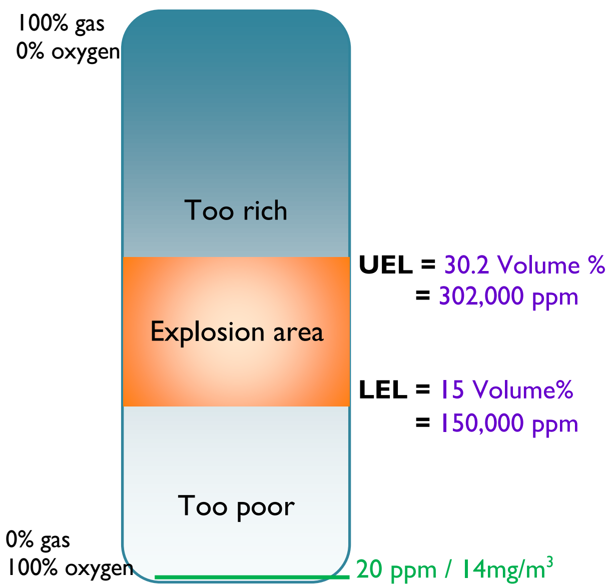
The limit values for toxicity are usually given in mg/m³, while the measuring equipment often gives the values in Parts Per Million (PPM). There is a relationship between ppm and mg/m³ at 20°C and an air pressure of 1013 mbar. To convert the values, a conversion factor can be used. In some cases, the conversion factor is already shown on the information sheets, but it can also be calculated. Below the calculation is shown.

The concept of volume percentage (abbreviated as % vol or vol.-%) or volume percentage is a measure of the concentration of a substance in a mixture. It is the ratio of the volume of the substance to the total volume, expressed as a percentage.

Example calculation ammonia:

(The material information must always be looked up in the safety data sheet.)

Given information	
Boiling point, °C	38
Melting point, °C	-58
Flash point, °C	n.b.[2)]
Auto-ignition temperature, °C	651
Explosive limits, volume % in air	15 – 30.2
Minimum ignition energy, mJ	680
Vapor pressure in mbar at 20°C	483
Relative vapor density (air = 1) (NH_3)	0.6
Relative density at 20 °C of saturated vapor/air mixture (air = 1)	0.8
Relative density (water = 1)	0.9
Solubility in water, g/100ml	Fully
Log P octanol/water (ber.)	-1.3
MAC value (as NH_3)*	20 ppm 14mg/m³
MAX TGG-15min. (as NH_3)	50 ppm 36mg/m³
Gross formula	H_2NO
Relative molecular mass	35.1
Conversion factor from mg/m³ to ppm	1.463
Conversion factor from ppm to mg/m³	0.684



* Maximum Acceptable Concentration, maximum value in order to work safely

If the conversion factor is given

We read in the Chemical Data Sheet book that for ammonia a limit value of 14 mg/m³ applies and we are going to measure the gas in the tank to see if this is being met. We must first know how many ppm this is.

Limit value: 14 mg/m³
Conversion factor from mg/m³ to ppm: 1.463
Calculation example:

14 mg/m³ x 1.433 = 20 ppm

So now we know when we measure below 20 ppm that we remain below the limit of 14 mg/m³.

The other way around, of course, is that we can first measure the gas. Suppose we measure 30 ppm:

Conversion factor from ppm to mg/m³: 0.684

30 ppm x 0.684 = 20.52 milligrams per m^3

This is therefore above the limit value of 14 mg/m^3.

If the conversion factor is not given, you can calculate it
With gas there is 1 molecule present on 24 dm^3 (or 1 on 24,000cm^3)
Molecular mass of ammonia: 35.1 grams (or 35,100 milligrams)

The formula for the conversion factor:

1 ppm $= \frac{\text{Molecular mass}}{24}$ = mg/m3

Calculation example:
1 ppm = $\frac{35.1 \text{ g}}{24 \text{ dm3}}$ of $\frac{35{,}100 \text{ mg}}{24{,}000 \text{ cm3}}$ = 1.463 milligram per cm^3

1 ppm = 1.463 milligram per cm^3

Or vice versa
1 mg/m^3 = $\frac{mg}{m^3} = \frac{24}{35.1} = 0.684 \text{ ppm}$

1 mg/m^3 = 0.684 ppm

5.2. Before You Start Measuring

Before starting with measurements, keep the following points into account:

- Make sure you have the information of the right substance. The substance name must exactly match the correct shipping name.
- Consider synonyms that can be used.
- Know which information is relevant for correctly interpreting measured values.
- Select the correct PPE for performing a measurement.
- Consult an expert in case of doubt or questions about product properties.
- Check if the product information is not too old. Review dates may not be longer than one year.
- An MSDS must come from the manufacturer of the relevant cargo of that trip.
- Select the correct meter (suitable for the product).
- Before you measure, check the equipment.
- Read the instructions carefully.
- Remove the meter from the charger, check the moisture filter and switch on the meter. (warm-up time measuring cells approx. 30-120 sec.)
- Check battery, alarm settings and the pump alarm.
- If necessary, a fresh air calibration in an expected clean environment (outside, upwind and for example not near an exhaust).

5.3. The Measuring Process

- Keep an eye on your display at all times to detect fluctuations.
- Always carry out measurements at different heights and locations.
- In tanks you measure from above and straight down, therefore you do not know how the situation is in a corner or behind a truss. Take the highest measured value as a starting point.
- When measuring in a tank during degassing, wait at least 5 minutes after the fan has stopped so that the atmosphere in the tank can first stabilize for a reliable measurement.
- Make sure that the hose does not have any kinking or is pinched.
- Always use a floating ball on the hose to prevent liquids from being sucked up.
- During the first 2 hours after starting the degassing on deck, measure near the opening with a baffled grid and take into account wind direction and wind strength.
- At least 10 Vol.% Oxygen (O_2) is required for a good LEL measurement.

5.4. Registration

Follow the procedure and the corresponding form for gas measurement (from the office) and record the measured values. The registration is important for being able to interpret the state of for example cargo tanks during degassing.

To register measured values, procedures are available. Think also of this when filling out work permits and the like.

In the unlikely event that an accident occurs, an authority institution and insurer will always ask for the measured values.

5.5. After Measurement

- Let the pump flush until all values are zero (with hose attached).
- Switch the meter off and put it back into the charger with a clean moisture filter.
- Report deviations and damages. Sometimes it must be recalibrated, or a sensor replaced (for example, if it has become too hot by offering too much combustible gas).

6. EQUIPMENT

It is very important that the right equipment is used for a measurement. Measurement of gases is done with a gas meter. A gas meter contains sensors. These can detect the gas. A gas meter can contain one or more different sensors. There are sensors that measure the amount of gas with a specific hazard. These are sensors that detect for example combustible gases or a sensor that can detect toxic gases. These sensors tell you the amount of gas that is present but cannot indicate which gas is present. The moment you take a measurement and the meter indicates that you measure 10% LEL, you know that there is a fire or explosion hazard. But by which gases this danger is caused, you cannot determine with this sensor. If a PID sensor shows 20 ppm, you know that 20 particles are toxic to the 1 million particles. The sensor cannot indicate which these are.

There are also sensors that can measure a specific gas (Oxygen, H_2S, CO_2). This sensor can only measure that specific gas and does not say anything about the other gases and hazards in the space. If your meter indicates that there is 20.9% oxygen present, this does not say anything about the other gases that are present in a room.

Seemingly Safe

False sense of safety can be created when a meter is used for something it is not intended for. For example, wearing a personal H_2S meter when working on deck, while there are no H_2S-containing products. Someone can then have the feeling of security, because nothing happens in the display and the meter does not give an alarm. However, this is not a guarantee for a safe environment.

Portable measuring instruments

Various portable measuring instruments are available for detecting product concentrations and dangerous atmospheres, oxygen and toxic gases. Operation of the meters is often based on the same principle, however, it is important to know the operating instructions of the manufacturer.

Different values

Also, meters can differ in the values shown even in exactly the same conditions. This is something that we cannot do anything about, but it can lead to dangerous situations. It is therefore important that the users of the meters have some knowledge of the gas measurement. The models shown in this document are just a few examples of the many types and types of meters on the market.

Each measuring instrument must:

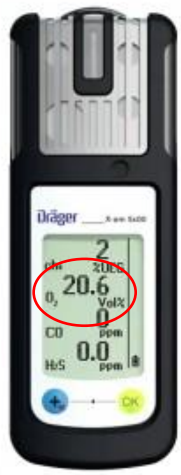
- Be suitable for the required test.
- To be sufficiently accurate for the required test.
- Be of an approved type.
- To be properly maintained and;
- Regularly checked against standard samples (calibration).

Below are specific characteristics per type of meter, in addition to the manuals (and videos) that belong to the meters.

- Know and understand the manual of the measuring instrument.
- Use the correct measuring instrument and sensors or measuring tubes for the right gas.
- Know the limitations of the measuring instrument.
- Know what you measure and how to interpret the values.
- Consider possible correction factors.
- If possible, always place a moisture filter, even if the meter is not switched on.
- The suction hose affects the measurement. Both the length (response time) and the material (absorption of gas). Every extra meter of hose can result in a delay of 10-30 seconds. This is different per brand/type of meter and depends among other things on the pump capacity.
- When switching off the combimeter, all sensors, including the H_2S and CO, must be reset to 0 PPM before the device is switched off. Let the pump run as long as it is necessary to flush the room with sensors with enough clean air ... WITH THE HOSE STILL ATTACHED!

6.1. Oxygen Meter

The oxygen meter is also called O_2/OX/OXY meter.



- Perform a fresh air calibration prior to measurement in an expected clean environment (no wheelhouse or near exhaust) to establish a reference point of 20.9 Vol.%.
  If this is not possible, do not perform a fresh air calibration. The "non-clean" air would be seen as clean air, the measurement is therefore not reliable. Most sensors "memorize" the values of the last calibration and offer a option at the start up to perform the calibration automatically or manually. If the values are correct, this is not necessary.
- ALWAYS leave the (Combi-) meter in the charger when it is not being used.
- In most cases, the operation is based on a measuring cell with an electrolyte that always uses electricity. Therefore, the lithium-ion battery is empty after approx. 4 days when it is not being charged. So this is normal.
- Most oxygen sensors are not suitable for performing an oxygen measurement in a nitrogen environment. Ask your supplier whether this is the case before you have to measure, for example, the percentage of oxygen in a cargo tank that is under nitrogen. There are suitable sensors for this.
- Preferably only use an oxygen meter when tanks are under nitrogen and not a combined meter. A LEL sensor that works on the combustion principle does not work properly (<10 Vol%. O_2) and will get contaminated.

6.2. Toxicity meter

Toxicity meters or TOX or toximeters occur in different forms. There are chemical indicator tubes with a hand pump, electrochemical sensors and PID sensor.

6.2.1. Chemical Indicator Tubes with Hand Pump

When using chemical indicator tubes, note the following points:

- Know exactly which gas is to be measured.
- Large standard deviation of 5 to 30%.
- Inaccurate and therefore only to be used as INDICATION!
- It needs exactly the right amount of air, usually 100ml per pump stroke.
- Warranty date (shelflife) of tubes is ± 2 years.
- For every measurement a new tube is needed, so high in consumption.
- Many different types of tubes needed for use on board on tanker carrying various products.
- Often the tubes from different manufacturers cannot be used in a pump of a different brand (there are exceptions that do fit and are allowed).
- Not every manufacturer has an equally large assortment of tubes to be able to measure many different substances.
- ALWAYS read the operating instructions in the packaging of the box with measuring tubes. This contains essential information regarding the tubes and the execution of a correct measurement. It shows what the tube can do, but also what it cannot do. And the latter is often disappointing.

When using the hand pump, pay attention to the following points:

- Test the pump and the extension hose for leaks by inserting a new tube and make a pump stroke. The pump must then remain in a squeezed position for about 15 seconds.
- Read the instruction card of the tube carefully and determine the number of pump strokes, opening time of the pump and which discoloration should take place.
- Reset stroke counter.
- Break off the tips of the tube and place it in the pump with the arrow pointing towards the pump.
- Perform measurement by squeezing pump or pulling out until indicator on the pump completely discolors for full pump stroke.
- **STOP:** - When the number of pump strokes has been reached.
  - The tubes for ¾ is discolored (Compare the discoloration with an unused tube.) In this case, write down the number of pump strokes.
- Keep track of exactly how many pump strokes you make. After each measurement, set the stroke counter to 0 again!
- After the measurement, flush the pump with clean air by making a number of pump strokes without a tube (DO NOT DIRECTLY POINT TO SOMEONE, THE DUST FROM THE TUBES ALSO CONTAIN CHEMICALS!)
- Store the used tube with chemical waste and keep in mind that the tips are razor-sharp.

6.2.2. PID sensor – Photo Ionisation Detector – PID

A PID meter continuously detects the concentration of volatile organic compounds (VOCs) present, toxic gases and/or vapors expressed in parts per million (PPM). However, a PID meter does not detect gas specifically, all VOCs in the gas sample to be measured are displayed as one common values on the display of the PID detector.

A PID meter measures by "ionizing" the molecule of a substance with a special UV lamp. This happens at the molecular level. The PID meter actually measures positive and negative particles of a substance, it does something with pluses and minuses, simply put. The substance itself does not change, there is no combustion or the like.

There are roughly 3 types of UV lamps that are used for this, the most common is the so-called 10.6eV. This lamp is relatively inexpensive and will last a long time under normal circumstances. This can measure the most common VOCs, but for example no Methanol or Acrylonitrile. Here is a 11.7eV lamp needed, but this lamp is much more expensive and only lasts about 6 months. PID sensors are also very moisture-sensitive, so always use a clean moisture filter.

When a measurement has to be carried out for the presence of toxic gases with the aid of a PID meter, it is important that the user ensures in advance that the relevant lamp in the meter responds to the substance to be measured and the associated correction factor for conversion must also be known. Only use the correction factors that the meter manufacturer has determined. These have been determined in their laboratory with their meters.

The PID meter does not "know" what it measures, so we have to "tell" the meter. With pure substances this is not difficult, it only becomes difficult when we have to deal with a mixture of hydrocarbon compounds. The composition of this is often difficult to determine and complex calculation methods are then required to carry out this measurement. To keep this simple, you use values on the display, which are not converted. The settings of the measuring gas in the device must then be equal to the gas to which it is calibrated. This is almost always Isobutylene in a PID meter.

The advantage of a PID meter is that it can also be used for continuous measurements and leak detection. This is virtually impossible with tubes. When substances where toxicity measurements are required are transported often, a PID meter is cost effective, because you save the costs of measuring tubes, provided that they are measurable hydrocarbons.

6.2.3. Electrochemical Sensors

Electrochemical sensors, or product specific meters, are available in the combination gas meters and as separate personal safety meters.

Points of attention:

- H_2S and CO sensors are often cross-sensitive on many other substances, such as alcohols and high concentrations of H_2S. This means that an H_2S sensor can react to the presence of carbon monoxide and vice versa.
- The CO sensor can also react to the application of a large amount of combustible gas to the LEL sensor. After all, a combustion takes place in the measuring cell for LEL (filament) and then CO is released logically.
- A CO measurement will mainly be important when entering confined spaces, such as ballast tanks, front and rear peaks, etc.
- Make sure that the paper filter on the sensor is clean.

H_2S personal measurement

At refineries and when transporting products that are known to contain H_2S, a personal H_2S detector must be worn on top of the clothing at chest height during loading/unloading and operations (connecting/dismounting and measuring/sampling). A gas mask with filter (type B) must also be within reach.

6.3. Explosion Meter

There are 2 types of LEL sensors, a catalytic and an infra-red. The former burns the drawn-in air by means of a filament. The infra-red lamp does not do this. This is also called a process meter, because it can measure the risk of explosion not only in percentages of the LEL, but also in volume percentages, i.e. more than 100% of the lower explosion limit. The infra-red Explosion Hazard Meters can also take a measurement in an environment with little oxygen. This is often the case with gas tankers. This infra-red lamp is very expensive and is rare on board inland vessels, mainly on gas tankers. That is why we do not go into this further.

At a concentration higher than 10-20% LEL an acoustic and optical alarm is given. When 100% of the lower explosion limit is measured, this means that the mixture can be ignited. For such an ignition only a source of sufficient energy is needed.

Points to take into account for the most common LEL sensors, which "burn" the vapors (different from infra-red):

- Caustic and oxidizing gases can damage the measuring element (e.g. Ammonia).
- Measuring element can be poisoned, e.g. silicone vapors.
- Not suitable for measuring mists of flammable liquid. Measuring cell is seriously damaged and is unusable.
- Always place a moisture filter, even if the meter is not switched on.
- At least 10 Vol.% Oxygen required for proper measurement (gas mixture is burned in the measuring cell). Pay attention to this when the tanks are under nitrogen!
- Always combine the LEL measurement with an O_2 measurement.
- If there is too little oxygen for proper combustion, the LEL sensor will become contaminated and give an unreliable measurement.

LEL sensors that work with an infra-red light are not affected by the above-mentioned issues. However, these sensors do have a high price and respond to a smaller number of combustible substances than a sensor that works on the basis of combustion. There are meters on the market where both types of LEL sensors are present

6.4. Maintenance

For properly working meters it is important to carry out regular maintenance. Below are a number of points to take into account:

- Before each use, check if the meter is in good condition.
- The manual contains instructions for bump tests and calibrations.
- Moisture is harmful to gas detection equipment.
- ALWAYS ensure that a moisture filter is installed and replace it regularly, as it may become contaminated and clogged.
- Sensors have a limited life span, even under normal conditions. The warranty period is also often limited. This can vary per brand.
- When offering large amounts of combustible gas, the sensors can get damaged, so that they are no longer reliable or usable.
- Ensure that the hose is also clean for storage after measurement. See the manual for this.
- Leave the meter on and flush until the values are back to the original values. Leave the hose with floating ball on it and also rinse it.
- Hoses; length (at least the cavity of the tank + 1 m) and quality/state of floating ball at the end (so that the hose does not hang in the liquid).
- Store measuring tubes cool and dark (storage temperature <20°C). Make sure that the measuring tubes are suitable for the substance to be measured.

CONSULTED SOURCES

LAWS, REGULATIONS AND STANDARDS

- BPR Art. 4 and 6
- RPR 3.18, 4 and 6.04
- Manual VHF Maritime
- http://www.ccr-zkr.org/13020500-nl.html#02
- ISGINTT Chapter 2.4 “Gas Measurement” and Chapter 11.4 “Gas Freeing”
    - Version 2010
- REACH
- RAE-Benelux
- Dräger Nederland B.V. - Marine & Offshore

VERSION CONTROL

Version	Date	Change	Reference
0	29-01-2019	-	-
1	13-10-2020	- §3.6 Sentence deleted "The gas is … of a space." - Addition of version control table	-

APPENDIX 01: TABLE LEL-METER RAE

TN-156

TECHNICAL NOTE

CORRECTION FACTORS FOR COMBUSTIBLE GAS (LEL) SENSORS

LEL Correction Factors

RAE Systems LEL sensors (including LEL only sensor and LEL/TC dual-range sensor) can be used for the detection of a wide variety of combustible gases and vapors that exhibit different responses. Because LEL sensors use a diffusion barrier to limit the gas flux to the catalytic bead, high diffusivity compounds tend to have the greatest sensitivity. Therefore small molecules like hydrogen and methane are substantially more sensitive than heavy components like kerosene. The best way to calibrate any 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 methane or pentane. In our LEL sensors, correction factors (CFs) can be used in one of three ways:

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

2) Calibrate the unit with methane and then call up the correction factor from the instrument memory or download from a personal computer. The unit will then read directly in %LEL of the gas of interest.

3) Calibrate the unit with methane, but input an equivalent, "corrected" span gas concentration when prompted for this value. For example, to read in isopropanol LEL units, apply 20% LEL methane but enter 20 x 2.6 = 52 for the span gas concentration.

Oxygen Requirement and Matrix Effects

LEL sensors require oxygen for combustion and cannot be used in environments that contain less than about 10% oxygen. This threshold is the safe limit for up to 100% LEL of nearly all chemicals, but it depends on the combustible gas concentration. For example, for 10% LEL methane, RAE LEL sensors show little or no oxygen dependence down to about 5 vol% oxygen. Inserting an LEL sensor from air into pure nitrogen can cause a transient response that decays after several minutes to the background reading. This is because the reference bead takes time to equilibrate with the slightly lower thermal conductivity of the nitrogen. Likewise, other inert matrix gases may cause a transient response.

Humidity and temperature generally have little effect on the sensor response. Increasing temperature increases the response by <6% between 0 and 40°C. Increasing RH decreases the response by 8% between 5 and 95% RH. Some LEL sensor-instrument combinations have a small humidity response and may read a few % LEL in air at 50% RH if zeroed with dry air.

Methane Sensitivity Changes

The correction factors in this table apply to new sensor. As the sensor becomes used and gradually loses sensitivity, the response to methane may decrease more rapidly than for higher hydrocarbons. In this case, the correction factors will gradually decrease, and calibration with methane will tend to over estimate the %LEL of the other gas. Therefore, methane calibration is the safest approach. RAE LEL sensors do not exhibit changes in correction factors in laboratory tests, but may do so under special use conditions. Calibrating with other organic vapors such as propane or pentane is a good way to avoid correction factor changes. The only drawback to this approach is that it is possible to miss methane while still measuring the higher hydrocarbons. If methane is known to be absent under all circumstances, the use of propane or pentane calibration is appropriate.

Correction Factors when Calibrating with Non-methane Compounds

To obtain correction factors for other span gases, simply divide the value on the methane scale in the table by the methane value for the span compound. For example, to obtain CFs on the n-pentane scale, divide all the numbers in the table by 2.2. Thus, when calibrating with n-pentane the new CF for acetylene is 2.8/2.2 = 1.3, and the new CF for ammonia is 0.8/2.2 = 0.4. Note that this calculation is done internally in RAE instruments that have separately selectable span and measurement gases. Therefore, in these cases, simply enter the span and measurement compounds (without changing the CFs), and the unit will automatically calculate and apply the new factor.

Chemical	100% LEL (Vol%)	LEL CF*
Acetaldehyde	4.0	*1.8*
Acetic acid	4.0	*3.4*
Acetic Anhydride	2.7	*2.0*
Acetone	2.5	2.2
Acetylene	2.5	*2.8*
Allyl Alcohol	2.5	1.7
Ammonia	15.0	*0.8*
Aniline	1.3	*3.0*
Benzene	1.2	2.2
Butadiene, 1,3-	2.0	*2.5*

RAE SYSTEMS

1339 Moffett Park Drive, Sunnyvale CA 94089 U.S.A.
Tel: 1.408.752.0723 | Fax: 1.408.752.0724 | E-mail: raesales@raesystems.com
www.raesystems.com | rev.6b.wy-wh 5-04

Chemical	100% LEL (Vol%)	LEL CF*
Butane, n-	1.9	*2.0*
Butane, i-	1.8	*1.8*
Butanol, n-	1.4	*3.0*
Butanol, i-	1.7	*2.5*
Butanol, t-	2.4	*1.8*
Butene-1	1.6	*2.1*
Butene-2, cis	1.7	*2.1*
Butene-2, trans	1.8	*1.9*
Butyric acid	2.0	*2.4*
Carbon disulfide	1.3	**
Carbon monoxide	12.5	*1.2*
Carbonyl sulfide	12.0	*1.0*
Chlorobenzene	1.3	*3.0*
Chloropropane, 1-	2.6	*1.8*
Cyanogen	6.6	*1.1*
Cyclohexane	1.3	*2.5*
Cyclopropane	2.4	*1.5*
Decane, n-	0.8	*3.4*
Dichloroethane, 1,2-	6.2	*1.5*
Dichloromethane	13.0	*1.0*
Dimethylbutane	1.2	*2.7*
Dimethylpentane, 2,3-	1.1	*2.3*
Dimethyl sulfide	2.2	*2.3*
Dioxane, 1,4-	2.0	*2.5*
Ethane	3.0	*1.4*
Ethanol	3.3	*1.7*
Ethene	2.7	1.4
Ethyl acetate	2.0	2.2
Ethylamine	3.5	*1.4*
Ethyl benzene	0.8	*2.8*
Ethyl bromide	6.8	*0.9*
Ethyl chloride	3.8	*1.7*
Ethyl ether	1.9	*2.3*
Ethyl formate	2.8	*2.4*
Ethyl mercaptan	2.8	*1.8*
Ethyl methyl ether	2.0	*2.3*
Ethyl pentane	1.2	*2.4*
Ethylene oxide	3.0	*2.3*
Gasoline,	1.3	2.1
Heptane, n-	1.1	2.4
Hexadiene, 1,4-	2.0	*1.5*
Hexane, n-	1.1	2.3
Hydrazine	2.9	*2.1*
Hydrogen	4.0	1.1
Hydrogen cyanide	5.6	*2.0*
Hydrogen sulfide	4.0	**
Isobutene (Isobutylene)	1.8	1.5
Isopropanol	2.0	2.6
Jet fuel JP-4, -5, -8	0.7	*3.4*
Methane	5.0	1.0
Methanol	6.0	*1.5*
Methyl acetate	3.1	*2.2*
Methylamine	4.9	*1.3*
Methyl bromide	10.0	*1.1*
Methyl chloride	8.1	*1.3*
Methylcyclohexane	1.2	*2.6*
Methyl ether	3.4	*1.7*
Methyl ethyl ketone	1.4	2.6
Methyl formate	4.5	*1.9*
Methyl hexane	1.2	*2.4*
Methyl mercaptan	3.9	*1.6*
Methylpentane	1.2	*2.7*
Methyl propionate	2.5	*2.1*
Methyl n-propyl ketone (2-pentanone)	1.5	*2.7*
Naphthalene	0.9	*2.9*
Nitromethane	7.3	*2.1*
Nonane, n-	0.8	*3.2*
Octane, n-	1.0	*2.9*
Pentane, n-	1.5	2.2
Pentane, i-	1.4	*2.3*
Pentane, Neo-	1.4	*2.5*
Pentene, 1-	1.5	*2.3*
Phosphine	1.6	*0.3*
Propane	2.1	1.6
Propanol, n-	2.2	*2.0*
Propene	2.0	1.5
Propylamine, n-	2.0	*2.1*
Propylene oxide	2.3	*2.6*
Propyl ether, iso-	1.4	*2.3*
Propyne	1.7	*2.3*
Toluene	1.1	2.6
Triethylamine	1.2	*2.5*
Trimethylamine	2.0	*1.9*
Trimethylbutane	1.2	*2.3*
Turpentine	0.8	*2.9*
Vinyl chloride	3.6	*1.8*
Xylene, m-	1.1	*2.7*
Xylene, o-	0.9	*3.0*
Xylene, p-	1.1	*2.8*

* Values in italics are calculated from diffusion properties; values in normal type are confirmed with RAE sensors.

** CAUTION!! On LEL/TC sensors (3R/TC & 4R/TC) CS_2 may cause a large baseline shift and sensitivity loss; for LEL-only sensor (4R), an approximate CF of 3±2 can be used. H_2S may cause a large baseline shift and sensitivity loss on LEL and TC/LEL sensors.

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APPENDIX 02: TABLE PID-METER RAE

Technical Note TN-106

Revised 12/2007

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Acetaldehyde		75-07-0	C_2H_4O	NR	+	6	+	3.3	+	10.23	C25
Acetic acid	Ethanoic Acid	64-19-7	$C_2H_4O_2$	NR	+	22	+	2.6	+	10.66	10
Acetic anhydride	Ethanoic Acid Anhydride	108-24-7	$C_4H_6O_3$	NR	+	6.1	+	2.0	+	10.14	5
Acetone	2-Propanone	67-64-1	C_3H_6O	1.2	+	1.1	+	1.4	+	9.71	500
Acetone cyanohydrin	2-Hydroxyisobutyronitrile	75-86-5	C_4H_7NO					4	+	11.1	C5
Acetonitrile	Methyl cyanide, Cyanomethane	75-05-8	C_2H_3N					100		12.19	40
Acetylene	Ethyne	74-86-2	C_2H_2					2.1	+	11.40	ne
Acrolein	Propenal	107-02-8	C_3H_4O	42	+	3.9	+	1.4	+	10.10	0.1
Acrylic acid	Propenoic Acid	79-10-7	$C_3H_4O_2$			12	+	2.0	+	10.60	2
Acrylonitrile	Propenenitrile	107-13-1	C_3H_3N			NR	+	1.2	+	10.91	2
Allyl alcohol		107-18-6	C_3H_6O	4.5	+	2.4	+	1.6	+	9.67	2
Allyl chloride	3-Chloropropene	107-05-1	C_3H_5Cl			4.3		0.7		9.9	1
Ammonia		7664-41-7	H_3N	NR	+	9.7	+	5.7	+	10.16	25
Amyl acetate	mix of n-Pentyl acetate & 2-Methylbutyl acetate	628-63-7	$C_7H_{14}O_2$	11	+	2.3	+	0.95	+	<9.9	100
Amyl alcohol	1-Pentanol	75-85-4	$C_5H_{12}O$			5		1.6		10.00	ne
Aniline	Aminobenzene	62-53-3	C_7H_7N	0.50	+	0.48	+	0.47	+	7.72	2
Anisole	Methoxybenzene	100-66-3	C_7H_8O	0.89	+	0.58	+	0.56	+	8.21	ne
Arsine	Arsenic trihydride	7784-42-1	AsH_3			1.9	+			9.89	0.05
Benzaldehyde		100-52-7	C_7H_6O					1		9.49	ne
Benzenamine, N-methyl-	N-Methylphenylamine	100-61-8	C_7H_9N			0.7				7.53	
Benzene		71-43-2	C_6H_6	0.55	+	0.53	+	0.6	+	9.25	0.5
Benzonitrile	Cyanobenzene	100-47-0	C_7H_5N			1.6				9.62	ne
Benzyl alcohol	α-Hydroxytoluene, Hydroxymethylbenzene, Benzenemethanol	100-51-6	C_7H_8O	1.4	+	1.1	+	0.9	+	8.26	ne
Benzyl chloride	α-Chlorotoluene, Chloromethylbenzene	100-44-7	C_7H_7Cl	0.7	+	0.6	+	0.5	+	9.14	1
Benzyl formate	Formic acid benzyl ester	104-57-4	$C_8H_8O_2$	0.9	+	0.73	+	0.66	+		ne
Boron trifluoride		7637-07-2	BF_3	NR		NR		NR		15.5	C1
Bromine		7726-95-6	Br_2	NR	+	1.30	+	0.74	+	10.51	0.1
Bromobenzene		108-86-1	C_6H_5Br			0.6		0.5		8.98	ne
2-Bromoethyl methyl ether		6482-24-2	C_3H_7OBr			0.84	+			~10	ne
Bromoform	Tribromomethane	75-25-2	$CHBr_3$	NR	+	2.5	+	0.5	+	10.48	0.5
Bromopropane,1-	n-Propyl bromide	106-94-5	C_3H_7Br	150	+	1.5	+	0.6	+	10.18	ne
Butadiene	1,3-Butadiene, Vinyl ethylene	106-99-0	C_4H_6	0.8		0.85	+	1.1		9.07	2
Butadiene diepoxide, 1,3-	1,2,3,4-Diepoxybutane	298-18-0	$C_4H_6O_2$	25	+	3.5	+	1.2		~10	ne
Butanal	1-Butanal	123-72-8	C_4H_8O			1.8				9.84	
Butane		106-97-8	C_4H_{10}			67	+	1.2		10.53	800
Butanol, 1-	Butyl alcohol, n-Butanol	71-36-3	$C_4H_{10}O$	70	+	4.7	+	1.4	+	9.99	20
Butanol, t-	tert-Butanol, t-Butyl alcohol	75-65-0	$C_4H_{10}O$	6.9	+	2.9	+			9.90	100
Butene, 1-	1-Butylene	106-98-9	C_4H_8			0.9				9.58	ne
Butoxyethanol, 2-	Butyl Cellosolve, Ethylene glycol monobutyl ether	111-76-2	$C_6H_{14}O_2$	1.8	+	1.2	+	0.6	+	<10	25
Butoxyethanol acetate	Ethanol, 2-(2-butoxyethoxy)-, acetate	124-17-4	$C_{10}H_{20}O_4$			5.6				≤10.6	
Butoxyethoxyethanol	2-(2-Butoxyethoxy)ethanol	112-34-5	$C_8H_{18}O_3$			4.6				≤10.6	
Butyl acetate, n-		123-86-4	$C_6H_{12}O_2$			2.6	+			10	150
Butyl acrylate, n-	Butyl 2-propenoate, Acrylic acid butyl ester	141-32-2	$C_7H_{12}O_2$			1.6	+	0.6	+		10
Butylamine, n-		109-73-9	$C_4H_{11}N$	1.1	+	1.1	+	0.7	+	8.71	C5
Butyl cellosolve	see 2-Butoxyethanol	111-76-2									
Butyl hydroperoxide, t-		75-91-2	$C_4H_{10}O_2$	2.0	+	1.6	+			<10	1
Butyl mercaptan	1-Butanethiol	109-79-5	$C_4H_{10}S$	0.55	+	0.52	+			9.14	0.5
Carbon disulfide		75-15-0	CS_2	4	+	1.2	+	0.44		10.07	10
Carbon tetrachloride	Tetrachloromethane	56-23-5	CCl_4	NR	+	NR	+	1.7	+	11.47	5
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	Cl_2					1.0	+	11.48	0.5
Chlorine dioxide		10049-04-4	ClO_2	NR	+	NR	+	NR	+	10.57	0.1
Chlorobenzene	Monochlorobenzene	108-90-7	C_6H_5Cl	0.44	+	0.40	+	0.39	+	9.06	10

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RAE Systems Inc.
3775 N. First St., San Jose, CA 95134-1708 USA
Phone: +1.888.723.8823
Email: raesales@raesystems.com
Web Site: www.raesystems.com

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Chlorobenzotrifluoride, 4-	PCBTF, OXSOL 100 p-Chlorobenzotrifluoride	98-56-6	$C_7H_4ClF_3$	0.74	+	0.63	+	0.55	+	<9.6	25
Chloro-1,3-butadiene, 2-	Chloroprene	126-99-8	C_4H_5Cl			3					10
Chloro-1,1-difluoroethane, 1-	HCFC-142B, R-142B	75-68-3	$C_2H_3ClF_2$	NR		NR		NR		12.0	ne
Chlorodifluoromethane	HCFC-22, R-22	75-45-6	$CHClF_2$	NR		NR		NR		12.2	1000
Chloroethane	Ethyl chloride	75-00-3	C_2H_5Cl	NR	+	NR	+	1.1	+	10.97	100
Chloroethanol	Ethylene chlrohydrin	107-07-3	C_2H_5ClO					2.9		10.52	C1
Chloroethyl ether, 2-	bis(2-chloroethyl) ether	111-44-4	$C_4H_8Cl_2O$	8.6	+	3.0	+				5
Chloroethyl methyl ether, 2-	Methyl 2-chloroethyl ether	627-42-9	C_3H_7ClO			3					ne
Chloroform	Trichloromethane	67-66-3	$CHCl_3$	NR	+	NR	+	3.5	+	11.37	10
Chloro-2-methylpropene, 3-	Methallyl chloride, Isobutenyl chloride	563-47-3	C_4H_7Cl	1.4	+	1.2	+	0.63	+	9.76	ne
Chloropicrin		76-06-2	CCl_3NO_2	NR	+	~400	+	7	+	?	0.1
Chlorotoluene, o-	o-Chloromethylbenzene	95-49-8	C_7H_7Cl			0.5		0.6		8.83	50
Chlorotoluene, p-	p-Chloromethylbenzene	106-43-4	C_7H_7Cl					0.6		8.69	ne
Chlorotrifluoroethene	CTFE, Chlorotrifluoroethylene Genetron 1113	79-38-9	C_2ClF_3	6.7	+	3.9	+	1.2	+	9.76	5
Chlorotrimethylsilane		75-77-4	C_3H_9ClSi	NR		NR		0.82	+	10.83	ne
Cresol, m-	m-Hydroxytoluene	108-39-4	C_7H_8O	0.57	+	0.50	+	0.57	+	8.29	5
Cresol, o-	o-Hydroxytoluene	95-48-7	C_7H_8O			1.0				8.50	
Cresol, p-	p-Hydroxytoluene	106-44-5	C_7H_8O			1.4				8.35	
Crotonaldehyde	*trans*-2-Butenal	123-73-9 4170-30-3	C_4H_6O	1.5	+	1.1	+	1.0	+	9.73	2
Cumene	Isopropylbenzene	98-82-8	C_9H_{12}	0.58	+	0.54	+	0.4	+	8.73	50
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	C_6H_{12}	3.3	+	1.4	+	0.64	+	9.86	300
Cyclohexanol	Cyclohexyl alcohol	108-93-0	$C_6H_{12}O$	1.5	+	0.9	+	1.1	+	9.75	50
Cyclohexanone		108-94-1	$C_6H_{10}O$	1.0	+	0.9	+	0.7	+	9.14	25
Cyclohexene		110-83-8	C_6H_{10}			0.8	+			8.95	300
Cyclohexylamine		108-91-8	$C_6H_{13}N$			1.2				8.62	10
Cyclopentane 85% 2,2-dimethylbutane 15%		287-92-3	C_5H_{10}	NR	+	15	+	1.1		10.33	600
Cyclopropylamine	Aminocyclpropane	765-30-0	C_3H_7N	1.1	+	0.9	+	0.9	+		ne
Decamethylcyclopentasiloxane		541-02-6	$C_{10}H_{30}O_5Si_5$	0.16	+	0.13	+	0.12	+		ne
Decamethyltetrasiloxane		141-62-8	$C_{10}H_{30}O_3Si_4$	0.17	+	0.13	+	0.12	+	<10.2	ne
Decane		124-18-5	$C_{10}H_{22}$	4.0	+	1.4	+	0.35	+	9.65	ne
Diacetone alcohol	4-Methyl-4-hydroxy-2-pentanone	123-42-2	$C_6H_{12}O_2$			0.7					50
Dibromochloromethane	Chlorodibromomethane	124-48-1	$CHBr_2Cl$	NR	+	5.3	+	0.7	+	10.59	ne
Dibromo-3-chloropropane, 1,2-	DBCP	96-12-8	$C_3H_5Br_2Cl$	NR	+	1.7	+	0.43	+		0.001
Dibromoethane, 1,2-	EDB, Ethylene dibromide, Ethylene bromide	106-93-4	$C_2H_4Br_2$	NR	+	1.7	+	0.6	+	10.37	ne
Dichlorobenzene, o-	1,2-Dichlorobenzene	95-50-1	$C_6H_4Cl_2$	0.54	+	0.47	+	0.38	+	9.08	25
Dichlorodifluoromethane	CFC-12	75-71-8	CCl_2F_2			NR	+	NR	+	11.75	1000
Dichlorodimethylsilane		75-78-5	$C_2H_6Cl_2Si$	NR		NR		1.1	+	>10.7	ne
Dichloroethane, 1,2-	EDC, 1,2-DCA, Ethylene dichloride	107-06-2	$C_2H_4Cl_2$			NR	+	0.6	+	11.04	10
Dichloroethene, 1,1-	1,1-DCE, Vinylidene chloride	75-35-4	$C_2H_2Cl_2$			0.82	+	0.8	+	9.79	5
Dichloroethene, c-1,2-	*c*-1,2-DCE, *cis*-Dichloroethylene	156-59-2	$C_2H_2Cl_2$			0.8				9.66	200
Dichloroethene, t-1,2-	*t*-1,2-DCE, *trans*-Dichloroethylene	156-60-5	$C_2H_2Cl_2$			0.45	+	0.34	+	9.65	200
Dichloro-1-fluoroethane, 1,1-	R-141B	1717-00-6	$C_2H_3Cl_2F$	NR	+	NR	+	2.0	+		ne
Dichloromethane	see Methylene chloride										
Dichloropentafluoropropane	AK-225, mix of ~45% 3,3-dichloro-1,1,1,2,2-pentafluoro-propane (HCFC-225ca) & ~55% 1,3-Dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)	442-56-0 507-55-1	$C_3HCl_2F_5$	NR	+	NR	+	25	+		ne

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Dichloropropane, 1,2-		78-87-5	$C_3H_6Cl_2$					0.7		10.87	75
Dichloro-1-propene, 1,3-		542-75-6	$C_3H_4C_{12}$	1.3	+	0.96	+			<10	1
Dichloro-1-propene, 2,3-		78-88-6	$C_3H_4Cl_2$	1.9	+	1.3	+	0.7	+	<10	ne
Dichloro-1,1,1-trifluoroethane, 2,2-	R-123	306-83-2	$C_2HCl_2F_3$	NR	+	NR	+	10.1	+	11.5	ne
Dichloro-2,4,6-trifluoropyridine, 3,5-	DCTFP	1737-93-5	$C_5Cl_2F_3N$	1.1	+	0.9	+	0.8	+		ne
Dichlorvos *	Vapona; O,O-dimethyl O-dichlorovinyl phosphate	62-73-7	$C_4H_7Cl_2O_4P$			0.9	+			<9.4	0.1
Dicyclopentadiene	DCPD, Cyclopentadiene dimer	77-73-6	$C_{10}H_{12}$	0.57	+	0.48	+	0.43	+	8.8	5
Diesel Fuel		68334-30-5	m.w. 226			0.9	+				11
Diesel Fuel #2 (Automotive)		68334-30-5	m.w. 216	1.3		0.7	+	0.4	+		11
Diethylamine		109-89-7	$C_4H_{11}N$			1	+			8.01	5
Diethylaminopropylamine, 3-		104-78-9	$C_7H_{18}N_2$			1.3					ne
Diethylbenzene	See Dowtherm J										
Diethylmaleate		141-05-9	$C_8H_{12}O_4$			4					ne
Diethyl sulfide	see Ethyl sulfide										
Diglyme	See Methoxyethyl ether	111-96-6	$C_6H_{14}O_3$								
Diisobutyl ketone	DIBK, 2,2-dimethyl-4-heptanone	108-83-8	$C_9H_{18}O$	0.71	+	0.61	+	0.35	+	9.04	25
Diisopropylamine		108-18-9	$C_6H_{15}N$	0.84	+	0.74	+	0.5	+	7.73	5
Diketene	Ketene dimer	674-82-8	$C_4H_4O_2$	2.6	+	2.0	+	1.4	+	9.6	0.5
Dimethylacetamide, N,N-	DMA	127-19-5	C_4H_9NO	0.87	+	0.8	+	0.8	+	8.81	10
Dimethylamine		124-40-3	C_2H_7N			1.5				8.23	5
Dimethyl carbonate	Carbonic acid dimethyl ester	616-38-6	$C_3H_6O_3$	NR	+	~70	+	1.7	+	~10.5	ne
Dimethyl disulfide	DMDS	624-92-0	$C_2H_6S_2$	0.2	+	0.20	+	0.21	+	7.4	ne
Dimethyl ether	see Methyl ether										
Dimethylethylamine	DMEA	598-56-1	$C_4H_{11}N$	1.1	+	1.0	+	0.9	+	7.74	~3
Dimethylformamide, N,N-	DMF	68-12-2	C_3H_7NO	0.7	+	0.7	+	0.8	+	9.13	10
Dimethylhydrazine, 1,1-	UDMH	57-14-7	$C_2H_8N_2$			0.8	+	0.8	+	7.28	0.01
Dimethyl methylphosphonate	DMMP, methyl phosphonic acid dimethyl ester	756-79-6	$C_3H_9O_3P$	NR	+	4.3	+	0.74	+	10.0	ne
Dimethyl sulfate		77-78-1	$C_2H_6O_4S$	~23		~20	+	2.3	+		0.1
Dimethyl sulfide	see Methyl sulfide										
Dimethyl sulfoxide	DMSO, Methyl sulfoxide	67-68-5	C_2H_6OS			1.4	+			9.10	ne
Dioxane, 1,4-		123-91-1	$C_4H_8O_2$			1.3				9.19	25
Dioxolane, 1,3-	Ethylene glycol formal	646-06-0	$C_3H_6O_2$	4.0	+	2.3	+	1.6	+	9.9	20
Dowtherm A see Therminol® *											
Dowtherm J (97% Diethylbenzene) *		25340-17-4	$C_{10}H_{14}$			0.5					
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	+		ne
Epichlorohydrin	ECH Chloromethyloxirane, 1-chloro2,3-epoxypropane	106-89-8	C_2H_5ClO	~200	+	8.5	+	1.4	+	10.2	0.5
Ethane		74-84-0	C_2H_6			NR	+	15	+	11.52	ne
Ethanol	Ethyl alcohol	64-17-5	C_2H_6O			10	+	3.1	+	10.47	1000
Ethanolamine *	MEA, Monoethanolamine	141-43-5	C_2H_7NO	5.6	+	1.6	+			8.96	3
Ethene	Ethylene	74-85-1	C_2H_4			9	+	4.5	+	10.51	ne
Ethoxyethanol, 2-	Ethyl cellosolve	110-80-5	$C_4H_{10}O_2$			1.3				9.6	5
Ethyl acetate		141-78-6	$C_4H_8O_2$			4.6	+	3.5		10.01	400
Ethyl acetoacetate		141-97-9	$C_6H_{10}O_3$	1.4	+	1.2	+	1.0	+	<10	ne
Ethyl acrylate		140-88-5	$C_5H_8O_2$			2.4	+	1.0	+	<10.3	5
Ethylamine		75-04-7	C_2H_7N			0.8				8.86	5
Ethylbenzene		100-41-4	C_8H_{10}	0.52	+	0.52	+	0.51	+	8.77	100
Ethyl caprylate	Ethyl octanoate	106-32-1	$C_{10}H_{20}O_2$		+	0.52	+	0.51	+		
Ethylenediamine	1,2-Ethanediamine; 1,2-Diaminoethane	107-15-3	$C_2H_8N_2$	0.9	+	0.8	+	1.0	+	8.6	10
Ethylene glycol *	1,2-Ethanediol	107-21-1	$C_2H_6O_2$			16	+	6	+	10.16	C100
Ethylene glycol, Acrylate	2-hydroxyethyl Acrylate	818-61-1	$C_5H_8O_3$			8.2				≤10.6	

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Ethylene glycol dimethyl ether	1,2-Dimethoxyethane, Monoglyme	110-71-4	$C_4H_{10}O_2$	1.1		0.86		0.7		9.2	ne
Ethylene glycol monobutyl ether acetate	2-Butoxyethyl acetate	112-07-2	$C_8H_{16}O_3$			1.3				≤10.6	
Ethylene glycol, monothio	mercapto-2-ethanol	60-24-2	C_2H_6OS			1.5				9.65	
Ethylene oxide	Oxirane, Epoxyethane	75-21-8	C_2H_4O			13	+	3.5	+	10.57	1
Ethyl ether	Diethyl ether	60-29-7	$C_4H_{10}O$			1.1	+	1.7		9.51	400
Ethyl 3-ethoxypropionate	EEP	763-69-9	$C_7H_{14}O_3$	1.2	+	0.75	+				ne
Ethyl formate		109-94-4	$C_3H_6O_2$					1.9		10.61	100
Ethylhexyl acrylate, 2-	Acrylic acid 2-ethylhexyl ester	103-11-7	$C_{11}H_{20}O_2$			1.1	+	0.5	+		ne
Ethylhexanol	2-Ethyl-1-hexanol	104-76-7	$C8H_{18}O$			1.9				≤10.6	
Ethylidenenorbornene	5-Ethylidene bicyclo(2,2,1)hept-2-ene	16219-75-3	C_9H_{12}	0.4	+	0.39	+	0.34	+	≤8.8	ne
Ethyl (S)-(-)-lactate see also DS-108F	Ethyl lactate, Ethyl (S)-(-)-hydroxypropionate	687-47-8 97-64-3	$C_5H_{10}O_3$	13	+	3.2	+	1.6	+	~10	ne
Ethyl mercaptan	Ethanethiol	75-08-1	C_2H_6S	0.60	+	0.56	+			9.29	0.5
Ethyl sulfide	Diethyl sulfide	352-93-2	$C_4H_{10}S$			0.5	+			8.43	ne
Formaldehyde	Formalin	50-00-0	CH_2O	NR	+	NR	+	1.6	+	10.87	C0.3
Formamide		75-12-7	CH_3NO			6.9	+	4		10.16	10
Formic acid		64-18-6	CH_2O_2	NR	+	NR	+	9	+	11.33	5
Furfural	2-Furaldehyde	98-01-1	$C_5H_4O_2$			0.92	+	0.8	+	9.21	2
Furfuryl alcohol		98-00-0	$C_5H_6O_2$			0.80	+			<9.5	10
Gasoline #1		8006-61-9	m.w. 72			0.9	+				300
Gasoline #2, 92 octane		8006-61-9	m.w. 93	1.3	+	1.0	+	0.5	+		300
Glutaraldehyde	1,5-Pentanedial, Glutaric dialdehyde	111-30-8	$C_5H_8O_2$	1.1	+	0.8	+	0.6	+		C0.05
Glycidyl methacrylate	2,3-Epoxypropyl methacrylate	106-91-2	$C_7H_{10}O_3$	2.6	+	1.2	+	0.9	+		0.5
Halothane	2-Bromo-2-chloro-1,1,1-trifluoroethane	151-67-7	$C_2HBrClF_3$					0.6		11.0	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	C_7H_{16}	45	+	2.8	+	0.60	+	9.92	400
Heptanol, 4-	Dipropylcarbinol	589-55-9	$C_7H_{16}O$	1.8	+	1.3	+	0.5	+	9.61	ne
Hexamethyldisilazane, 1,1,1,3,3,3- *	HMDS	999-97-3	$C_6H_{19}NSi_2$			0.2	+	0.2	+	~8.6	ne
Hexamethyldisiloxane	HMDSx	107-46-0	$C_6H_{18}OSi_2$	0.33	+	0.27	+	0.25	+	9.64	ne
Hexane, n-		110-54-3	C_6H_{14}	350	+	4.3	+	0.54	+	10.13	50
Hexanol, 1-	Hexyl alcohol	111-27-3	$C_6H_{14}O$	9	+	2.5	+	0.55	+	9.89	ne
Hexene, 1-		592-41-6	C_6H_{12}			0.8				9.44	30
HFE-7100 see Methyl nonafluorobutyl ether											
Histoclear (Histo-Clear)	Limonene/corn oil reagent		m.w. ~136	0.5	+	0.4	+	0.3	+		ne
Hydrazine *		302-01-2	H_4N_2	>8	+	2.6	+	2.1	+	8.1	0.01
Hydrazoic acid	Hydrogen azide		HN_3							10.7	
Hydrogen	Synthesis gas	1333-74-0	H_2	NR	+	NR	+	NR	+	15.43	ne
Hydrogen cyanide	Hydrocyanic acid	74-90-8	HCN	NR	+	NR	+	NR	+	13.6	C4.7
Hydrogen iodide *	Hydriodic acid	10034-85-2	HI			~0.6*				10.39	
Hydrogen peroxide		7722-84-1	H_2O_2	NR	+	NR	+	NR	+	10.54	1
Hydrogen sulfide		7783-06-4	H_2S	NR	+	3.3	+	1.5	+	10.45	10
Hydroxypropyl methacrylate		27813-02-1 923-26-2	$C_7H_{12}O_3$	9.9	+	2.3	+	1.1	+		ne
Iodine *		7553-56-2	I_2	0.1	+	0.1	+	0.1	+	9.40	C0.1
Iodomethane	Methyl iodide	74-88-4	CH_3I	0.21	+	0.22	+	0.26	+	9.54	2
Isoamyl acetate	Isopentyl acetate	123-92-2	$C_7H_{14}O_2$	10.1		2.1		1.0		<10	100
Isobutane	2-Methylpropane	75-28-5	C_4H_{10}			100	+	1.2	+	10.57	ne
Isobutanol	2-Methyl-1-propanol	78-83-1	$C_4H_{10}O$	19	+	3.8	+	1.5		10.02	50
Isobutene	Isobutylene, Methyl butene	115-11-7	C_4H_8	1.00	+	1.00	+	1.00	+	9.24	Ne

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Isobutyl acrylate	Isobutyl 2-propenoate	106-63-8	$C_7H_{12}O_2$			1.5	+	0.60	+		Ne
Isoflurane	1-Chloro-2,2,2-trifluoroethyl difluoromethyl ether, forane	26675-46-7	$C_3H_2ClF_5O$	NR	+	NR	+	48	+	~11.7	Ne
Isooctane	2,2,4-Trimethylpentane	540-84-1	C8H18			1.2				9.86	ne
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. 148			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	+	0.4	+		Ne
Isopentane	2-Methylbutane	78-78-4	C_5H_{12}			8.2					Ne
Isophorone		78-59-1	$C_9H_{14}O$					3		9.07	C5
Isoprene	2-Methyl-1,3-butadiene	78-79-5	C_5H_8	0.69	+	0.63	+	0.60	+	8.85	Ne
Isopropanol	Isopropyl alcohol, 2-propanol, IPA	67-63-0	C_3H_8O	500	+	6.0	+	2.7		10.12	200
Isopropyl acetate		108-21-4	$C_5H_{10}O_2$			2.6				9.99	100
Isopropyl ether	Diisopropyl ether	108-20-3	$C_6H_{14}O$			0.8				9.20	250
Jet fuel JP-4	Jet B, Turbo B, F-40 Wide cut type aviation fuel	8008-20-6 + 64741-42-0	m.w. 115			1.0	+	0.4	+		Ne
Jet fuel JP-5	Jet 5, F-44, Kerosene type aviation fuel	8008-20-6 + 64747-77-1	m.w. 167			0.6	+	0.5	+		29
Jet fuel JP-8	Jet A-1, F-34, Kerosene type aviation fuel	8008-20-6 + 64741-77-1	m.w. 165			0.6	+	0.3	+		30
Jet fuel A-1 (JP-8)	F-34, Kerosene type aviation fuel	8008-20-6 + 64741-77-1	m.w. 145			0.67					34
Jet Fuel TS	Thermally Stable Jet Fuel, Hydrotreated kerosene fuel	8008-20-6 + 64742-47-8	m.w. 165	0.9	+	0.6	+	0.3	+		30
Limonene, D-	(R)-(+)-Limonene	5989-27-5	$C_{10}H_{16}$			0.33	+			~8.2	Ne
Kerosene C10-C16 petro.distillate – see Jet Fuels		8008-20-6									
MDI – see 4,4'-Methylenebis(phenylisocyanate)											
Maleic anhydride	2,5-Furandione	108-31-6	$C_4H_2O_3$							~10.8	0.1
Mesitylene	1,3,5-Trimethylbenzene	108-67-8	C_9H_{12}	0.36	+	0.35	+	0.3	+	8.41	25
Methallyl chloride – see 3-Chloro-2-methylpropene											
Methane	Natural gas	74-82-8	CH_4	NR	+	NR	+	NR	+	12.61	Ne
Methanol	Methyl alcohol, carbinol	67-56-1	CH_4O	NR	+	NR	+	2.5	+	10.85	200
Methoxyethanol, 2-	Methyl cellosolve, Ethylene glycol monomethyl ether	109-86-4	$C_3H_8O_2$	4.8	+	2.4	+	1.4	+	10.1	5
Methoxyethoxyethanol, 2-	2-(2-Methoxyethoxy)ethanol Diethylene glycol monomethyl ether	111-77-3	$C_7H_{16}O$	2.3	+	1.2	+	0.9	+	<10	Ne
Methoxyethyl ether, 2-	bis(2-Methoxyethyl) ether, Diethylene glycol dimethyl ether, Diglyme	111-96-6	$C_6H_{14}O_3$	0.64	+	0.54	+	0.44	+	<9.8	Ne
Methyl acetate		79-20-9	$C_3H_6O_2$	NR	+	6.6	+	1.4	+	10.27	200
Methyl acrylate	Methyl 2-propenoate, Acrylic acid methyl ester	96-33-3	$C_4H_6O_2$			3.7	+	1.2	+	(9.9)	2
Methylamine	Aminomethane	74-89-5	CH_5N			1.2				8.97	5
Methyl amyl ketone	MAK, 2-Heptanone, Methyl pentyl ketone	110-43-0	$C_7H_{14}O$	0.9	+	0.85	+	0.5	+	9.30	50
Methyl bromide	Bromomethane	74-83-9	CH_3Br	110	+	1.7	+	1.3	+	10.54	1
Methyl t-butyl ether	MTBE, *tert*-Butyl methyl ether	1634-04-4	$C_5H_{12}O$			0.9	+			9.24	40
Methyl cellosolve	see 2-Methoxyethanol										
Methyl chloride	Chloromethane	74-87-3	CH_3Cl	NR	+	NR	+	0.74	+	11.22	50
Methylcyclohexane		107-87-2	C_7H_{14}	1.6	+	0.97	+	0.53	+	9.64	400
Methylene bis(phenyl-isocyanate), 4,4'- *	MDI, Mondur M		$C_{15}H_{10}N_2O_2$	Very slow ppb level response							0.005
Methylene chloride	Dichloromethane	75-09-2	CH_2Cl_2	NR	+	NR	+	0.89	+	11.32	25
Methyl ether	Dimethyl ether	115-10-6	C_2H_6O	4.8	+	3.1	+	2.5	+	10.03	Ne
Methyl ethyl ketone	MEK, 2-Butanone	78-93-3	C_4H_8O	0.86	+	0.9	+	1.1	+	9.51	200
Methylhydrazine	Monomethylhydrazine, Hydrazomethane	60-34-4	$C_2H_6N_2$	1.4	+	1.2	+	1.3	+	7.7	0.01
Methyl isoamyl ketone	MIAK, 5-Methyl-2-hexanone	110-12-3	$C_7H_{14}O$	0.8	+	0.76	+	0.5	+	9.28	50

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Methyl isobutyl ketone	MIBK, 4-Methyl-2-pentanone	108-10-1	$C_6H_{12}O$	0.9	+	0.8	+	0.6	+	9.30	50
Methyl isocyanate	CH3NCO	624-83-9	C_2H_3NO	NR	+	4.6	+	1.5		10.67	0.02
Methyl isothiocyanate	CH3NCS	551-61-6	C_2H_3NS	0.5	+	0.45	+	0.4	+	9.25	ne
Methyl mercaptan	Methanethiol	74-93-1	CH_4S	0.65		0.54		0.66		9.44	0.5
Methyl methacrylate		80-62-6	$C_5H_8O_2$	2.7	+	1.5	+	1.2	+	9.7	100
Methyl nonafluorobutyl ether	HFE-7100DL	163702-08-7, 163702-07-6	$C_5H_3F_9O$			NR	+	~35	+		ne
Methyl-1,5-pentanediamine, 2- (coats lamp) *	Dytek-A amine, 2-Methyl pentamethylenediamine	15520-10-2	C6H16N2			~0.6	+			<9.0	ne
Methyl propyl ketone	MPK, 2-Pentanone	107-87-9	$C_5H_{12}O$			0.93	+	0.79	+	9.38	200
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	ne
Methyl salicylate	Methyl 2-hydroxybenzoate	119-36-8	C_8H_8O3	1.3	+	0.9	+	0.9	+	~9	ne
Methylstyrene, α-	2-Propenylbenzene	98-83-9	C_9H_{10}			0.5				8.18	50
Methyl sulfide	DMS, Dimethyl sulfide	75-18-3	C_2H_6S	0.49	+	0.44	+	0.46	+	8.69	ne
Mineral spirits	Stoddard Solvent, Varsol 1, White Spirits	8020-83-5, 8052-41-3, 68551-17-7	m.w. 144	1.0		0.69	+	0.38	+		100
Mineral Spirits - Viscor 120B Calibration Fluid, b.p. 156-207°C		8052-41-3	m.w. 142	1.0	+	0.7	+	0.3	+		100
Monoethanolamine - see Ethanolamine											
Mustard *	HD, Bis(2-chloroethyl) sulfide	505-60-2, 39472-40-7, 68157-62-0	$C_4H_8Cl_2S$			0.6					0.0005
Naphtha - see VM & P Naptha											
Naphthalene	Mothballs	91-20-3	$C_{10}H_8$	0.45	+	0.42	+	0.40	+	8.13	10
Nickel carbonyl (in CO)	Nickel tetracarbonyl	13463-39-3	C_4NiO_4			0.18				<8.8	0.001
Nicotine		54-11-5	$C_{10}H_{14}N_2$			2.0				≤10.6	
Nitric oxide		10102-43-9	NO	~6		5.2	+	2.8	+	9.26	25
Nitrobenzene		98-95-3	$C_6H_5NO_2$	2.6	+	1.9	+	1.6	+	9.81	1
Nitroethane		79-24-3	$C_2H_5NO_2$					3		10.88	100
Nitrogen dioxide		10102-44-0	NO_2	23	+	16	+	6	+	9.75	3
Nitrogen trifluoride		7783-54-2	NF_3	NR		NR		NR		13.0	10
Nitromethane		75-52-5	CH_3NO_2					4		11.02	20
Nitropropane, 2-		79-46-9	$C_3H_7NO_2$					2.6		10.71	10
Nonane		111-84-2	C_9H_{20}			1.4				9.72	200
Norpar 12	n-Paraffins, mostly C_{10}-C_{13}	64771-72-8	m.w. 161	3.2	+	1.1	+	0.28	+		ne
Norpar 13	n-Paraffins, mostly C_{13}-C_{14}	64771-72-8	m.w. 189	2.7	+	1.0	+	0.3	+		ne
Octamethylcyclotetrasiloxane		556-67-2	$C_8H_{24}O_4Si_4$	0.21	+	0.17	+	0.14	+		ne
Octamethyltrisiloxane		107-51-7	$C_8H_{24}O_2Si_3$	0.23	+	0.18	+	0.17	+	<10.0	ne
Octane, n-		111-65-9	C_8H_{18}	13	+	1.8	+			9.82	300
Octene, 1-		111-66-0	C_8H_{16}	0.9	+	0.75	+	0.4	+	9.43	75
Pentane		109-66-0	C_5H_{12}	80	+	8.4	+	0.7	+	10.35	600
Peracetic acid *	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	$C_2H_4O_3$	NR	+	NR	+	2.3	+		ne
Peracetic/Acetic acid mix *	Peroxyacetic acid, Acetyl hydroperoxide	79-21-0	$C_2H_4O_3$			50	+	2.5	+		ne
Perchloroethene	PCE, Perchloroethylene, Tetrachloroethylene	127-18-4	C_2Cl_4	0.69	+	0.57	+	0.31	+	9.32	25
PGME	Propylene glycol methyl ether, 1-Methoxy-2-propanol	107-98-2	$C_6H_{12}O_3$	2.4	+	1.5	+	1.1	+		100
PGMEA	Propylene glycol methyl ether acetate, 1-Methoxy-2-acetoxypropane, 1-Methoxy-2-propanol acetate	108-65-6	$C_6H_{12}O_3$	1.65	+	1.0	+	0.8	+		ne
Phenol	Hydroxybenzene	108-95-2	C_6H_6O	1.0	+	1.0	+	0.9	+	8.51	5
Phosgene	Dichlorocarbonyl	75-44-5	CCl_2O	NR	+	NR	+	8.5	+	11.2	0.1
Phosgene in Nitrogen	Dichlorocarbonyl	75-44-5	CCl_2O	NR	+	NR	+	6.8	+	11.2	0.1
Phosphine (coats lamp)		7803-51-2	PH_3	28		3.9	+	1.1	+	9.87	0.3

RAE Systems Inc.
3775 N. First St., San Jose, CA 95134-1708 USA
Phone: +1.888.723.8823
Email: raesales@raesystems.com
Web Site: www.raesystems.com

Technical Note TN-106

Revised 12/2007

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Photocopier Toner	Isoparaffin mix					0.5	+	0.3	+		ne
Picoline, 3-	3-Methylpyridine	108-99-6	C_6H_7N			0.9				9.04	ne
Pinene, α-		2437-95-8	$C_{10}H_{16}$			0.31	+	0.47		8.07	ne
Pinene, β-		18172-67-3	$C_{10}H_{16}$	0.38	+	0.37	+	0.37	+	~8	100
Piperylene, isomer mix	1,3-Pentadiene	504-60-9	C_5H_8	0.76	+	0.69	+	0.64	+	8.6	100
Propane		74-98-6	C_3H_8			NR	+	1.8	+	10.95	2500
Propanol, n-	Propyl alcohol	71-23-8	C_3H_8O			5		1.7		10.22	200
Propene	Propylene	115-07-1	C_3H_6	1.5	+	1.4	+	1.6	+	9.73	ne
Propionaldehyde	Propanal	123-38-6	C_3H_6O			1.9				9.95	ne
Propyl acetate, n-		109-60-4	$C_5H_{10}O_2$			3.5		2.3		10.04	200
Propylamine, n-	1-Propylamine, 1-Aminopropane	107-10-8	C_3H_9N	1.1	+	1.1	+	0.9	+	8.78	ne
Propylene carbonate *		108-32-7	$C_4H_6O_3$			62	+	1	+	10.5	ne
Propylene glycol	1,2-Propanediol	57-55-6	$C_3H_8O_2$	18		5.5	+	1.6	+	<10.2	ne
Propylene glycol propyl ether	1-Propoxy-2-propanol	1569-01-3	$C_6H_{14}O_2$	1.3	+	1.0	+	1.6	+		ne
Propylene oxide	Methyloxirane	75-56-9 16088-62-3 15448-47-2	C_3H_6O	~240		6.6	+	2.9	+	10.22	20
Propyleneimine	2-Methylaziridine	75-55-8	C_3H_7N	1.5	+	1.3	+	1.0	+	9.0	2
Propyl mercaptan, 2-	2-Propanethiol, Isopropyl mercaptan	75-33-2	C_3H_8S	0.64	+	0.66	+			9.15	ne
Pyridine		110-86-1	C_5H_5N	0.78	+	0.7	+	0.7	+	9.25	5
Pyrrolidine (coats lamp)	Azacyclohexane	123-75-1	C_4H_9N	2.1	+	1.3	+	1.6	+	~8.0	ne
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	+		ne
Sarin	GB, Isopropyl methylphosphonofluoridate	107-44-8 50642-23-4	$C_4H_{10}FO_2P$			~3					
Stoddard Solvent - see Mineral Spirits		8020-83-5									
Styrene		100-42-5	C_8H_8	0.45	+	0.40	+	0.4	+	8.43	20
Sulfur dioxide		7446-09-5	SO_2	NR		NR	+	NR	+	12.32	2
Sulfur hexafluoride		2551-62-4	SF_6	NR		NR		NR		15.3	1000
Sulfuryl fluoride	Vikane	2699-79-8	SO_2F_2	NR		NR		NR		13.0	5
Tabun *	Ethyl N, N-dimethylphosphoramidocyanidate	77-81-6	$C_5H_{11}N_2O_2P$			0.8					15ppt
Tetrachloroethane, 1,1,1,2-		630-20-6	$C_2H_2Cl_4$					1.3		~11.1	ne
Tetrachloroethane, 1,1,2,2-		79-34-5	$C_2H_2Cl_4$	NR	+	NR	+	0.60	+	~11.1	1
Tetrachlorosilane		10023-04-7	$SiCl_4$	NR		NR		15	+	11.79	ne
Tetraethyl lead	TEL	78-00-2	$C_8H_{20}Pb$	0.4		0.3		0.2		~11.1	0.008
Tetraethyl orthosilicate	Ethyl silicate, TEOS	78-10-4	$C_8H_{20}O_4Si$			0.7	+	0.2	+	~9.8	10
Tetrafluoroethane, 1,1,1,2-	HFC-134A	811-97-2	$C_2H_2F_4$			NR		NR			ne
Tetrafluoroethene	TFE, Tetrafluoroethylene, Perfluoroethylene	116-14-3	C_2F_4			~15				10.12	ne
Tetrafluoromethane	CFC-14, Carbon tetrafluoride	75-73-0	CF_4			NR	+	NR	+	>15.3	ne
Tetrahydrofuran	THF	109-99-9	C_4H_8O	1.9	+	1.7	+	1.0	+	9.41	200
Tetramethyl orthosilicate	Methyl silicate, TMOS	681-84-5	$C_4H_{12}O_4Si$	10	+	1.9	+			~10	1
Therminol® D-12 *	Hydrotreated heavy naphtha	64742-48-9	m.w. 160	0.8	+	0.51	+	0.33	+		ne
Therminol® VP-1 *	Dowtherm A, 3:1 Diphenyl oxide: Biphenyl	101-84-8 92-52-4	$C_{12}H_{10}O$ $C_{12}H_{10}$			0.4	+				1
Toluene	Methylbenzene	108-88-3	C_7H_8	0.54	+	0.50	+	0.51	+	8.82	50
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	+		0.002
Trichlorobenzene, 1,2,4-	1,2,4-TCB	120-82-1	$C_6H_3Cl_3$	0.7	+	0.46	+			9.04	C5
Trichloroethane, 1,1,1-	1,1,1-TCA, Methyl chloroform	71-55-6	$C_2H_3Cl_3$			NR	+	1	+	11	350
Trichloroethane, 1,1,2-	1,1,2-TCA	79-00-5	$C_2H_3Cl_3$	NR	+	NR	+	0.9	+	11.0	10
Trichloroethene	TCE, Trichoroethylene	79-01-6	C_2HCl_3	0.62	+	0.54	+	0.43	+	9.47	50
Trichloromethylsilane	Methyltrichlorosilane	75-79-6	CH_3Cl_3Si	NR		NR		1.8	+	11.36	ne
Trichlorotrifluoroethane, 1,1,2-	CFC-113	76-13-1	$C_2Cl_3F_3$			NR		NR		11.99	1000
Triethylamine	TEA	121-44-8	$C_6H_{15}N$	0.95	+	0.9	+	0.65	+	7.3	1
Triethyl borate	TEB; Boric acid triethyl ester	150-46-9	$C_6H_{15}O_3B$			2.2	+	1.1	+	~10	ne

RAE Systems Inc.
3775 N. First St., San Jose, CA 95134-1708 USA
Phone: +1.888.723.8823
Email: raesales@raesystems.com
Web Site: www.raesystems.com

Compound Name	Synonym/Abbreviation	CAS No.	Formula	9.8	C	10.6	C	11.7	C	IE (eV)	TWA
Triethyl phosphate	Ethyl phosphate	78-40-0	$C_6H_{15}O_4P$	~50	+	3.1	+	0.60	+	9.79	ne
Trifluoroethane, 1,1,2-		430-66-0	$C_2H_3F_3$					34		12.9	ne
Trimethylamine		75-50-3	C_3H_9N			0.9				7.82	5
Trimethylbenzene, 1,3,5- - see Mesitylene		108-67-8									25
Trimethyl borate	TMB; Boric acid trimethyl ester, Boron methoxide	121-43-7	$C_3H_9O_3B$			5.1	+	1.2	+	10.1	ne
Trimethyl phosphate	Methyl phosphate	512-56-1	$C_3H_9O_4P$			8.0	+	1.3	+	9.99	ne
Trimethyl phosphite	Methyl phosphite	121-45-9	$C_3H_9O_3P$			1.1	+		+	8.5	2
Turpentine	Pinenes (85%) + other diisoprenes	8006-64-2	$C_{10}H_{16}$	0.37	+	0.30	+	0.29	+	~8	20
Undecane		1120-21-4	$C_{11}H_{24}$			2				9.56	ne
Varsol – see Mineral Spirits											
Vinyl actetate		108-05-4	$C_4H_6O_2$	1.5	+	1.2	+	1.0	+	9.19	10
Vinyl bromide	Bromoethylene	593-60-2	C_2H_3Br			0.4				9.80	5
Vinyl chloride	Chloroethylene, VCM	75-01-4	C_2H_3Cl			2.0	+	0.6	+	9.99	5
Vinyl-1-cyclohexene, 4-	Butadiene dimer, 4-Ethenylcyclohexene	100-40-3	C_8H_{12}	0.6	+	0.56	+			9.83	0.1
Vinylidene chloride - see 1,1-Dichloroethene											
Vinyl-2-pyrrolidinone, 1-	NVP, N-vinylpyrrolidone, 1-ethenyl-2-pyrrolidinone	88-12-0	C_6H_9NO	1.0	+	0.8	+	0.9	+		ne
Viscor 120B - see Mineral Spirits - Viscor 120B Calibration Fluid											
V. M. & P. Naphtha	Ligroin; Solvent naphtha; Varnish maker's & painter's naptha	64742-89-8	m.w. 111 (C_8-C_9)	1.7	+	0.97	+				300
Xylene, m-	1,3-Dimethylbenzene	108-38-3	C_8H_{10}	0.50	+	0.44	+	0.40	+	8.56	100
Xylene, o-	1,2-Dimethylbenzene	95-47-6	C_8H_{10}	0.56	+	0.46	+	0.43		8.56	100
Xylene, p-	1,4-Dimethylbenzene	106-42-3	C_8H_{10}	0.48	+	0.39	+	0.38	+	8.44	100
None				1		1		1			
Undetectable				1E+6		1E+6		1E+6			

* Compounds indicated in green can be detected using a MiniRAE 2000 or ppbRAE/+ with slow response, but may be lost by adsorption on a MultiRAE or EntryRAE. Response on multi-gas meters can give an indication of relative concentrations, but may not be quantitative and for some chemicals no response is observed.

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	0.6	0.01	1	0.5	2.5
Toluene	0.54	0.5	0.51	0.06	10	50	150
Hexane, n-	300	4.3	0.54	0.06	10	50	150
Heptane, n-	45	2.8	0.6	0.28	50	400	500
Styrene	0.45	0.4	0.42	0.06	10	20	40
Acetone	1.2	1.1	1.4	0.28	50	750	1000
Isopropanol	500	6	2.7	0.28	50	400	500
None	1	1	1	0.00	0	1	
Mixture Value:	2.1	1.5	0.89	1.00	181 ppm	56 ppm	172 ppm
TLV Alarm Setpoint when Calibrated to Isobutylene:	26 ppm	37 ppm	62 ppm				
STEL Alarm Setpoint, same Calibration	86 ppm	115 ppm	193 ppm				

RAE Systems Inc.
3775 N. First St., San Jose, CA 95134-1708 USA
Phone: +1.888.723.8823
Email: raesales@raesystems.com
Web Site: www.raesystems.com

APPENDIX 03: TABLE PID-METER DRÄGER

Version 10, October 2017

Substance	Substanz	CAS	Ionization potential	Multi-PID 2 Code	Multi-PID 2 RF	X-am 7000 Code	X-am 7000 Smart PID RF
Acetaldehyde	Acetaldehyd	75-07-0	10.21 eV	ACETAL	10.5		
Acetic acid	Essigsäure	64-19-7		not possible with 10.6eV			
Acetic anhydride	Essigsäureanhydrid	108-24-7	10.0 eV		4.9		
Acetone	Aceton	67-64-1	9.69 eV	ACTO	1.2	ACTO	1.15
Acetophenone	Acetophenon	98-86-2	9.28 eV		1.7		
Acrolein (2-Propenal)	Acrolein	107-02-8	10.10 eV	ACROLEIN	4.0		
Acrylonitrile	Acrylnitril			not detectable			
Allyl Chloride (3-Chloro-l-Propene)	Allylchlorid	107-05-1	10.20 eV	ALLCHLOR	3.9		3.50
Allylalcohol	Allylakohol	107-18-6	9.67 eV		2.7		
2-Amino-2-methylpropanol	2-Amino-2-methylpropanol	124-68-5			2.2		6.5
Ammonia	Ammoniak	7664-41-7	10.16 eV		10.0		>15
Aniline	Anilin	62-53-3	7.70 eV		0.5		1.90
Benzene	Benzol	71-43-2	9.25 eV	BENZ	0.5	BENZ	0.62
Benzoyl chloride	Benzoylchlorid	98-88-4			1.6		6.7
Benzonitrile	Benzonitril	100-47-0	9.70 eV		0.5		
Benzylacohol	Benzylalkohol	100-51-6	9.00 eV		1.0		
Biphenyl	Biphenyl	92-52-4	7.95 eV		1.3	not possible[1)]	
Bromine	Brom	7726-95-6		not detectable			
Bromoform (Tribromomethane)	Bromoform	75-25-2	10.48 eV	BROMFORM	2.0		
1-Bromopropane	1-Brompropan	106-94-5	10.18 eV		1.5		1.10
1,3-Butadiene	1,3-Butadien	106-99-0	9.07 eV	13BUTADI	0,7		1.00
n-Butanal	n-Butanal	123-72-8			1.6		
n-Butane	n-Butan	106-97-8			0.2		
n-Butanol	1-Butanol	71-36-3	10.23 eV	nBUTANOL	3.4		5.10
2-Butoxyethanol	2-Butoxyethanol	111-76-2			1.2		
2-Butoxyethyl acetate	2-Butoxyethylacetat	112-07-2			2.3		
n-Butyl Acetate	1-Butylacetat	123-86-4	10.01 eV	nBUTACET	2.3		3.30
n-Butyl Acrylate	n-Butylacrylat	141-32-2		nBUTACRY	1.8		1.00
n-Butyl Mercaptan (1-Butanethiol)	n-Butylmercaptan	109-79-5	9.15 eV	nBUTMERC	0.6		
Carbon Dioxide	Kohlenstoffdioxid	124-38-9		not detectable			
Carbon Disulfide	Schwefelkohlenstoff	75-15-0	10.13 eV	CS2	1.3		1.05
Carbon monoxide	Kohlenstoffmonoxid	630-08-0		not detectable			
Carbonyl sulfide	Carbonylsulfid	463-58-1		not detectable			
Chlorine dioxide	Chlordioxid	10049-04-4	10.33 eV	not detectable			
Chloroacetone	Chloraceton	78-95-5	9.92 eV		1.3		1.6

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Substance	Substanz	CAS	Ionization potential	Multi-PID 2 Code	Multi-PID 2 RF	X-am 7000 Code	X-am 7000 Smart PID RF
4-Chloroaniline	p-Chloranilin	106-47-8	8.10 eV		1.3		
Chlorobenzene	Chlorbenzol	108-90-7	9.07 eV	CLBZ	0.4	CLBZ	0.77
2-Chloro-1,3-butadiene	2-Chlor-1,3-butadien	126-99-8			0.4		
Chlorodifluoromethane	Chlordifluormethan (R22)	75-45-6		not detectable			
Chloroform	Chloroform (Trichlormethan)	67-66-3		not detectable			
Chloropicrin	Chlorpicrin	76-06-2		not detectable			
m-Cresol	m-Kresol	108-39-4	8.29 eV		1.0	not possible[1)]	
o-Cresol	o-Kresol	95-48-7	8.24 eV		0.55	not possible[1)]	
p-Cresol	p-Kresol	106-44-5	8.34 eV		2.1	not possible[1)]	
Crotonaldehyde (2-Butenal)	Crotonaldehyd (2-Butenal)	4170-30-3	9.73 eV	CROTONAL	1.2		
Cumene (Isopropylbenzene)	Cumol	98-82-8	8,75 eV	CUMOL	0.6		1.20
Cyanogen bromide	Bromcyan	506-68-3		not detectable			
Cyclohexane	Cyclohexan	110-82-7	9.98 eV	CYHE	1.3	CYHE	1.53
Cyclohexanone	Cyclohexanon	108-94-1	9.14 eV	CYCHEXON	0.9		3.20
Cyclohexylamine	Cyclohexylamin	108-91-8	8.60 eV		0.5		
Cyclopentane	Cyclopentan	287-92-3	10.33 eV		> 20		
Decane	n-Decan	124-18-5	10.19 eV		1.1		
Dibutylamine	Dibutylamin	111-92-2	7.69 eV		0.7		
Dibutylether	Dibutylether	142-96-1	9.28 eV		1.0		
1,2-Dichlorobenzene (ortho-)	1,2-Dichlorbenzol	95-50-1	9.07 eV	12DCBENZ	0.5		
cis-1,2-Dichloroethylene	1,2-Dichlorethen (cis)	156-59-2	9.65 eV	cis12DCE	0.8		0.80
trans-1,2-Dichloroethylene	1,2-Dichlorethen (trans)	156-60-5	9.66 eV	trn12DCE	0.4		0.42
1,3 Dichloropropene (Telone)	1,3-Dichlorpropen	542-75-6			0.8		
1,1-Difluorethylene	1,1-Difluorethen	75-38-7	10.29 eV		12.0		
N,N Diethylanilin	N,N Diethylanilin	91-66-7	6.99eV		0.4		
Dicyclopentadiene	Dicyclopentadien	77-73-6			0.5		1.25
Diethylene glycol monoethyl ether	Diethylenglycolmonoethylether	111-90-0			6.1	no display	
Diisobutyl carbinol	Diisobutyl carbinol	108-82-7			0.7		2.2
N,N-Diisopropylethylamine	N,N-Diisopropylethylamin	7087-68-5					0.9
N,N-Dimethylacetamide	N,N-Dimethylacetamid	127-19-5	9.20 eV		1.0	not possible[1)]	
Dimethyldisulfide	Dimethyldisulfid	624-92-0	8.96 eV		0.2		0.37
Dimethyl ether	Dimethylether	115-10-6	10,03 eV		2.2		2.70
N,N-Dimethylformamide (DMF)	N,N-Dimethylformamid	68-12-2	9.45 eV	N,N-DMF	0.8		1.40
Dimethyl sulfate	Dimethylsulfat	77-78-1		not detectable		not detectable	

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				Multi-PID 2		X-am 7000	
			Ionization				Smart PID
Substance	Substanz	CAS	potential	Code	RF	Code	RF
Dimethylsulfide	Dimethylsulfid	75-18-3	8.69 eV		1.0		0.52
1,4-Dioxane	1,4-Dioxan	123-91-1	9.41 eV	DIOXAN	1.3		1.20
Diphenyl ether	Diphenylether	101-84-8			1.4	not possible[1)]	
Epichlorohydrin	Epichlorohydrin	106-89-8	10.60 eV	EPICLHYD	6.5		
Ethanol	Ethanol	64-17-5	10.48 eV	ETHANOL	8.8		10.0
Ethyl Acetate	Ethylacetat	141-78-6	10.11 eV	ETAC	3.8	ETAC	3.83
Ethyl Acrylate	Ethylacrylat	140-88-5	10.30 eV	ETHYACRY	2.3		
Ethylbenzene	Ethylbenzol	100-41-4	8.76 eV	ETBZ	0.5	ETBZ	0.88
Ethylbromide	Ethylbromid	74-96-4	10.29 eV		4.8		
Ethyl Cellosolve (2-Ethoxyethanol)	2-Ethoxyethanol	110-80-5	9,60 eV	ETHCELLO	1.3		
Ethylenediamine	Ethylendiamin	107-15-3	9.25 eV		3.0		
Ethylen oxide	Ethylenoxid	75-21-8	10.56 eV		approx. 17	not possible[1)]	
Ethylene	Ethylen	74-85-1	10.52 eV	ETHYLEN	10.1	100 ppm = RF 10 1000 ppm = RF 9,4	
Ethylene chlorohydrin	2-Chlorethanol	107-07-3		not detectable			
Ethylene glycol	Ethylenglycol	107-21-1					> 15
Ethyl Ether (Diethyl Ether)	Diethylether	60-29-7	9.41 eV	ETHETHER	1.2		1.30
Ethyl formate	Ethylformiat	109-94-4		not detectable			
2-Ethyl hexanal	2-Ethylhexanal	123-05-7			0.9		1.84
2-Ethylhexylacrylate	2-Ethylhexylacrylat	103-11-7			1.8		
Ethyl lactate	Ethyllactat	97-64-3			3.8		4.35
Ethyl Mercaptan (Ethanethiol)	Ethylmercaptan	75-08-1	9.29 eV	ETHMERC	0.6		
Ethyl tert Butyl Ether (ETBE)	2-Ethoxy-2-methylpropan (ETBE)	637-92-3	9.39 eV		0.9		0.75
4-Ethyltoluene	4-Ethyltoluol	622-96-8			0.5		1.7
Formaldehyde	Formaldehyd	50-00-0		not detectable			
Furan	Furan	110-00-9			0.8		0.79
Furfural	Furfural	98-01-1	9.22 eV		1.0		1.90
n-Heptane	n-Heptan	142-82-5	10.07 eV	nHEPTAN	2.4		2.10
Heptane-2-one	2-Heptanon	110-43-0	9.27 eV		0.9		1.20
Hexachlorocyclopentadiene	Hexachlorcyclopentadien	77-47-4			0.7		
Hexamethyldisiloxane (HMDSO)	Hexamethyldisiloxan (HMDSO)	107-46-0			0.4		0.4
Hexamethylenediamine	Hexamethylendiamin	124-09-4				no measurement values	
n-Hexane	n-Hexan	110-54-3	10.18 eV	nHEXAN	4.7		5.30
1-Hexene	1-Hexen	592-41-6	9.46 eV		1.6		1.00
HFE-7100 (3M)	HFE-7100 (3M)	163702-07-6		not detectable			

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				Multi-PID 2		X-am 7000	
			Ionization				Smart PID
Substance	Substanz	CAS	potential	Code	RF	Code	RF
HFE-7100 (3M)	HFE-7100 (3M)	163702-08-7		not detectable			
Hydrazine	Hydrazin	302-01-2	8.10 eV		1.0		
Hydrazoic acid	Stickstoffwasserstoffsäure			not detectable			
Hydrogen	Wasserstoff	1333-74-0		not detectable			
Hydrogen cyanide	Cyanwasserstoff (Blausäure)	74-90-8		not detectable			
Hydrogen Selenide	Selenwasserstoff	7783-07-5	9.9 eV		0.8		
Hydrogen Sulfide	Schwefelwasserstoff	7783-06-4	10.46 eV	H2S	3.3		3.00
4-Hydroxy-4-methyl-2-pentanone (Diaceton alcohol)	4-Hydroxy-4-methylpentan-2-on	123-42-2	9.96 eV		0.6		
Iodomethane	Iodmethan	74-88-4	9.54 eV		0.9		0.4
Iron pentacarbonyl	Eisenpentacarbonyl	13463-40-6	8.00 eV		0.6		
Isoamyl Acetate	Isoamylacetat	123-92-2	9.90 eV	IAMYACET	1.8		
Isobutane	Isobutan	75-28-5		not possible with 10.6 eV		not possible with 10.6 eV	
Isobutene	Isobuten	115-11-7	9.24 eV	IBUT	1.0	IBUT	1.00
Isobutyl Acetate	iso-Butylacetat	110-19-0	9.97 eV	IBUTACET	3.6		3.6
Isobutyraldehyde	Isobutyraldehyd	78-84-2	9.73 eV	IBUTALDE	1.1		
Isofluran	Isofluran	26675-46-7		not detectable			
iso-Octane (2,2,4-Trimethylpentane)	Isooctan	540-84-1	10.24 eV	IOCTAN	1.2		1.20
Isopentane	2-Methylbutan	78-78-4	10.32 eV	IPENTAN	8.2		
Isoprene (2-Methyl-1,3-Butadiene)	Isopren	78-79-5	8.85 eV	ISOPREN	0.6		0.14
Isopropanol	2-Propanol (IPA)	67-63-0	10.16 eV	IPA	4.4		4.20
Isopropyl Acetate	Isopropylacetat	108-21-4	9.99 eV	IPACETAT	2.6		
Isopropyl Cellosolve	Isopropylcellosolv	109-59-1			1.2		
Isopropyl Ether	Isopropylether	108-20-3	9.20 eV	IPROPETH	0.8		
Isopropyl glycidyl ether	Isopropylglycidether	4016-14-2			1.1		1.92
Kerosine / Jet Fuel	Kerosin / Jet Fuel (FP bis 55°C)	8008-20-6					1.00
Methane	Methan	74-82-8		not detectable			
Methanol	Methanol	67-56-1		not detectable			
1-Methoxy-2-propanol	1-Methoxy-2-propanol	107-98-2			1.4		1.95
1-Methoxy-2-propylacetate	1-Methoxypropylacetate	108-65-6			1.2		1.46
2-Methoxy-ethanol	2-Methoxyethanol	109-86-4	10.13 eV		3.0		
Methyl acetate	Methylacetat	79-20-9	10.27 eV		5.5		
Methyl Bromide (Bromomethane)	Methylbromid (Brommethan)	74-83-9	10.53 eV	MEBR	1.6	MEBR	1.92
Methyl chloride	Methylchlorid	74-87-3		not detectable			
Methylcyclohexane	Methylcyclohexan	108-87-2	9.64 eV		0.8		0.87

PLATFORM
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Version 10, October 2017				Multi-PID 2		X-am 7000	
Substance	**Substanz**	**CAS**	**Ionization potential**	**Code**	**RF**	**Code**	**Smart PID RF**
Methylene chloride	Methylenchlorid	75-09-2		not detectable			
Methyl Ethyl Ketone	Methylethylketon	78-93-3	9.53 eV	MEK	0.8	**MEK**	**0.64**
Methyl Isobutyl Ketone	Methylisobutylketon	108-10-1	9.30 eV	MIBK	1.0		0.90
Methyl Mercaptan (Methanethiol)	Methylmercaptan	74-93-1	9.44 eV	METHMERC	0.5		
Methyl Methacrylate	Methylmethacrylat	80-62-6	9.74 eV	MeMeACRY	1.4		1.30
2-Methylpentane	2-Methylpentan	107-83-5	10.00 eV		4.2		
Methyl propyl ether	Methylpropylether	557-17-5	9.41 eV		1.8		1.52
1-Methyl-2-pyrrolidone	N-Methyl Pyrrolidone	872-50-4	9.17 eV		1.4	not possible[1)]	
Methyl salicylate	Methylsalicylat	119-36-8	7.65 eV		1.2	not possible[1)]	
Methyl tert-Butyl Ether (MTBE)	Methyl tert-Butylether (MTBE)	1634-04-4	9.41 eV	MTBE	0.8	**MTBE**	**0.85**
Monomethylamine	Monomethylamin	74-89-5	8.97 eV	MMeAMIN	1.3		
Naphthalene	Naphthalen	91-20-3	8.10 eV		0.55	not possible[1)]	
Nitrobenzene	Nitrobenzol	98-95-3	9.92 eV		1.7		10.3
Nitrogen	Stickstoff	7727-37-9		not detectable			
Nitrogen dioxide	Stickstoffdioxid	10102-44-0		not detectable			
2-Nitrotoluene	o-Nitrotoluol	88-72-2	9.24 eV		1.5		
3-Nitrotoluene	3-Nitrotoluol	99-08-1	9.50 eV		1.6		
n-Nonane	n-Nonan	111-84-2	10.21 eV	NONA	1.4	**NONA**	**1.70**
n-Octane	n-Octan	111-65-9	10.24 eV	OCTA	1.6	**OCTA**	**2.30**
1-Octene	1-Octen	111-66-0			0.95		0.85
Oxygen	Sauerstoff	7782-44-7		not detectable			
n-Pentane	n-Pentan	109-66-0	10.53 eV	nPENTAN	10.4		8.00
Phenol	Phenol	108-95-2	8.69 eV		0.4	not possible[1)]	
Phenyl hydrazine	Phenylhydrazin	100-63-0	7.74 eV		1.3		
Phosphine	Phosphorwasserstoff	7803-51-2	9.87 eV		3.4		4.35
alpha-Pinene	alpha-Pinen	2437-95-8	8.10 eV	aPIN	0.4	**aPIN**	**0.49**
Propane	Propan	74-98-6		not detectable			
n-Propanol	n-Propanol	71-23-8	10.51 eV	nPA	5.1		5.60
Propionaldehyde (Propanal)	Propanal	123-38-6	9.98 eV	PROPANAL	14.8		
n-Propyl Acetate	n-Propylacetat	109-60-4	10.04 eV	nPROACET	3.1		
Propylene	Propylen	115-07-1	9.73 eV	PROPYLEN	1.2		0.60
Propylene Oxide	1,2-Epoxypropan	75-56-9	10.22 eV	PROPOXID	5.8		6.50
Styrene	Styrol	100-42-5	8.47 eV	STYR	0.4	**STYR**	**0.84**
Sulfur hexafluoride	Schwefelhexafluorid (SF6)	2551-62-4		not detectable			

Version 10, October 2017				Multi-PID 2		X-am 7000	
Substance	**Substanz**	**CAS**	**Ionization potential**	**Code**	**RF**	**Code**	**Smart PID RF**
Sulfuryl difluoride	Sulfuryldifluorid (Vikane)	2699-79-8		not detectable			
Tetrachloroethylene (PCE)	Perchlorethylen	127-18-4	9.32 eV	PCE	0.5		0.62
Tetraethyl lead	Bleitetraethyl	78-00-2	8.00 eV		0.4		
1,1,1,2 Tetrafluoroethane (F	1,1,1,2-Tetrafluorethan (R134a)	811-97-2		not detectable			
Tetrahydrofuran	Tetrahydrofuran	109-99-9	9.54 eV	THF	1.5		1.65
Tetrahydrothiophene	Tetrahydrothiophen	110-01-0	8.38 eV		0.5		0.95
Thiophene	Thiophen	110-02-1	8.86 eV		0.5		
Toluene	Toluol	108-88-3	8.82 eV	TOLU	0.5	**TOLU**	**0.70**
2,4-toluene diisocyanate	2,4-Toluylendiisocyanat	584-84-9			0.4		
o-Toluidine	o-Toluidin	95-53-4	7.60 eV		0.5		
Trichloroethylene	Trichlorethylen	79-01-6	9.45 eV	TCE	0.5	**TCE**	**0.75**
1,1,1-Trichloroethane	1,1,1-Trichlorethan	71-55-6		not detectable			
Triethanolamine	Triethanolamin	102-71-6		not detectable			
Triethylamine	Triethylamin	121-44-8	1.00 eV		1.0		1.15
Trimethylamine	Trimethylamin	75-50-3	7.82 eV	TRMeAMIN	0.9		
1,2,4-Trimethylbenzene	1,2,4-Trimethylbenzol	95-63-6			0.52		
1,3,5-Trimethylbenzene (Mesitylene)	1,3,5-Trimethylbenzol	108-67-8	8.40 eV		0.3		1.25
Vinyl Acetate	Vinylacetat	108-05-4	9.19 eV	VINACET	1.2		1.15
Vinyl Bromide	Vinylbromid	593-60-2	9.80 eV	VINBROM	0.4		
Vinyl Chloride (Chloroethylene)	Vinylchlorid	75-01-4	10.00 eV	VC	1.5	**VC**	**1.65**
Vinylidene Chloride (1,1-DCE)	1,1-Dichlorethen	75-35-4	10.00 eV	1,1-DCE	0.8		
4-Vinylcyclohexene	4-Vinylcyclohexen	100-40-3	8.8 eV		0.45		0.45
meta-Xylene	m-Xylol	108-38-3	8.56 eV	mXYLOL	0.5		0.90
ortho-Xylene	o-Xylol	95-47-6	8.56 eV	oXYLOL	0.5	**XYLE**	**0.90**
para-Xylene	p-Xylol	106-42-3	8.45 eV	pXYLOL	0.5		0.90
Xylene	Xylol (Isomerengemisch)	1330-20-7	8.5 eV				0.90
Diesel fuel	Diesel	68476-34-6				**DESL**	**1.00**
Gasoline	Benzin	8006-61-9				**GASO**	**1.21**
Jet Fuel	Jet Fuel					**JP8**	**1.00**
						VOC 1	**0.50**
						VOC 2	**1.00**
						VOC 3	**2.00**