biosystems Application Note	**The meaning of negative gas readings**	Date	August 29, 2001
		Nº	AN20010829
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Preface

Although it is physically impossible for the atmosphere to contain a negative quantity of a substance, it is not uncommon for a gas detector to display a negative reading on either the LEL or Toxic channel. This application note will address some of the reasons why negative readings may occur.

Negative readings are a result of the way the detector software interprets sensor output. While the LEL sensor and the toxic sensor are very different in the way they detect gases, they have one thing in common. The sensor creates a signal (electrical output) that is directly proportional to the amount of gas it detects.

In the case of the LEL sensor, the output is created when the active bead in the sensor changes its electrical characteristics when combustible gas is oxidized (burned) on the sensor bead.

In the case of the toxic sensors, the output is created as a result of a chemical reaction between the gas entering the sensor and the electrolyte in the sensor.

The "output" as described above is actually not as simple as "gas in = signal out". The output is actually a change in a current flow. In other words, even if the sensor is not detecting gas there is still a current flowing through the sensor. This means that when you zero, or fresh air, calibrate a gas detector you simply tell the instrument that the "output" of the sensor at the time of this calibration is 0% LEL or 0 PPM toxic contaminant.

Relative to the time of the zero, or fresh air calibration, the output can be either negative or positive. A positive output is most often because the sensor is reacting to the presence of detectable gas. There are several reasons why the output can be negative.

Zeroing in the presence of contaminants

Probably the easiest way to produce negative readings is to zero, or fresh air calibrate the sensor while in the presence of measurable contaminants. Remember that when you zero an instrument, the output of the sensor at that moment becomes the point of comparison. If a toxic sensor is zeroed in air that contains 10 ppm of toxic contaminant, and is then taken to an area where the air contains no toxic contaminant, the instrument will display a reading of minus 10 ppm. When taken to an area where that toxic contaminant is actually present, readings will be low by this same amount. For instance, if the air contains 15 ppm, the instrument would read only 5 ppm. The same is true for the combustible gas sensor where the readings are expressed in % LEL.

Zeroing before the sensors have fully warmed-up

Sensors require a certain period of time to warm-up or stabilize after the instrument is first turned on. Until sensor output has fully stabilized and reached a "steady state" condition the output will be subject to change even while the sensor is located in fresh air. Some types of sensors require only a few moments to stabilize, while some may take longer. Some sensors start with negative readings and "count up" as they stabilize. Others start with positive readings and "count down" as they stabilize. The important thing is to let your instrument run a sufficient period of time after being turned on for readings to stabilize.

Most sensors will fully stabilize in less than 3 minutes. If the instrument is zeroed before stabilization is complete, further change in the output as the sensors continue to stabilize may produce either positive or negative "drift". Never zero your instrument until after the readings have stopped changing!

Interfering contaminants

Substance-specific electrochemical sensors have been carefully designed to minimize the effects of common interfering gases. Substance-specific sensors are designed to respond only to the gases that they are supposed to measure. Even though care has been taken to reduce cross-sensitivity, some interfering gases may still have an effect on toxic sensor readings. In some cases the interfering effect may be "positive" and result in readings, which are higher than actual. In a few cases the interference may be negative and produce readings, which are lower than actual.

Environmental Changes

Most sensors show little change in output as a function of environmental changes, such as humidity and temperature. Some sensors, especially those with high resolution capability, are strongly influenced by environmental changes such as humidity and temperature.

What to do

The first thing to do is take the instrument to an area where the air is known to be fresh and wait for the readings to stabilize. If the readings are still negative, simply re-zero the instrument.

If a Biosystems gas detector has drifted more than ±50% of the default alarm value it will be necessary to do a "forced" zero calibration. Please refer to the manual for your model gas detector for the appropriate procedure.

Remember that calibration is a two step procedure. Simply "zeroing" the instrument is not enough, it's also necessary to verify sensor response while the sensor is actually exposed to known concentration test gas.

Please read Biosystems application note AN20010807 for recommendation for the frequency of verifying sensor accuracy.