

**RAE Systems Technical Note TN-114****Sensor Specifications and Cross-Sensitivities**

Technical Note TN-114 presents specifications, cross-sensitivities, and calibration information on select RAE Systems sensors. All specifications presented in this Technical Note reflect the performance of standalone sensors. Actual sensor characteristics may differ when the sensor is installed in different instruments. As sensor performance may change over time, specifications provided are for brand new sensors.

All specifications have been verified under the following environmental conditions:

- Temperature: 68° F (20° C)
- Relative humidity (non-condensing): 50%
- Ambient pressure: 1 atm (1,013 mbar)

Please refer to the Glossary for specification definitions.

Specifications are subject to change without notice.



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## Glossary

**Range:** The normal operating concentration of a sensor where the best linearity is found. Exceeding the normal operating range may result in erroneous readings and long recovery times, but should not permanently damage the sensor as long as the Max Overload is not exceeded.

**Max Overload:** The maximum exposure concentration. Exceeding this value will likely give erroneous readings and cause permanent damage to the sensor. This can be viewed as the sensor IDLH. Ammonia sensors often fail because they have been exposed to over 200 to 300 ppm (see Application Note AP-201).

**Resolution:** The least significant digit on the display or the minimum amount of chemical that the sensor can “see” (also known as: “Increment of measurement”).

**Response Time ( $t_{90}$ ):** The time for a sensor to reach 90% of its final stable reading. Typically an exposure of twice the  $t_{90}$  time is required to get a stable reading.

**Bias / Equilibration:** Some electrochemical sensors (NO, NH<sub>3</sub>) require a bias voltage to detect the gas, while most do not. Unbiased sensors may be shipped with a shorting pin across the electrodes to avoid an accidental bias. The pin should be removed before installation. Biased sensors require an equilibration time (also known as warm-up time) of about 6 hours after installation for the baseline to become stable enough to calibrate the sensor. Unbiased sensors require only about 10 minutes to stabilize. Once installed, any sensor bias stays on, even when the meter is off. Therefore, even biased sensors are ready for immediate use when the instrument is turned on again, and the equilibration time is needed only when first installed or if the battery becomes completely drained. The SensorRAE can be used to maintain bias on NO and other bias sensors, so long equilibration times can be avoided when installing such sensors into a multi-gas instrument.

**Temperature Range:** The normal operating temperature of the sensor. Sensors embody physico-chemical processes, which slow down when cooled and speed up when heated. Storing and using detectors outside in the winter may result in low readings if not recalibrated at the temperature of use. Storing detectors in hot cars in the summer may result in high readings and even dry out the sensors. Allowing a meter to return to normal operating temperature typically restores readings.

**Pressure Range:** The normal operating pressure of the sensor, typically atmospheric (14.7 psi)  $\pm 10\%$ . Some sensors have a transient response to sudden pressure changes, which may cause them to go into alarm for a short time.

**Operating Humidity:** Normal operating humidity. Typically 15 to 90% relative humidity, “non-condensing.” Condensing humidity blocks the diffusion pathway, lowering the reading, and consistently high humidity can dilute the electrolyte and cause the cell to burst. Running or storing for extended periods in <10% RH gas can dry out the electrolyte and make the sensor inoperable.

**Drift:** The amount the sensor output may change over time, expressed in %.

**Storage Life:** The recommended maximum time a sensor should be stored in its original packaging before being installed in an instrument.

## **Glossary (Continued)**

**Storage Temperature:** The recommended temperature to store sensors prior to use.

**Operating Life:** The expected useable life of the sensor after it is installed, as long as the "Storage Life" was not exceeded before installation.

**Warranty:** The time from shipment up to which RAE Systems will replace a sensor free of charge, or at reduced charge, in case of failure. The warranty period is generally equal to or less than the Operating Life. Thus, a sensor with a storage life of 6 months, operating life of 2 years and warranty of 2 years, stored for 6 months before installation, is expected to be useable for up to 2½ years from the date of manufacture, even though the warranty expires 1½ years after it is installed. The warranty expiration date is programmed into the sensor and displayed during start-up of most RAE Systems single- and multi-gas meters. Sensors can be used beyond the expiration date provided that the sensor is properly zeroed and calibrated and the resolution is acceptable for the purpose of the measurements. The resolution can be tested by simply observing the zero fluctuations, or more accurately by measuring the response in the instrument's Diagnostic Mode according to Technical Note TN-123. The expiration date is provided on the instrument only as a reminder to the user that the warranty period for that sensor is complete and that it may become necessary to replace the sensor in the near future. The sensor, however, can operate properly beyond the expiration date as long as it responds to the gas of interest and is tested as noted above.

**Calibration Gas:** Recommended calibration gas concentration. A lower concentration might not give a stable calibration, while higher concentrations might use up the sensor prematurely. However, if the sensor is operated outside the typical range, it is recommended to use a calibration gas as close as possible to the actual concentrations and gas type being measured. For example, an NO sensor used to measure in the 200 to 500 ppm range is preferably calibrated with 500 ppm NO, instead of 25 ppm. A CO sensor used to measure 100-1,000 ppm hydrogen should be calibrated with 1,000 ppm hydrogen gas.

**Calibration Flow Rate:** Recommended calibration gas flow rate.

**Cross-Sensitivity:** Every sensor has some cross-sensitivity, where the sensor responds to other gases that are not filtered out and can react on the electrode. It is very important to be aware of potentially cross-sensitive compounds when interpreting data.

## Sensors for Combustible Gases and Vapors

### Combustible Gases and Vapors (LEL - 1)

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | Protected catalytic bead  |
| <b>Gases Detected:</b>                 | Most combustible gases and vapors                               |
| <b>Range:</b>                          | 0-100% LEL  |
| <b>Resolution:</b>                     | 1% LEL  |
| <b>Response Time (t<sub>90</sub>):</b> | 30 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation                            |
| <b>Drift:</b>                          | <10% LEL/month  |
| <b>Storage Life:</b>                   | 2 years in sealed container                                     |
| <b>Operating Life:</b>                 | 2 years in air  |
| <b>Warranty:</b>                       | 2 years from date of shipment                                   |
| <b>Calibration Gas:</b>                | 50% LEL of Methane, or 2.5% by volume, balance air              |
| <b>Part Number(s):</b>                 | 014-0101-000, 008-1171-001                                      |
| <b>Supported Instruments:</b>          | AreaRAE, MultiRAE IR, MultiRAE Plus, QRAE, RAEGuard, RAEGuard S |

#### Catalytic Bead LEL - 1 Sensor Response Data

| Compound            | LEL Relative Sensitivity <sup>1</sup> | LEL CF |
|---------------------|---------------------------------------|--------|
| Acetone             | 45                                    | 2.2    |
| Ammonia             | 125                                   | 0.8    |
| Benzene             | 45                                    | 2.2    |
| Carbon monoxide     | 75                                    | 1.2    |
| Cyclohexane         | 40                                    | 2.5    |
| Ethanol             | 59                                    | 1.7    |
| Ethyl acetate       | 45                                    | 2.2    |
| Hydrogen            | 91                                    | 1.1    |
| Isobutylene         | 67                                    | 1.5    |
| Isopropanol         | 38                                    | 2.6    |
| Leaded gasoline     | 48                                    | 2.1    |
| Methane             | 100                                   | 1      |
| Methanol            | 67                                    | 1.5    |
| Methyl ethyl ketone | 38                                    | 2.6    |
| n-Butane            | 50                                    | 2      |
| n-Heptane           | 42                                    | 2.4    |
| n-Hexane            | 43                                    | 2.3    |
| n-Octane            | 34                                    | 2.9    |
| n-Pentane           | 45                                    | 2.2    |
| Phosphine           | 385                                   | 0.26   |
| Propane             | 62                                    | 1.6    |
| Propene             | 67                                    | 1.5    |
| Toluene             | 38                                    | 2.6    |
| Turpentine          | 34                                    | 2.9    |

<sup>1</sup> - Response of the RAE Systems LEL sensor to a range of gases at the same LEL, expressed as percent of Methane response (=100). These figures are for guidance only and are rounded to the nearest 5%. For the most accurate measurements, the instrument should be calibrated with the gas under investigation. See Technical Note TN-156 for more details and more compounds.

## Combustible Gases and Vapors (LEL - 2)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Protected catalytic bead                           |
| <b>Gases Detected:</b>                 | Most combustible gases and vapors                  |
| <b>Range:</b>                          | 0-100% LEL   |
| <b>Resolution:</b>                     | 1% LEL   |
| <b>Response Time (t<sub>90</sub>):</b> | 15 sec.  |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation               |
| <b>Drift:</b>                          | <10% LEL/month                                     |
| <b>Storage Life:</b>                   | 2 years in sealed container                        |
| <b>Operating Life:</b>                 | 2 years in air                                     |
| <b>Warranty:</b>                       | 2 years from date of shipment                      |
| <b>Calibration Gas:</b>                | 50% LEL of Methane, or 2.5% by volume, balance air |
| <b>Part Number(s):</b>                 | 014-0114-000, C03-0911-000                         |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro LEL                   |

### Catalytic Bead LEL - 2 Sensor Response Data

| Compound            | LEL Relative Sensitivity <sup>1</sup> | LEL CF |
|---------------------|---------------------------------------|--------|
| Acetone             | 45                                    | 2.2    |
| Ammonia             | 125                                   | 0.8    |
| Benzene             | 40                                    | 2.5    |
| Carbon monoxide     | 75                                    | 1.2    |
| Cyclohexane         | 40                                    | 2.5    |
| Ethanol             | 62                                    | 1.6    |
| Ethyl acetate       | 45                                    | 2.2    |
| Hydrogen            | 91                                    | 1.1    |
| Isobutylene         | 67                                    | 1.5    |
| Isopropanol         | 38                                    | 2.6    |
| Leaded gasoline     | 48                                    | 2.1    |
| Methane             | 100                                   | 1      |
| Methanol            | 67                                    | 1.5    |
| Methyl ethyl ketone | 38                                    | 2.6    |
| n-Butane            | 50                                    | 2      |
| n-Heptane           | 42                                    | 2.4    |
| n-Hexane            | 43                                    | 2.3    |
| n-Octane            | 36                                    | 2.8    |
| n-Pentane           | 45                                    | 2.2    |
| Phosphine           | 385                                   | 0.26   |
| Propane             | 62                                    | 1.6    |
| Propene             | 58                                    | 1.7    |
| Toluene             | 38                                    | 2.6    |
| Turpentine          | 34                                    | 2.9    |

<sup>1</sup> - Response of the RAE Systems LEL sensor to a range of gases at the same LEL, expressed as percent of Methane response (=100). These figures are for guidance only and are rounded to the nearest 5%. For the most accurate measurements, the instrument should be calibrated with the gas under investigation. See Technical Note TN-156 for more details and more compounds.



## Combustible Gases and Vapors (NDIR, % LEL Methane)

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | NDIR CH <sub>4</sub> % LEL (Non-dispersive infrared)    |
| <b>Gases Detected:</b>                 | Methane (CH <sub>4</sub> )                              |
| <b>Range:</b>                          | 0-100% LEL (0-5.0% Vol. CH <sub>4</sub> )               |
| <b>Resolution:</b>                     | 1% LEL  |
| <b>Response Time (t<sub>90</sub>):</b> | 30 sec.   |
| <b>Equilibration:</b>                  | 1 min. after installation                               |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                           |
| <b>Pressure Range:</b>                 | Atmospheric ±20%  |
| <b>Operating Humidity:</b>             | 0-95% non-condensing                                    |
| <b>Drift:</b>                          | <5% signal/month  |
| <b>Storage Life:</b>                   | 2 years in sealed container                             |
| <b>Storage Temperature:</b>            | -40°F to 122°F (-40°C to 50°C)                          |
| <b>Operating Life:</b>                 | 2 years in air  |
| <b>Warranty:</b>                       | 1 year from date of shipment                            |
| <b>Calibration Gas:</b>                | 50% LEL CH <sub>4</sub> , balance air or N <sub>2</sub> |
| <b>Calibration Flow Rate:</b>          | 500 cc/min for 1 min.                                   |
| <b>Part Number(s):</b>                 | C03-0962-000  |
| <b>Supported Instruments:</b>          | MultiRAE Lite Pumped, MultiRAE, MultiRAE Pro            |

## Combustible Gases and Vapors (NDIR, % Vol. Methane)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | NDIR CH <sub>4</sub> % Vol. (Non-dispersive infrared)    |
| <b>Gases Detected:</b>                 | Methane (CH <sub>4</sub> )                               |
| <b>Range:</b>                          | 0-100% Vol. Methane (CH <sub>4</sub> )                   |
| <b>Resolution:</b>                     | 0.1% Vol.  |
| <b>Response Time (t<sub>90</sub>):</b> | 30 sec.  |
| <b>Equilibration:</b>                  | 1 min. after installation                                |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                            |
| <b>Pressure Range:</b>                 | Atmospheric ±20%   |
| <b>Operating Humidity:</b>             | 0-95% non-condensing                                     |
| <b>Drift:</b>                          | <5% signal/month   |
| <b>Storage Life:</b>                   | 2 years in sealed container                              |
| <b>Storage Temperature:</b>            | -40°F to 122°F (-40°C to 50°C)                           |
| <b>Operating Life:</b>                 | 2 years in air   |
| <b>Warranty:</b>                       | 1 year from date of shipment                             |
| <b>Calibration Gas:</b>                | 20% Vol. CH <sub>4</sub> , balance air or N <sub>2</sub> |
| <b>Calibration Flow Rate:</b>          | 500 cc/min for 1 min.                                    |
| <b>Part Number(s):</b>                 | C03-0963-000   |
| <b>Supported Instruments:</b>          | MultiRAE Lite Pumped, MultiRAE, MultiRAE Pro             |

## Oxygen Sensors

### Oxygen (O<sub>2</sub>)

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | Electrochemical   |
| <b>Range:</b>                          | 0 to 30% Vol.   |
| <b>Resolution:</b>                     | 0.1% Vol.   |
| <b>Response Time (t<sub>90</sub>):</b> | 15 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation  |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)   |
| <b>Pressure Range:</b>                 | Atmospheric ±10%  |
| <b>Operating Life:</b>                 | 2 years in air  |
| <b>Warranty:</b>                       | 2 years from date of shipment   |
| <b>Calibration Gas:</b>                | Ambient air (20.9% oxygen) or 18% O <sub>2</sub>  |
| <b>Zero Gas:</b>                       | 99.9% N <sub>2</sub>  |
| <b>Part Number(s):</b>                 | 170-0003-002, 008-1161-000, C03-0942-000  |
| <b>Supported Instruments:</b>          | AreaRAE, MultiRAE Family, MultiRAE IR, MultiRAE Plus, QRAE, QRAE+, RAEGuard EC, ToxiRAE Pro, VRAE |

**Note:** Measurements can be made in pure ethylene; recovery to ambient air may require a few hours.

### Oxygen (O<sub>2</sub>) - SPE O<sub>2</sub>

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical (Solid Polymer Electrolyte)      |
| <b>Range:</b>                          | 0 to 30% Vol.                                    |
| <b>Resolution:</b>                     | 0.1% Vol.  |
| <b>Response Time (t<sub>90</sub>):</b> | 30 sec.  |
| <b>Bias / Equilibration:</b>           | -600 mV / 30 min. after installation             |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                    |
| <b>Pressure Range:</b>                 | Atmospheric ± 10%                                |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                            |
| <b>Drift:</b>                          | < 2% signal/month                                |
| <b>Storage Life:</b>                   | 6 months in sealed container                     |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)                       |
| <b>Operating Life:</b>                 | 2 years in air                                   |
| <b>Warranty:</b>                       | 2 years from date of shipment                    |
| <b>Calibration Gas:</b>                | Ambient air (20.9% oxygen) or 18% O <sub>2</sub> |
| <b>Zero Gas:</b>                       | 99.9% N <sub>2</sub>                             |
| <b>Part Number(s):</b>                 | 022-0300-000                                     |
| <b>Supported Instruments:</b>          | QRAE II, RAEGuard S, ToxiRAE II                  |

## Electrochemical Sensors for Toxic Gases

### Ammonia (NH<sub>3</sub>)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical  |
| <b>Range:</b>                          | 0-100 ppm  |
| <b>Resolution:</b>                     | 1 ppm  |
| <b>Response Time (t<sub>90</sub>):</b> | 60 sec.  |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation   |
| <b>Temperature Range:</b>              | -4°F to 104°F (-20°C to 40°C)  |
| <b>Pressure Range:</b>                 | Atmospheric ±10%   |
| <b>Operating Humidity:</b>             | 15-90% non-condensing  |
| <b>Drift:</b>                          | <2% signal loss / month  |
| <b>Storage Life:</b>                   | 1 year in sealed container   |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)   |
| <b>Operating Life:</b>                 | 1 year in air  |
| <b>Warranty:</b>                       | 1 year from date of shipment   |
| <b>Calibration Gas:</b>                | 50 ppm NH <sub>3</sub> , balance N <sub>2</sub>  |
| <b>Calibration Flow Rate:</b>          | 1,000 cc/min for 3 min.  |
| <b>Part Number(s):</b>                 | 170-0025-000, 008-1125-000, C03-0950-000   |
| <b>Supported Instruments:</b>          | AreaRAE, MeshGuard, MultiRAE Family, MultiRAE IR, MultiRAE+, QRAE+, RAEGuard EC, ToxiRAE II, ToxiRAE Pro, VRAE |

#### Cross-Sensitivity Data, NH<sub>3</sub> Sensor

| Gas              | Concentration | Response                 |
|------------------|---------------|--------------------------|
| Alcohols         | 1,000 ppm     | 0 ppm                    |
| CO               | 100 ppm       | 0 ppm                    |
| CO <sub>2</sub>  | 5,000 ppm     | 0 ppm                    |
| H <sub>2</sub>   | 10,000 ppm    | 0 ppm                    |
| H <sub>2</sub> S | 20 ppm        | about 2 ppm <sup>1</sup> |
| Hydrocarbons     | % range       | 0 ppm                    |

<sup>1</sup> - Short exposure of less than few minutes.

## Carbon Monoxide (CO)

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | Electrochemical   |
| <b>Range:</b>                          | 0-500 ppm   |
| <b>Max Overload:</b>                   | 1,500 ppm   |
| <b>Resolution:</b>                     | 1 ppm   |
| <b>Response Time (t<sub>90</sub>):</b> | 30 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation  |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)   |
| <b>Pressure Range:</b>                 | Atmospheric ±10%  |
| <b>Operating Humidity:</b>             | 15-90% non-condensing   |
| <b>Drift:</b>                          | <2% signal/month  |
| <b>Storage Life:</b>                   | 6 months in sealed container  |
| <b>Storage Temp.:</b>                  | 32°F to 68°F (0°C to 20°C)  |
| <b>Operating Life:</b>                 | 2 years in air  |
| <b>Warranty:</b>                       | 2 years from date of shipment   |
| <b>Calibration Gas:</b>                | 50 ppm CO, balance air  |
| <b>Cal. Flow Rate:</b>                 | 150 cc/min  |
| <b>Part Number(s):</b>                 | 032-0100-000, 008-1112-000, C03-0906-000  |
| <b>Supported Instruments:</b>          | AreaRAE, MeshGuard, MultiRAE Family, MultiRAE IR, MultiRAE+, QRAE, QRAE+, RAEGuard, RAEGuard S, ToxiRAE II, ToxiRAE Pro, VRAE |

### Cross-Sensitivity Data, CO Sensor

| Gas              | Concentration | Response w/o Filter <sup>1</sup> | Response w/ Filter <sup>2</sup> |
|------------------|---------------|----------------------------------|---------------------------------|
| Acetylene        | 250 ppm       | 250 ppm                          | NT <sup>3</sup>                 |
| Butane           | 100 ppm       | 1 ppm                            | 1 ppm                           |
| Cl <sub>2</sub>  | 10 ppm        | 0-1 ppm                          | NT                              |
| Ethanol          | 200 ppm       | 0 ppm                            | 0 ppm                           |
| Ethylene         | 100 ppm       | 16 ppm                           | NT                              |
| Ethylene oxide   | 125 ppm       | >=40 ppm                         | NT                              |
| H <sub>2</sub>   | 100 ppm       | 40 ppm                           | 40 ppm                          |
| H <sub>2</sub> S | 10 ppm        | 0 ppm                            | 0 ppm                           |
| HCl              | 10 ppm        | 0 ppm                            | 0 ppm                           |
| Hexane           | 500 ppm       | 0 ppm                            | 0 ppm                           |
| Isobutylene      | 100 ppm       | 9 ppm                            | 4 ppm                           |
| Isobutylene      | 1,000 ppm     | 30 ppm                           | 22 ppm                          |
| MEK              | 100 ppm       | 0 ppm                            | 0 ppm                           |
| NH <sub>3</sub>  | 100 ppm       | 0 ppm                            | 0 ppm                           |
| Nitrogen         | 100%          | 0-4 ppm                          | NT                              |
| NO               | 35 ppm        | 0 ppm                            | 0 ppm                           |
| NO <sub>2</sub>  | 5 ppm         | 0 ppm                            | 0 ppm                           |
| Propane          | 100 ppm       | 0 ppm                            | 0 ppm                           |
| SO <sub>2</sub>  | 5 ppm         | 0 ppm                            | 0 ppm                           |
| TCE              | 100 ppm       | 25 ppm                           | 15 ppm                          |

<sup>1</sup> - New sensor specs. Used sensors show increasing response to VOCs. See Technical Note TN-121 for more information.

<sup>2</sup> - A disk-shaped activated carbon fiber filter (P/N 008-3006-005) placed on top of the CO sensor helps reduce the response to VOCs.

<sup>3</sup> - Not tested (NT).

## Carbon Monoxide (CO) - Extended Range

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical                          |
| <b>Range:</b>                          | 0-2000 ppm                               |
| <b>Resolution:</b>                     | 10 ppm                                   |
| <b>Response Time (t<sub>90</sub>):</b> | 35 sec.                                  |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation     |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)            |
| <b>Pressure Range:</b>                 | Atmospheric ±10%                         |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                    |
| <b>Drift:</b>                          | <2% signal/month                         |
| <b>Storage Life:</b>                   | 6 months in sealed container             |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)               |
| <b>Operating Life:</b>                 | 2 years in air                           |
| <b>Warranty:</b>                       | 2 years from date of shipment            |
| <b>Calibration Gas:</b>                | 100 ppm CO or 1,000 ppm CO, balance air  |
| <b>Part Number(s):</b>                 | 032-0100-202, 008-1126-000, C03-0903-000 |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro             |

### Cross-Sensitivity Data, CO Extended-Range Sensor

| Gas              | Concentration | Response w/o Filter <sup>1</sup> | Response w/ Filter <sup>2</sup> |
|------------------|---------------|----------------------------------|---------------------------------|
| Cl <sub>2</sub>  | 10 ppm        | 0-1 ppm                          | NT <sup>3</sup>                 |
| Ethanol          | 200 ppm       | 0 ppm                            | 0 ppm                           |
| Ethylene         | 100 ppm       | <30 ppm                          | NT                              |
| H <sub>2</sub>   | 100 ppm       | <50 ppm                          | NT                              |
| H <sub>2</sub> S | 15 ppm        | 0 ppm                            | 0 ppm                           |
| NO               | 35 ppm        | -10-0 ppm <sup>4</sup>           | NT                              |
| NO <sub>2</sub>  | 5 ppm         | 0 ppm                            | 0 ppm                           |
| SO <sub>2</sub>  | 5 ppm         | 0 ppm                            | 0 ppm                           |

<sup>1</sup> - New sensor specs. Used sensors show increasing response to VOCs. See Tech. Note TN-121 for more information.

<sup>2</sup> - A disk-shaped activated carbon fiber filter (P/N 008-3006-005) placed on top of the CO sensor helps reduce the response to VOCs.

<sup>3</sup> - Not tested (NT).

<sup>4</sup> - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

## Carbon Monoxide (CO) Compensated to Hydrogen (H<sub>2</sub>)

|  |                                      |
|--|--------------------------------------|
| <b>Sensor Type:</b>                    | Electrochemical                      |
| <b>Range:</b>                          | 0-2,000 ppm                          |
| <b>Max Overload:</b>                   | 4,000 ppm                            |
| <b>Resolution:</b>                     | 1 ppm                                |
| <b>Response Time (t<sub>90</sub>):</b> | <45 sec (at 800 ppm CO)              |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)        |
| <b>Pressure Range:</b>                 | Atmospheric ±10%                     |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                |
| <b>Drift:</b>                          | < 1% signal/month                    |
| <b>Storage Life:</b>                   | 6 months in sealed container         |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)           |
| <b>Operating Life:</b>                 | 1 years in air                       |
| <b>Warranty:</b>                       | 1 year from date of shipment         |
| <b>Calibration Gas:</b>                | 100 ppm CO, balance Air              |
| <b>Calibration Flow Rate:</b>          | 450 cc/min                           |
| <b>Part Number(s):</b>                 | 170-0077-000, C03-0979-000           |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro         |

### Cross-Sensitivity Data, CO Sensor (H<sub>2</sub>-compensated)

| Gas                           | Concentration | Response  |
|-------------------------------|---------------|-----------|
| C <sub>2</sub> H <sub>4</sub> | 400 ppm       | <140 ppm  |
| Cl <sub>2</sub>               | 10 ppm        | <0.05 ppm |
| H <sub>2</sub> (at 10°C)      | 900 ppm       | 18 ppm    |
| H <sub>2</sub> (at 20°C)      | 900 ppm       | 36 ppm    |
| H <sub>2</sub> (at 30°C)      | 900 ppm       | 54 ppm    |
| NH <sub>3</sub>               | 20 ppm        | <0.02 ppm |
| NO                            | 50 ppm        | <1.5 ppm  |
| NO <sub>2</sub>               | 10 ppm        | <0.05 ppm |
| SO <sub>2</sub>               | 20 ppm        | <0.1 ppm  |

## CO+H<sub>2</sub>S Combination Sensor

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | Electrochemical                                 |
| <b>Range:</b>                          | CO: 500 ppm, H <sub>2</sub> S: 200 ppm          |
| <b>Max Overload:</b>                   | CO: 1,500 ppm , H <sub>2</sub> S: 500 ppm       |
| <b>Resolution:</b>                     | CO: 1ppm, H <sub>2</sub> S: 0.5 ppm             |
| <b>Response Time (t<sub>90</sub>):</b> | CO: 35 sec., H <sub>2</sub> S: 35 sec.          |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation            |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                   |
| <b>Pressure Range:</b>                 | Atmospheric ±10%                                |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                           |
| <b>Drift:</b>                          | < 1% signal/month                               |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)                      |
| <b>Operating Life:</b>                 | 1 year in air                                   |
| <b>Warranty:</b>                       | 1 year from date of shipment                    |
| <b>Calibration Gas:</b>                | 50 ppm CO, 10 ppm H <sub>2</sub> S, balance air |
| <b>Calibration Flow Rate:</b>          | 500 cc/min CO and H <sub>2</sub> S gas mix      |
| <b>Part Number(s):</b>                 | 170-0075-000, C03-0913-000                      |
| <b>Supported Instruments:</b>          | MultiRAE Family                                 |

### Cross-Sensitivity Data, CO+H<sub>2</sub>S Combination Sensor

| Gas              | Concentration | H <sub>2</sub> S Response | CO Response |
|------------------|---------------|---------------------------|-------------|
| Cl <sub>2</sub>  | 1 ppm         | 0 ppm                     | 0 ppm       |
| CO               | 300 ppm       | <6 ppm                    | 300 ppm     |
| H <sub>2</sub>   | 100 ppm       | 0.03 ppm                  | 20 ppm      |
| H <sub>2</sub> S | 15 ppm        | 15 ppm                    | 0-6 ppm     |
| NO               | 35 ppm        | 1.0 ppm                   | 0.1 ppm     |
| NO <sub>2</sub>  | 5 ppm         | -1 ppm <sup>1</sup>       | 0.1 ppm     |
| SO <sub>2</sub>  | 5 ppm         | 1 ppm                     | 0 ppm       |

<sup>1</sup> - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

## Chlorine (Cl<sub>2</sub>)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical  |
| <b>Range:</b>                          | 0 to 50 ppm  |
| <b>Resolution:</b>                     | 0.1 ppm  |
| <b>Response Time (t<sub>90</sub>):</b> | 30 sec.  |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation   |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)  |
| <b>Temperature Effect:</b>             | No effect on sensitivity or zero   |
| <b>Pressure Range:</b>                 | Atmospheric ±10%   |
| <b>Operating Humidity:</b>             | 5 to 95% non-condensing  |
| <b>Drift:</b>                          | < 10% signal / 6 months  |
| <b>Storage Life:</b>                   | 6 months in sealed container   |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)   |
| <b>Operating Life:</b>                 | 2 years in air   |
| <b>Warranty:</b>                       | 1 year from date of shipment   |
| <b>Calibration Gas:</b>                | 10 ppm Cl <sub>2</sub> , balance N <sub>2</sub>  |
| <b>Calibration Flow Rate:</b>          | 1,000 cc/min for 2 min.  |
| <b>Part Number(s):</b>                 | 032-0121-000, 008-1116-001, C03-0978-000   |
| <b>Supported Instruments:</b>          | AreaRAE, MeshGuard, MultiRAE Family, MultiRAE-IR, MultiRAE+, QRAE +, ToxiRAE II, ToxiRAE Pro, VRAE |

### Cross-Sensitivity Data, Cl<sub>2</sub> Sensor

| Gas              | Concentration | Response            |
|------------------|---------------|---------------------|
| Br <sub>2</sub>  | 1 ppm         | 1 ppm               |
| ClO <sub>2</sub> | 1 ppm         | 3.5 ppm             |
| CO               | 300 ppm       | 0 ppm               |
| CO <sub>2</sub>  | 10%           | 0 ppm               |
| Ethanol          | 6.60%         | 0 ppm               |
| H <sub>2</sub>   | 1,000 ppm     | 0 ppm               |
| H <sub>2</sub> S | 20 ppm        | -6 ppm <sup>1</sup> |
| HCl              | 20 ppm        | 0 ppm               |
| HCN              | 10 ppm        | 0 ppm               |
| Hydrocarbons     | % range       | 0 ppm               |
| N <sub>2</sub>   | 100%          | 0 ppm               |
| NH <sub>3</sub>  | 65 ppm        | 0 ppm               |
| NO               | 35 ppm        | 0 ppm               |
| NO <sub>2</sub>  | 10 ppm        | 12 ppm              |
| SO <sub>2</sub>  | 5 ppm         | 0 ppm               |

<sup>1</sup> - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

## Chlorine Dioxide (ClO<sub>2</sub>)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical  |
| <b>Range:</b>                          | 0 to 1 ppm   |
| <b>Resolution:</b>                     | 0.01 ppm   |
| <b>Response Time (t<sub>90</sub>):</b> | 120 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation   |
| <b>Temperature Range:</b>              | -4°F to 104°F (-20°C to 40°C)  |
| <b>Pressure Range:</b>                 | Atmospheric ±10%   |
| <b>Operating Humidity:</b>             | 5 to 95% non-condensing; no effect   |
| <b>Drift:</b>                          | <5% signal/6 months  |
| <b>Temperature Effect:</b>             | <0.02 ppm increase from -4°F to 104°F (-20°C to 40°C)  |
| <b>Storage Life:</b>                   | 6 months in sealed container   |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)   |
| <b>Operating Life:</b>                 | 2 years in air   |
| <b>Warranty:</b>                       | 1 year from date of shipment   |
| <b>Calibration Gas:</b>                | 0.8 ppm ClO <sub>2</sub> from gas generator or equivalent of 2 ppm Cl <sub>2</sub><br>Requires ClO <sub>2</sub> gas generator, Cl <sub>2</sub> surrogate gas, or quarterly factory calibration |
| <b>Calibration Flow Rate:</b>          | 1,000 cc/min for 2.5 min.  |
| <b>Part Number(s):</b>                 | 170-0017-000, 008-1120-000, C03-0956-000   |
| <b>Supported Instruments:</b>          | ToxiRAE II, ToxiRAE Pro, MultiRAE Family, VRAE   |

### Notes on ClO<sub>2</sub> Sensor Calibration and Operation:

ClO<sub>2</sub> sensors require a ClO<sub>2</sub> generator for calibration because this gas is too unstable to store in a cylinder. ClO<sub>2</sub> sensors may contain a built-in filter that removes Cl<sub>2</sub> and therefore using Cl<sub>2</sub> surrogate gas may not be possible when the filter is present. ClO<sub>2</sub> sensors without the filter may be calibrated using a Cl<sub>2</sub> surrogate gas. NO<sub>2</sub> is not a reliable surrogate whether filter is present or not. This sensor should not be exposed to H<sub>2</sub>S, which plugs the on-board filter, unless the filter is absent.

### Cross-Sensitivity Data, ClO<sub>2</sub> Sensor

| Gas              | Conc.      | Response             |
|------------------|------------|----------------------|
| Alcohols         | 1,000 ppm  | 0 ppm                |
| AsH <sub>3</sub> | 1 ppm      | 0.8 ppm              |
| Chloropicrin     | 100 ppm    | 0 ppm <sup>2</sup>   |
| Cl <sub>2</sub>  | 1 ppm      | 0 ppm <sup>1</sup>   |
| Cl <sub>2</sub>  | 1 ppm      | 0.6 ppm <sup>2</sup> |
| ClF <sub>3</sub> | 1 ppm      | 1 (theor.) ppm       |
| CO               | 1,000 ppm  | 0 ppm                |
| CO               | 50 ppm     | 0 ppm <sup>2</sup>   |
| CO <sub>2</sub>  | 5,000 ppm  | 0 ppm                |
| H <sub>2</sub>   | 10,000 ppm | 0 ppm                |
| H <sub>2</sub> S | 10 ppm     | 0 ppm <sup>1</sup>   |

| Gas               | Conc.   | Response                    |
|-------------------|---------|-----------------------------|
| H <sub>2</sub> S  | 20 ppm  | -5 ppm <sup>2,3</sup>       |
| HCl               | 5 ppm   | 0 ppm                       |
| H <sub>2</sub> Se | 0.1 ppm | 0 ppm                       |
| HCN               | 10 ppm  | 0 ppm                       |
| HF                | 3 ppm   | 0 ppm                       |
| Hydrocarbons      | % range | 0%                          |
| NH <sub>3</sub>   | 50 ppm  | 0 ppm <sup>2</sup>          |
| NO                | 25 ppm  | 0.9 ppm <sup>2</sup>        |
| NO <sub>2</sub>   | 5 ppm   | 1.5 to 2.3 ppm <sup>2</sup> |
| O <sub>3</sub>    | 0.1 ppm | 0.03 ppm                    |
| PH <sub>3</sub>   | 300 ppm | 0.3 ppm                     |
| SO <sub>2</sub>   | 5 ppm   | 0 ppm <sup>2</sup>          |

<sup>1</sup> - Short exposure of < few minutes of <100 ppm, with filters.

<sup>2</sup> - With onboard filters removed.

<sup>3</sup> - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air. ClO<sub>2</sub> sensors without the on-board filter have a negative cross-sensitivity to H<sub>2</sub>S and other reducing gases, and may underestimate the ClO<sub>2</sub> concentration if H<sub>2</sub>S is present.

## Ethylene Oxide (ETO-A)

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | Electrochemical                                     |
| <b>Range:</b>                          | 0-100 ppm   |
| <b>Resolution:</b>                     | 1 ppm   |
| <b>Response Time (t<sub>90</sub>):</b> | <120 sec.   |
| <b>Bias / Equilibration:</b>           | Bias on; 6 hours after installation                 |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                       |
| <b>Pressure Range:</b>                 | Atmospheric ± 10%                                   |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                               |
| <b>Drift:</b>                          | < 2% signal/month                                   |
| <b>Storage Life:</b>                   | 6 months in sealed container                        |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)                          |
| <b>Operating Life:</b>                 | 1 year in air                                       |
| <b>Warranty:</b>                       | 1 year from date of shipment                        |
| <b>Calibration Gas:</b>                | 20 ppm ETO, or equivalent of 50 ppm CO, balance air |
| <b>Calibration Flow Rate:</b>          | 450 cc/min  |
| <b>Part Number(s):</b>                 | 032-0110-100, 008-1121-100, C03-0954-000            |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro, VRAE                  |

### Correction Factors, ETO-A Sensor

| Gas             | Correction Factor |
|-----------------|-------------------|
| Ethylene oxide  | 1                 |
| Carbon monoxide | 2.5               |
| Ethanol         | 2                 |
| Methanol        | 0.5               |
| i-Propanol      | 5                 |
| i-Butylene      | 2.5               |
| Butadiene       | 0.9               |
| Ethylene        | 0.8               |
| Propene         | 1.7               |
| Vinyl chloride  | 1.3               |
| Vinyl acetate   | 2                 |
| Formic acid     | 3.3               |
| Ethyl ether     | 2.5               |
| Formaldehyde    | 1                 |

## Ethylene Oxide (ETO-B)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical                                    |
| <b>Range:</b>                          | 0-10 ppm   |
| <b>Resolution:</b>                     | 0.1 ppm  |
| <b>Response Time (t<sub>90</sub>):</b> | <120 sec.  |
| <b>Bias / Equilibration:</b>           | Bias on; 6 hours after installation                |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                      |
| <b>Pressure Range:</b>                 | Atmospheric ±10%                                   |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                              |
| <b>Drift:</b>                          | <2% signal/month                                   |
| <b>Storage Life:</b>                   | 6 months in sealed container                       |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)                         |
| <b>Operating Life:</b>                 | 1 year in air                                      |
| <b>Warranty:</b>                       | 1 year from date of shipment                       |
| <b>Calibration Gas:</b>                | 6 ppm ETO, or equivalent of 15 ppm CO, balance air |
| <b>Calibration Flow Rate:</b>          | 450 cc/min   |
| <b>Part Number(s):</b>                 | 032-0110-200, C03-0922-100                         |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro                       |

### Correction Factors, ETO-B Sensor

| Gas             | Correction Factor |
|-----------------|-------------------|
| Ethylene oxide  | 1                 |
| Carbon monoxide | 2.5               |
| Ethanol         | 0.8               |
| Methanol        | 0.3               |
| i-Propanol      | 1.3               |
| Formaldehyde    | 0.5               |
| i-Butylene      | 0.9               |
| Butadiene       | 0.3               |
| Ethylene        | 0.7               |
| Propene         | 0.8               |
| Vinyl chloride  | 1.3               |
| Vinyl acetate   | 0.5               |
| Formic acid     | 1.4               |
| Acrylonitrile   | 2.5               |

## Ethylene Oxide (ETO-C) - Extended Range

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical                                      |
| <b>Range:</b>                          | 0-500 ppm  |
| <b>Resolution:</b>                     | 10 ppm   |
| <b>Response Time (t<sub>90</sub>):</b> | <120 sec.  |
| <b>Bias / Equilibration:</b>           | Bias on; 6 hours after installation                  |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                        |
| <b>Pressure Range:</b>                 | Atmospheric ±10%                                     |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                                |
| <b>Drift:</b>                          | <2% signal/month                                     |
| <b>Storage Life:</b>                   | 6 months in sealed container                         |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)                           |
| <b>Operating Life:</b>                 | 1 year in air  |
| <b>Warranty:</b>                       | 1 year from date of shipment                         |
| <b>Calibration Gas:</b>                | 40 ppm ETO, or equivalent of 100 ppm CO, balance air |
| <b>Calibration Flow Rate:</b>          | 450 cc/min   |
| <b>Part Number(s):</b>                 | 032-0110-300, C03-0923-100                           |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro                         |

### Correction Factors, ETO-C Sensor

| Gas             | Correction Factor |
|-----------------|-------------------|
| Ethylene oxide  | 1                 |
| Carbon monoxide | 2.5               |
| Ethanol         | 2.5               |
| Methanol        | 0.5               |
| i-Propanol      | 5                 |
| i-Butylene      | 2.5               |
| Butadiene       | 0.9               |
| Ethylene        | 0.8               |
| Propene         | 1.7               |
| Vinyl chloride  | 1.4               |
| Vinyl acetate   | 2.5               |
| Formic acid     | 5                 |

## Formaldehyde (HCHO)

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | Electrochemical                                     |
| <b>Range:</b>                          | 0-10 ppm  |
| <b>Resolution:</b>                     | 0.01 ppm  |
| <b>Response Time (t<sub>90</sub>):</b> | <80 sec.  |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation                |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                       |
| <b>Pressure Range:</b>                 | Atmospheric ±10%                                    |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                               |
| <b>Storage Life:</b>                   | 6 months in sealed container                        |
| <b>Storage Temp:</b>                   | 37°F to 68°F (5°C to 20°C)                          |
| <b>Operating Life:</b>                 | 1 year in air                                       |
| <b>Warranty:</b>                       | 1 year from date of shipment                        |
| <b>Calibration Gas:</b>                | 9 ppm HCHO, or equivalent of 50 ppm CO, balance air |
| <b>Calibration Flow Rate:</b>          | 450 cc/min  |
| <b>Part Number(s):</b>                 | 170-0078-000, C03-0982-000                          |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro                        |

### Cross-Sensitivity Data, HCHO Sensor

| Gas            | Cross-Sensitivity (%) |
|----------------|-----------------------|
| CO             | 10% to 18%            |
| H <sub>2</sub> | 1% to 3%              |

<sup>1</sup> - Interference from other reducing gases, such as alcohols, should be expected.

## Hydrogen (H<sub>2</sub>)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical                        |
| <b>Range:</b>                          | 0-1,000 ppm                            |
| <b>Max Overload:</b>                   | 2,000 ppm                              |
| <b>Resolution:</b>                     | 2 ppm                                  |
| <b>Response Time (t<sub>90</sub>):</b> | <90 sec.                               |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation   |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)          |
| <b>Pressure Range:</b>                 | Atmospheric ±10%                       |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                  |
| <b>Drift:</b>                          | <2% signal/month                       |
| <b>Storage Life:</b>                   | 6 months in sealed container           |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)             |
| <b>Operating Life:</b>                 | 1 year in air                          |
| <b>Warranty:</b>                       | 1 year from date of shipment           |
| <b>Calibration Gas:</b>                | 200 ppm H <sub>2</sub> , balance air   |
| <b>Calibration Flow Rate:</b>          | 450 cc/min                             |
| <b>Part Number(s):</b>                 | 170-0076-000, C03-0981-000             |
| <b>Supported Instruments:</b>          | MultiRAE Lite (diffusion), ToxiRAE Pro |

### Cross-Sensitivity Data, H<sub>2</sub> Sensor

| Gas              | Concentration | Response |
|------------------|---------------|----------|
| Cl <sub>2</sub>  | 1 ppm         | 0 ppm    |
| CO               | 300 ppm       | <=60 ppm |
| Ethylene         | 100 ppm       | 80 ppm   |
| H <sub>2</sub> S | 15 ppm        | <3 ppm   |
| HCl              | 5 ppm         | 0 ppm    |
| HCN              | 10 ppm        | 3 ppm    |
| NO               | 35 ppm        | 10 ppm   |
| NO <sub>2</sub>  | 5 ppm         | 0 ppm    |
| SO <sub>2</sub>  | 5 ppm         | 0 ppm    |

## Hydrogen Cyanide (HCN)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical  |
| <b>Range:</b>                          | 0-50 ppm   |
| <b>Max Overload:</b>                   | 100 ppm  |
| <b>Resolution:</b>                     | 1 ppm  |
| <b>Response Time (t<sub>90</sub>):</b> | 200 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation   |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to +50°C)   |
| <b>Pressure Range:</b>                 | Atmospheric ±10%   |
| <b>Operating Humidity:</b>             | 15-90% non-condensing  |
| <b>Drift:</b>                          | <2% signal/month   |
| <b>Storage Life:</b>                   | 6 months in sealed container   |
| <b>Storage Temp.:</b>                  | 32°F to 68°F (0°C to 20°C)   |
| <b>Operating Life:</b>                 | 2 years in air   |
| <b>Warranty:</b>                       | 1 year from date of shipment   |
| <b>Calibration Gas:</b>                | 10 ppm HCN, balance N <sub>2</sub>   |
| <b>Calibration Flow Rate:</b>          | 1,000 cc/min   |
| <b>Part Number(s):</b>                 | 170-0012-000, 008-1117-000, C03-0949-000   |
| <b>Supported Instruments:</b>          | AreaRAE, MultiRAE Family, MultiRAE IR, MultiRAE+, QRAE+, ToxiRAE II, ToxiRAE Pro, VRAE |

### Cross-Sensitivity Data, HCN Sensor

| Gas              | Concentration | Response                    |
|------------------|---------------|-----------------------------|
| CO               | 300 ppm       | 15 ppm                      |
| Ethylene         | 100 ppm       | 25 ppm                      |
| H <sub>2</sub>   | 200 ppm       | 0 ppm                       |
| H <sub>2</sub> S | 15 ppm        | 90 ppm <sup>1</sup>         |
| NO               | 35 ppm        | -28 to ~0 ppm <sup>2</sup>  |
| NO <sub>2</sub>  | 5 ppm         | -20 to ~10 ppm <sup>2</sup> |
| SO <sub>2</sub>  | 20 ppm        | 40~75 ppm                   |

<sup>1</sup> - Due to a very high cross-sensitivity to H<sub>2</sub>S, this sensor is unsuitable for use in atmospheres that contain H<sub>2</sub>S.

<sup>2</sup> - **CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.**

## Hydrogen Sulfide (H<sub>2</sub>S)

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | Electrochemical   |
| <b>Range:</b>                          | 0-100 ppm   |
| <b>Max Overload:</b>                   | 500 ppm   |
| <b>Resolution:</b>                     | 0.1 ppm   |
| <b>Response Time (t<sub>90</sub>):</b> | 35 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation  |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)   |
| <b>Pressure Range:</b>                 | Atmospheric ±10%  |
| <b>Operating Humidity:</b>             | 15-90% non-condensing   |
| <b>Drift:</b>                          | < 2% signal/month   |
| <b>Storage Life:</b>                   | 6 months in sealed container  |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)  |
| <b>Operating Life:</b>                 | 2 years in air  |
| <b>Warranty:</b>                       | 2 years from date of shipment   |
| <b>Calibration Gas:</b>                | 10 ppm H <sub>2</sub> S, balance N <sub>2</sub>   |
| <b>Calibration Flow Rate:</b>          | 400 cc/min  |
| <b>Part Number(s):</b>                 | 032-0102-000, 008-1111-000, C03-0907-000  |
| <b>Supported Instruments:</b>          | AreaRAE, MeshGuard, MultiRAE-IR, MultiRAE+, MultiRAE Family, QRAE, QRAE+, RAEGuard, RAEGuard S, ToxiRAE II, ToxiRAE Pro, VRAE |

### Cross-Sensitivity Data, H<sub>2</sub>S Sensor

| Gas              | Concentration | Response                  |
|------------------|---------------|---------------------------|
| CO               | 300 ppm       | <=1.5 ppm                 |
| CS <sub>2</sub>  | 100 ppm       | 0 ppm                     |
| Ethyl sulfide    | 100 ppm       | 10 ppm <sup>2</sup>       |
| Ethylene         | 100 ppm       | <= 0.2 ppm                |
| H <sub>2</sub>   | 3,000 ppm     | 0 ppm                     |
| HCl              | 10 ppm        | 0 ppm                     |
| HCN              | 10 ppm        | 0 ppm                     |
| Isobutylene      | 100 ppm       | 0 ppm                     |
| Methyl mercaptan | 5 ppm         | about 2 ppm               |
| Methyl sulfide   | 100 ppm       | 9 ppm                     |
| NH <sub>3</sub>  | 50 ppm        | 0 ppm                     |
| NO               | 35 ppm        | <0.7 ppm                  |
| NO <sub>2</sub>  | 5 ppm         | about -1 ppm <sup>1</sup> |
| PH <sub>3</sub>  | 5 ppm         | about 4 ppm               |
| SO <sub>2</sub>  | 5 ppm         | about 1 ppm               |
| Toluene          | 10000 ppm     | 0 ppm <sup>2</sup>        |
| Turpentine       | 3000 ppm      | about 70 ppm <sup>2</sup> |

**Note:** High levels of polar organic compounds including alcohols, ketones, and amines give a negative response.

<sup>1</sup> - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

<sup>2</sup> - Estimated based on data from similar sensors.

## Hydrogen Sulfide (H<sub>2</sub>S) - Extended Range

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | Electrochemical                                 |
| <b>Range:</b>                          | 0-1,000 ppm                                     |
| <b>Resolution:</b>                     | 1 ppm   |
| <b>Response Time (t<sub>90</sub>):</b> | 45 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation            |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                   |
| <b>Pressure Range:</b>                 | Atmospheric ±10%                                |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                           |
| <b>Drift:</b>                          | < 2% signal/month                               |
| <b>Storage Life:</b>                   | 6 months in sealed container                    |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)                      |
| <b>Operating Life:</b>                 | 2 years in air                                  |
| <b>Warranty:</b>                       | 2 years from date of shipment                   |
| <b>Calibration Gas:</b>                | 25 ppm H <sub>2</sub> S, balance N <sub>2</sub> |
| <b>Calibration Flow Rate:</b>          | 400 cc/min                                      |
| <b>Part Number(s):</b>                 | 032-0102-100, 008-1111-200, C03-0904-000        |
| <b>Supported Instruments:</b>          | AreaRAE, MultiRAE Family, QRAE+, ToxiRAE Pro    |

### Cross-Sensitivity Data, H<sub>2</sub>S Extended-Range Sensor

| Gas             | Concentration | Response |
|-----------------|---------------|----------|
| CO              | 300 ppm       | 0 ppm    |
| Ethylene        | 100 ppm       | 0 ppm    |
| H <sub>2</sub>  | 1,000 ppm     | 0 ppm    |
| NO              | 35 ppm        | <3 ppm   |
| NO <sub>2</sub> | 5 ppm         | 0 ppm    |
| SO <sub>2</sub> | 5 ppm         | 0 ppm    |

## Methyl Mercaptan (CH<sub>3</sub>SH)

|  |                                       |
|--|---------------------------------------|
| <b>Sensor Type:</b>                    | Electrochemical                       |
| <b>Range:</b>                          | 0-10 ppm                              |
| <b>Max Overload:</b>                   | 20 ppm                                |
| <b>Resolution:</b>                     | 0.1 ppm                               |
| <b>Response Time (t<sub>90</sub>):</b> | <35 sec.                              |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation  |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)         |
| <b>Pressure Range:</b>                 | Atmospheric ± 10%                     |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                 |
| <b>Drift:</b>                          | <2% signal/month                      |
| <b>Storage Life:</b>                   | 6 months in sealed container          |
| <b>Storage Temperature:</b>            | 37°F to 68°F (5°C to 20°C)            |
| <b>Operating Life:</b>                 | 1 year in air                         |
| <b>Warranty:</b>                       | 1 year from date of shipment          |
| <b>Calibration Gas:</b>                | 5 ppm CH <sub>3</sub> SH, balance air |
| <b>Calibration Flow Rate:</b>          | 450 cc/min                            |
| <b>Part Number(s):</b>                 | 032-0120-000, C03-0980-000            |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro          |

### Cross-Sensitivity Data, CH<sub>3</sub>SH Sensor

| Gas              | Concentration | Response             |
|------------------|---------------|----------------------|
| CO               | 100 ppm       | <0.2 ppm             |
| H <sub>2</sub>   | 20,000 ppm    | <1 ppm               |
| H <sub>2</sub> S | 15 ppm        | 33 ppm               |
| NO               | 35 ppm        | <0.5 ppm             |
| NO <sub>2</sub>  | 5 ppm         | <-3 ppm <sup>1</sup> |
| SO <sub>2</sub>  | 5 ppm         | <2.5 ppm             |

<sup>1</sup> - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

## Nitric Oxide (NO)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical  |
| <b>Range:</b>                          | 0-250 ppm  |
| <b>Max Overload:</b>                   | 1,000 ppm  |
| <b>Resolution:</b>                     | 0.5 ppm  |
| <b>Response Time (t<sub>90</sub>):</b> | 45 sec.  |
| <b>Bias / Equilibration:</b>           | Bias on; 6 hours after installation  |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)  |
| <b>Pressure Range:</b>                 | Atmospheric ±10%   |
| <b>Operating Humidity:</b>             | 15-90% non-condensing  |
| <b>Drift:</b>                          | < 2% signal/month  |
| <b>Storage Life:</b>                   | 6 months in sealed container   |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)   |
| <b>Operating Life:</b>                 | 2 years in air   |
| <b>Warranty:</b>                       | 1 year from date of shipment   |
| <b>Calibration Gas:</b>                | 25 ppm NO, balance N <sub>2</sub>  |
| <b>Calibration Flow Rate:</b>          | 250 cc/min   |
| <b>Part Number(s):</b>                 | 032-0111-000, 008-1114-000, C03-0974-000   |
| <b>Supported Instruments:</b>          | AreaRAE, MultiRAE Family, MultiRAE IR, MultiRAE+, QRAE+, ToxiRAE II, ToxiRAE Pro, VRAE |

### Cross-Sensitivity Data, NO Sensor

| Gas              | Concentration | Response              |
|------------------|---------------|-----------------------|
| ClO <sub>2</sub> | 1 ppm         | -0.2 ppm <sup>1</sup> |
| CO               | 300 ppm       | 0 ppm                 |
| H <sub>2</sub> S | 15 ppm        | -1.5 ppm <sup>1</sup> |
| HCl              | 10 ppm        | about 0.5 ppm         |
| NH <sub>3</sub>  | 50 ppm        | 0 ppm                 |
| NO <sub>2</sub>  | 5 ppm         | about 1.5 ppm         |
| SO <sub>2</sub>  | 5 ppm         | 0 ppm                 |

<sup>1</sup> - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

## Nitrogen Dioxide (NO<sub>2</sub>)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical                          |
| <b>Range:</b>                          | 0-20 ppm                                 |
| <b>Max Overload:</b>                   | 150 ppm                                  |
| <b>Resolution:</b>                     | 0.1 ppm                                  |
| <b>Response Time (t<sub>90</sub>):</b> | 45 sec.                                  |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation     |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)            |
| <b>Pressure Range:</b>                 | Atmospheric ±10%                         |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                    |
| <b>Drift:</b>                          | <2% signal/month                         |
| <b>Storage Life:</b>                   | 6 months in sealed container             |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)               |
| <b>Operating Life:</b>                 | 2 years in air                           |
| <b>Warranty:</b>                       | 1 year from date of shipment             |
| <b>Calibration Gas:</b>                | 5 ppm NO <sub>2</sub> , balance air      |
| <b>Calibration Flow Rate:</b>          | 400 cc/min                               |
| <b>Part Number(s):</b>                 | 032-0112-000, 008-1115-000, C03-0975-000 |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro             |

### Cross-Sensitivity Data, NO<sub>2</sub> Sensor

| Gas              | Concentration | Response              |
|------------------|---------------|-----------------------|
| Cl <sub>2</sub>  | 1 ppm         | -1 ppm <sup>1</sup>   |
| CO               | 300 ppm       | 0 ppm                 |
| H <sub>2</sub> S | 15 ppm        | -1.2 ppm <sup>1</sup> |
| NO               | 35 ppm        | 0 ppm                 |
| SO <sub>2</sub>  | 5 ppm         | -5 ppm <sup>1</sup>   |

<sup>1</sup> - CAUTION! Negative cross-sensitivities may cause the sensor to produce lower readings than the true concentration of gas in ambient air.

## Phosphine (PH<sub>3</sub>) - 1

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | Electrochemical  |
| <b>Range:</b>                          | 0-5 ppm  |
| <b>Max Overload:</b>                   | 20 ppm   |
| <b>Resolution:</b>                     | 0.1 ppm  |
| <b>Response Time (t<sub>90</sub>):</b> | <60 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation                     |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                            |
| <b>Pressure Range:</b>                 | Atmospheric ±10%   |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                                    |
| <b>Drift:</b>                          | <10% signal/month  |
| <b>Storage Life:</b>                   | 6 months in sealed container                             |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)                               |
| <b>Operating Life:</b>                 | 1 year in air  |
| <b>Warranty:</b>                       | 1 year from date of shipment                             |
| <b>Calibration Gas:</b>                | 5 ppm PH <sub>3</sub> , balance N <sub>2</sub>           |
| <b>Calibration Flow Rate:</b>          | 1,000 cc/min   |
| <b>Part Number(s):</b>                 | 032-0108-000, 008-1119-000                               |
| <b>Supported Instruments:</b>          | AreaRAE, MultiRAE IR, MultiRAE+, QRAE+, ToxiRAE II, VRAE |

### Cross-Sensitivity Data, PH<sub>3</sub> - 1 Sensor

| Gas                             | Concentration          | Response               |
|---------------------------------|------------------------|------------------------|
| Arsine                          | 150 ppb                | 0 ppb                  |
| Arsine                          | 2,000 ppb              | 1,200 ppb <sup>1</sup> |
| Benzene                         | 100 ppm                | 0 ppm                  |
| Chloroform                      | Headspace <sup>2</sup> | 0 ppm                  |
| CF <sub>2</sub> Cl <sub>2</sub> | 100 ppm                | 0 ppm                  |
| CO                              | 1,000 ppm              | 0 ppm                  |
| CO <sub>2</sub>                 | 50,000 ppm             | 0 ppm                  |
| Diborane                        | 300 ppb                | 105 ppb                |
| Ethylene                        | 100 ppm                | 0 ppm                  |
| Ethylene oxide                  | 10 ppm                 | 0 ppm                  |
| Germane                         | 600 ppb                | 510 ppb                |
| H <sub>2</sub>                  | 1,000 ppm              | 0 ppm                  |

| Gas               | Concentration          | Response |
|-------------------|------------------------|----------|
| H <sub>2</sub> S  | 15 ppm                 | 12 ppm   |
| HCl               | 10 ppm                 | 0.2 ppm  |
| HCN               | 10 ppm                 | 0.6 ppm  |
| Hexane, n-        | 1,500 ppm              | 0 ppm    |
| Isobutylene       | 250 ppm                | 0 ppm    |
| Methane           | 50,000 ppm             | 0 ppm    |
| NH <sub>3</sub>   | 100 ppm                | 0 ppm    |
| NO                | 100 ppm                | 0 ppm    |
| Silane            | 1,000 ppb              | 900 ppb  |
| SO <sub>2</sub>   | 5 ppm                  | 1 ppm    |
| Toluene           | 100 ppm                | 0 ppm    |
| Trichloroethylene | Headspace <sup>2</sup> | <0.3 ppm |

<sup>1</sup> - Response after 9 minutes of exposure. CF = 1.7 on average, tested in the range from 500 to 3,000 ppb AsH<sub>3</sub>.

<sup>2</sup> - Concentration in the headspace of the bottle with pure liquid chemical

## Phosphine (PH<sub>3</sub>) - 2

|  |                                      |
|--|--------------------------------------|
| <b>Sensor Type:</b>                    | Electrochemical                      |
| <b>Range:</b>                          | 0-20 ppm                             |
| <b>Resolution:</b>                     | 0.1 ppm                              |
| <b>Response Time (t<sub>90</sub>):</b> | <60 sec.                             |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)        |
| <b>Pressure Range:</b>                 | Atmospheric ± 10%                    |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                |
| <b>Drift:</b>                          | <2% signal/month                     |
| <b>Storage Life:</b>                   | 6 months in sealed container         |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)           |
| <b>Operating Life:</b>                 | 1 year in air                        |
| <b>Warranty:</b>                       | 1 year from date of shipment         |
| <b>Calibration Gas:</b>                | 5 ppm PH <sub>3</sub> , balance air  |
| <b>Calibration Flow Rate:</b>          | 450 cc/min, for 4 min.               |
| <b>Part Number(s):</b>                 | 032-0108-000, C03-0976-000           |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro         |

### Cross-Sensitivity Data, PH<sub>3</sub> - 2 Sensor

| Gas              | Concentration | Response |
|------------------|---------------|----------|
| CO               | 1,000 ppm     | 0 ppm    |
| Ethylene         | 100 ppm       | 0 ppm    |
| H <sub>2</sub>   | 1,000 ppm     | 0 ppm    |
| H <sub>2</sub> S | 15 ppm        | 12 ppm   |
| NH <sub>3</sub>  | 50 ppm        | 0 ppm    |
| SO <sub>2</sub>  | 5 ppm         | 0.9 ppm  |

## Phosphine (PH<sub>3</sub>) - Extended Range

|  |                                       |
|--|---------------------------------------|
| <b>Sensor Type:</b>                    | Electrochemical                       |
| <b>Range:</b>                          | 0-1,000 ppm                           |
| <b>Resolution:</b>                     | 1 ppm                                 |
| <b>Response Time (t<sub>90</sub>):</b> | <60 sec.                              |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation  |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)         |
| <b>Pressure Range:</b>                 | Atmospheric ± 10%                     |
| <b>Operating Humidity:</b>             | 15-90% non-condensing                 |
| <b>Drift:</b>                          | <2% signal/month                      |
| <b>Storage Life:</b>                   | 6 months in sealed container          |
| <b>Storage Temperature:</b>            | 32°F to 68°F (0°C to 20°C)            |
| <b>Operating Life:</b>                 | 1 year in air                         |
| <b>Warranty:</b>                       | 1 year from date of shipment          |
| <b>Calibration Gas:</b>                | 100 ppm PH <sub>3</sub> , balance air |
| <b>Calibration Flow Rate:</b>          | 450 cc/min                            |
| <b>Part Number(s):</b>                 | 032-0107-000, C03-0927-100            |
| <b>Supported Instruments:</b>          | MultiRAE Family, ToxiRAE Pro          |

### Cross-Sensitivity Data, PH<sub>3</sub> Extended-Range Sensor

| Gas              | Concentration | Response |
|------------------|---------------|----------|
| CO               | 1,000 ppm     | 0 ppm    |
| Ethylene         | 100 ppm       | 0 ppm    |
| H <sub>2</sub>   | 1,000 ppm     | 0 ppm    |
| H <sub>2</sub> S | 15 ppm        | 4 ppm    |
| NH <sub>3</sub>  | 50 ppm        | 0 ppm    |
| SO <sub>2</sub>  | 5 ppm         | 5 ppm    |

## NDIR Sensors for Carbon Dioxide

### Carbon Dioxide (CO<sub>2</sub>) - 1

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | NDIR (Non-dispersive infrared)                     |
| <b>Range:</b>                          | 0-50,000 ppm (0-5% Vol. CO <sub>2</sub> )          |
| <b>Resolution:</b>                     | 100 ppm  |
| <b>Response Time (t<sub>90</sub>):</b> | 60 sec.  |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation               |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                      |
| <b>Pressure Range:</b>                 | Atmospheric ±20%                                   |
| <b>Operating Humidity:</b>             | 5-95% non-condensing                               |
| <b>Drift:</b>                          | <5% signal/month                                   |
| <b>Storage Life:</b>                   | 2 years in sealed container                        |
| <b>Storage Temperature:</b>            | -40°F to 122°F (-40°C to 50°C)                     |
| <b>Operating Life:</b>                 | 2 years in air                                     |
| <b>Warranty:</b>                       | 2 years from date of shipment                      |
| <b>Calibration Gas:</b>                | 5,000 ppm CO <sub>2</sub> , balance N <sub>2</sub> |
| <b>Zero Gas:</b>                       | N <sub>2</sub>                                     |
| <b>Calibration Flow Rate:</b>          | 500 cc/min for 2 min.                              |
| <b>Part Number(s):</b>                 | 051-0011-000                                       |
| <b>Supported Instruments:</b>          | MultiRAE IR  |

## Carbon Dioxide (CO<sub>2</sub>) - 2

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | NDIR (Non-dispersive infrared)                                 |
| <b>Range:</b>                          | 0-50,000 ppm (0-5.0% Vol. CO <sub>2</sub> )                    |
| <b>Resolution:</b>                     | 250 ppm when below 25,000 ppm<br>500 ppm when above 25,000 ppm |
| <b>Response Time (t<sub>90</sub>):</b> | 30 sec.  |
| <b>Equilibration:</b>                  | 1 min. after installation                                      |
| <b>Temperature Range:</b>              | -4°F to 122°F (-20°C to 50°C)                                  |
| <b>Pressure Range:</b>                 | Atmospheric ±20%   |
| <b>Operating Humidity:</b>             | 0-95% non-condensing   |
| <b>Drift:</b>                          | <5% signal/month   |
| <b>Storage Life:</b>                   | 2 years in sealed container                                    |
| <b>Storage Temperature:</b>            | -40°F to 122°F (-40°C to 50°C)                                 |
| <b>Operating Life:</b>                 | 2 years in air   |
| <b>Warranty:</b>                       | 1 year from date of shipment                                   |
| <b>Calibration Gas:</b>                | 5,000 ppm CO <sub>2</sub> , balance N <sub>2</sub>             |
| <b>Zero Gas:</b>                       | N <sub>2</sub>   |
| <b>Calibration Flow Rate:</b>          | 500 cc/min for 1 min.  |
| <b>Part Number(s):</b>                 | C03-0961-000   |
| <b>Supported Instruments:</b>          | MultiRAE Family  |

## PID Sensors for Volatile Organic Compounds (VOCs)

### PID, Parts-Per-Billion (10.6eV)

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | PID   |
| <b>Gases Detected:</b>                 | VOCs (see Technical Note TN-106)                            |
| <b>Range:</b>                          | 0-2,000 ppm (Isobutylene equivalent)                        |
| <b>Resolution:</b>                     | 0.01 ppm (Isobutylene)                                      |
| <b>Response Time (t<sub>90</sub>):</b> | 15 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation                        |
| <b>Zero Drift:</b>                     | <10% signal/day   |
| <b>Span Drift:</b>                     | <10% signal/day   |
| <b>Storage Life:</b>                   | 3 months in sealed container                                |
| <b>Operating Life:</b>                 | 1 year in air   |
| <b>Warranty:</b>                       | 1 year from date of shipment                                |
| <b>Calibration Gas:</b>                | 10 ppm and 100 ppm Isobutylene for recommended 3-point cal. |
| <b>Part Number(s):</b>                 | C03-0912-001  |
| <b>Supported Instruments:</b>          | MultiRAE Pro  |

### PID (10.6eV) - MultiRAE Extended Range

|  |   |
|--|---|
| <b>Sensor Type:</b>                    | PID   |
| <b>Gases Detected:</b>                 | VOCs (see Technical Note TN-106)                              |
| <b>Range:</b>                          | 0-5,000 ppm (Isobutylene equivalent)                          |
| <b>Resolution:</b>                     | 0.1 ppm (Isobutylene)   |
| <b>Response Time (t<sub>90</sub>):</b> | 15 sec.   |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation                          |
| <b>Zero Drift:</b>                     | <10% signal/day   |
| <b>Span Drift:</b>                     | <10% signal/day   |
| <b>Storage Life:</b>                   | 3 months in sealed container                                  |
| <b>Operating Life:</b>                 | 1 year in air   |
| <b>Warranty:</b>                       | 1 year from date of shipment                                  |
| <b>Calibration Gas:</b>                | 100 ppm and 1000 ppm Isobutylene for recommended 3-point cal. |
| <b>Part Number(s):</b>                 | C03-0912-002  |
| <b>Supported Instruments:</b>          | MultiRAE, MultiRAE Pro  |

## PID (10.6eV)

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | PID  |
| <b>Gases Detected:</b>                 | VOCs (see Technical Note TN-106)                           |
| <b>Range:</b>                          | 0-1,000 ppm (Isobutylene equivalent)                       |
| <b>Resolution:</b>                     | 1 ppm (Isobutylene)  |
| <b>Response Time (t<sub>90</sub>):</b> | 15 sec.  |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation                       |
| <b>Zero Drift:</b>                     | <10% signal/day  |
| <b>Span Drift:</b>                     | <10% signal/day  |
| <b>Storage Life:</b>                   | 3 months in sealed container                               |
| <b>Operating Life:</b>                 | 1 year in air  |
| <b>Warranty:</b>                       | 1 year from date of shipment                               |
| <b>Calibration Gas:</b>                | 100 ppm Isobutylene  |
| <b>Part Number(s):</b>                 | C03-0912-003   |
| <b>Supported Instruments:</b>          | MultiRAE Lite Pumped, ToxiRAE Pro PID Safety Configuration |

## PID (10.6eV) - ToxiRAE Pro Extended Range

|  |  |
|--|--|
| <b>Sensor Type:</b>                    | PID  |
| <b>Gases Detected:</b>                 | VOCs (see Technical Note TN-106)                 |
| <b>Range:</b>                          | 0-2,000 ppm (Isobutylene equivalent)             |
| <b>Resolution:</b>                     | 0.1 ppm (Isobutylene)                            |
| <b>Response Time (t<sub>90</sub>):</b> | 15 sec.  |
| <b>Bias / Equilibration:</b>           | No bias / 10 min. after installation             |
| <b>Zero Drift:</b>                     | <10% signal/day                                  |
| <b>Span Drift:</b>                     | <10% signal/day                                  |
| <b>Storage Life:</b>                   | 3 months in sealed container                     |
| <b>Operating Life:</b>                 | 1 year in air                                    |
| <b>Warranty:</b>                       | 1 year from date of shipment                     |
| <b>Calibration Gas:</b>                | 100 ppm Isobutylene                              |
| <b>Part Number(s):</b>                 | C03-0912-000                                     |
| <b>Supported Instruments:</b>          | ToxiRAE Pro PID Industrial Hygiene Configuration |

## Sensor Cross-Sensitivities

Electrochemical sensors, like many other sensors, are known to have cross-sensitivity to gases other than its target gas. Depending on the nature of the reaction in the sensor, the gas can either decrease the signal (negative cross-sensitivity) or increase the signal (positive cross-sensitivity). The cross sensitivity data listed here are based on at most a few batches of electrochemical sensors. The actual values may vary between batches because the cross sensitivity is not typically controlled during the manufacturing process.

**When calibrating a multi-gas instrument that has two sensors which gases have significant cross-sensitivity, be sure to allow adequate time between calibrations to allow the sensors to clear.**

When calibrating sensors with cross-sensitivities, calibrate the most cross-sensitive first, followed by the least cross-sensitive. Wait for both sensors to recover to zero, then expose both to gas again with most cross sensitive first and least cross sensitive second. For example, 50 ppm of NH<sub>3</sub> produces 0 ppm response on a Cl<sub>2</sub> sensor and 1 ppm of Cl<sub>2</sub> produces about -0.5 ppm of response on a NH<sub>3</sub> sensor. So calibrate the NH<sub>3</sub> sensor first with 50 ppm of NH<sub>3</sub>. This should have no affect on the Cl<sub>2</sub> sensor. Then calibrate the Cl<sub>2</sub> sensor on 10 ppm Cl<sub>2</sub>. This will send the NH<sub>3</sub> sensor negative for some period of time. After calibrating the Cl<sub>2</sub> sensor, return the meter to clean air and wait until the most cross-sensitive sensor (NH<sub>3</sub>) fully recovers and/or stabilizes (if it stabilizes to a number other than zero then re-zero the meter). After both sensors return to zero apply calibration gas in the same order (NH<sub>3</sub> first then Cl<sub>2</sub>) and note the sensor response. If both sensors are within 10% of the value on the gas cylinder then the calibration of the cross-sensitive sensors was successful.

### Use extreme caution with mixtures of gases!

The following **table and data** are based on % cross-sensitivity to a single gas. Mixtures of the gases were not tested and results with mixed gases are unpredictable. The tables below show cross-sensitivities of various sensors to different gases.

| Item                       | Cross-Sensitivity Codes for Select Sensors Used in RAE Systems Monitors |   |
|----------------------------|---|---|
| Positive cross-sensitivity | •   | Slight positive cross-sensitivity ( $\leq 10\%$ reading of the specified gas)   |
|                            | ••  | Moderate positive cross-sensitivity (10-50% reading of the specified gas)       |
|                            | •••   | High positive cross-sensitivity (>50% reading of the specified gas)             |
| Negative cross-sensitivity | *   | Slight negative cross-sensitivity (-10% to 0 reading of the specified gas)      |
|                            | **  | Moderate negative cross-sensitivity (-10% to -50% reading of the specified gas) |
|                            | ***   | High negative cross-sensitivity (<-50% reading of the specified gas)            |
| No data                    | Blank   |   |

From the safety standpoint, a negative cross-sensitivity may present a higher risk than a positive one, as it will diminish the response to the target gas and so prevent an alarm.

| Cross-Sensitivity<br>Sensor     | Gas |                  |                 |     |                 |     |                 |                 |
|---------------------------------|-----|------------------|-----------------|-----|-----------------|-----|-----------------|-----------------|
|                                 | CO  | H <sub>2</sub> S | SO <sub>2</sub> | NO  | NO <sub>2</sub> | HCN | NH <sub>3</sub> | PH <sub>3</sub> |
| CO                              |     | •                | •               | •   | •               |     |                 |                 |
| CO-Extended Range               |     | •                | •               | **  | •               |     |                 |                 |
| CO-H <sub>2</sub> Compensated   |     |                  | •               | •   | •               |     | •               |                 |
| H <sub>2</sub> S                | •   |                  | ••              | •   | **              |     |                 |                 |
| H <sub>2</sub> S-Extended Range | •   |                  | •               | •   | •               |     |                 |                 |
| SO <sub>2</sub>                 | •   | •                |                 | •   | ***             |     |                 |                 |
| NO                              | •   | *                | •               |     | ••              |     |                 |                 |
| NO <sub>2</sub>                 | •   | *                | ***             | •   |                 |     |                 |                 |
| HCN                             | •   | •••              | •••             | *** | ***             |     |                 |                 |
| NH <sub>3</sub>                 | •   | •                |                 |     |                 |     |                 |                 |
| PH <sub>3</sub>                 | •   | •••              | ••              |     |                 |     | •               |                 |
| PH <sub>3</sub> -LR             | •   | •••              | ••              |     |                 |     | •               |                 |
| PH <sub>3</sub> -Extended Range | •   | ••               | •••             |     |                 |     | •               |                 |
| ETO-A                           | ••  |                  |                 |     |                 |     |                 |                 |
| ETO-B                           | ••  |                  |                 |     |                 |     |                 |                 |
| ETO-C                           | ••  |                  |                 |     |                 |     |                 |                 |
| Cl <sub>2</sub>                 | •   | **               | •               | •   | •••             |     | •               |                 |
| ClO <sub>2</sub>                | •   | **               |                 |     |                 |     |                 |                 |
| H <sub>2</sub>                  | ••  | ••               | •               | ••  | •               | ••  |                 |                 |
| CH <sub>3</sub> SH              | •   | •••              | ••              | •   | **              |     |                 |                 |
| HCHO                            | ••  |                  |                 |     |                 |     |                 |                 |

CAUTION! Negative cross-sensitivities may cause sensors to produce lower readings than the true concentration of gas in the air.

| Cross-Sensitivity<br>Sensor     | Gas |     |                 |                  |                |                    |      |
|---------------------------------|-----|-----|-----------------|------------------|----------------|--------------------|------|
|                                 | HCl | ETO | Cl <sub>2</sub> | ClO <sub>2</sub> | H <sub>2</sub> | CH <sub>3</sub> SH | HCHO |
| CO                              |     |     | ••              |                  | ••             |                    |      |
| CO-Extended Range               |     |     | ••              |                  | •••            |                    |      |
| CO-H <sub>2</sub> Compensated   |     |     | •               | •                | •              |                    |      |
| H <sub>2</sub> S                |     |     |                 |                  | •              |                    |      |
| H <sub>2</sub> S-Extended Range |     |     |                 |                  | •              |                    |      |
| SO <sub>2</sub>                 |     |     |                 |                  |                |                    |      |
| NO                              |     |     |                 |                  |                |                    |      |
| NO <sub>2</sub>                 |     |     | ***             |                  |                |                    |      |
| HCN                             |     |     |                 |                  |                |                    |      |
| NH <sub>3</sub>                 |     |     |                 |                  | •              |                    |      |
| PH <sub>3</sub>                 |     |     |                 |                  | •              |                    |      |
| PH <sub>3</sub> -LR             |     |     |                 |                  | •              |                    |      |
| PH <sub>3</sub> -Extended Range |     |     |                 |                  | •              |                    |      |
| ETO-A                           |     |     |                 |                  |                |                    |      |
| ETO-B                           |     |     |                 |                  |                |                    |      |
| ETO-C                           |     |     |                 |                  |                |                    |      |
| Cl <sub>2</sub>                 |     |     |                 | •••              | •              |                    |      |
| ClO <sub>2</sub>                |     |     | •••             |                  | •              |                    |      |
| H <sub>2</sub>                  | •   |     | •               |                  |                |                    |      |
| CH <sub>3</sub> SH              |     |     |                 |                  | •              |                    |      |
| HCHO                            |     |     |                 |                  |                |                    |      |

CAUTION! Negative cross-sensitivities may cause sensors to produce lower readings than the true concentration of gas in the air.

| Cross-Sensitivity, %            | Gas    |      |                  |                 |       |                 |      |                 |                 |
|---------------------------------|--------|------|------------------|-----------------|-------|-----------------|------|-----------------|-----------------|
|                                 | Sensor | CO   | H <sub>2</sub> S | SO <sub>2</sub> | NO    | NO <sub>2</sub> | HCN  | NH <sub>3</sub> | PH <sub>3</sub> |
| CO                              | 100%   | 0%   | 0%               | 0%              | 0%    | 0%              |      |                 |                 |
| CO-Extended Range               | 100%   | 0%   | 0%               |                 | -29%  | 0%              |      |                 |                 |
| CO-H <sub>2</sub> Compensated   | 100%   |      |                  | 3%              | 6%    | 5%              |      | 1%              |                 |
| H <sub>2</sub> S                | 1%     | 100% | 20%              | 2%              | -20%  |                 |      |                 |                 |
| H <sub>2</sub> S-Extended Range | 0%     | 100% | 0%               | 9%              | 0%    |                 |      |                 |                 |
| SO <sub>2</sub>                 | 1%     | 0%   | 100%             | 0%              | -100% |                 |      |                 |                 |
| NO                              | 0%     | -10% | 0%               | 100%            | 30%   |                 |      |                 |                 |
| NO <sub>2</sub>                 | 0%     | -8%  | -100%            | 0%              | 100%  |                 |      |                 |                 |
| HCN                             | 5%     | 600% | 375%             | -80%            | -400% | 100%            |      |                 |                 |
| NH <sub>3</sub>                 | 0%     | 10%  |                  |                 |       |                 | 100% |                 |                 |
| PH <sub>3</sub> (032-0108-000)  | 0%     | 80%  | 20%              |                 |       |                 | 0%   | 100%            |                 |
| PH <sub>3</sub>                 | 0%     | 80%  | 20%              |                 |       |                 | 0%   | 100%            |                 |
| PH <sub>3</sub> -Extended Range | 0%     | 27%  | 100%             |                 |       |                 | 0%   | 100%            |                 |
| ETO-A                           | 40%    |      |                  |                 |       |                 |      |                 |                 |
| ETO-B                           | 40%    |      |                  |                 |       |                 |      |                 |                 |
| ETO-C                           | 40%    |      |                  |                 |       |                 |      |                 |                 |
| Cl <sub>2</sub>                 | 0%     | -30% | 0%               | 0%              | 120%  |                 | 0%   |                 |                 |
| ClO <sub>2</sub>                | 0%     | -25% |                  |                 |       |                 |      |                 |                 |
| H <sub>2</sub>                  | 20%    | 20%  | 0%               | 29%             | 0%    | 30%             |      |                 |                 |
| CH <sub>3</sub> SH              | 0%     | 220% | 50%              | 1%              | -60%  |                 |      |                 |                 |
| HCHO                            | 70%    |      |                  |                 |       |                 |      |                 |                 |

**CAUTION!** Negative cross-sensitivities may cause sensors to produce lower readings than the true concentration of gas in the air.

| Cross-Sensitivity, %            | Gas    |     |      |                 |                  |                |                    |      |
|---------------------------------|--------|-----|------|-----------------|------------------|----------------|--------------------|------|
|                                 | Sensor | HCl | ETO  | Cl <sub>2</sub> | ClO <sub>2</sub> | H <sub>2</sub> | CH <sub>3</sub> SH | HCHO |
| CO                              |        |     |      | 10%             |                  | 40%            |                    |      |
| CO-Extended Range               |        |     |      | 10%             |                  | 50%            |                    |      |
| CO-H <sub>2</sub> Compensated   |        |     |      | 5%              |                  | 1%             |                    |      |
| H <sub>2</sub> S                |        |     |      |                 |                  | 0%             |                    |      |
| H <sub>2</sub> S-Extended Range |        |     |      |                 |                  | 0%             |                    |      |
| SO <sub>2</sub>                 |        |     |      |                 |                  |                |                    |      |
| NO                              |        |     |      |                 |                  |                |                    |      |
| NO <sub>2</sub>                 |        |     |      | -100%           |                  |                |                    |      |
| HCN                             |        |     |      |                 |                  |                |                    |      |
| NH <sub>3</sub>                 |        |     |      |                 |                  | 0%             |                    |      |
| PH <sub>3</sub> (032-0108-000)  |        |     |      |                 |                  | 0%             |                    |      |
| PH <sub>3</sub>                 |        |     |      |                 |                  | 0%             |                    |      |
| PH <sub>3</sub> -Extended Range |        |     |      |                 |                  | 0%             |                    |      |
| ETO-A                           |        |     | 100% |                 |                  |                |                    |      |
| ETO-B                           |        |     | 100% |                 |                  |                |                    |      |
| ETO-C                           |        |     | 100% |                 |                  |                |                    |      |
| Cl <sub>2</sub>                 |        |     |      | 100%            | 350%             | 0%             |                    |      |
| ClO <sub>2</sub>                |        |     |      | 60%             | 100%             | 0%             |                    |      |
| H <sub>2</sub>                  | 0%     |     | 0%   |                 |                  | 100%           |                    |      |
| CH <sub>3</sub> SH              |        |     |      |                 |                  | 0%             | 100%               |      |
| HCHO                            |        |     |      |                 |                  |                |                    | 100% |

**CAUTION!** Negative cross-sensitivities may cause sensors to produce lower readings than the true concentration of gas in the air.

## Extended Calibration and Warm-Up Times

Some RAE Systems instruments incorporating electrochemical or NDIR sensors have a fixed calibration time (typically 60 sec.) This time accommodates most sensors, but a few have longer response times. In these cases, it is necessary to apply the calibration gas before starting the 60-second automatic calibration step. The table below summarizes the recommended pre-exposure times. If the instrument's fixed calibration time is not 60 seconds, then the calibration time is just the total calibration time.

| Sensor           | Response Time ( $t_{90}$ , sec.) | Total Calibration Time (sec.) | Pre-Exposure Time (sec.) |
|------------------|----------------------------------|-------------------------------|--------------------------|
| Cl <sub>2</sub>  | 30                               | 120                           | 90                       |
| ClO <sub>2</sub> | 120                              | 150                           | 90                       |
| CO <sub>2</sub>  | 60                               | 120                           | 45 (std. cal.)           |
| HCN              | 200                              | 230                           | 170                      |
| NH <sub>3</sub>  | 60                               | 180                           | 120                      |
| PH <sub>3</sub>  | 60                               | 120                           | 60                       |
| SO <sub>2</sub>  | 75                               | 120                           | 60                       |

**Note:** MultiRAE and ToxiRAE Pro family instruments do not require manual pre-exposure for any of their sensors. Sensor calibration times are stored in the on-board memory of the intelligent sensors used in the MultiRAE and ToxiRAE Pro instruments and already include the extra time needed to calibrate sensors with longer response times.

Some RAE Systems instruments do not recognize the presence of calibration gas when a flow is started before the "Apply Gas Now..." prompt, giving a warning, "No gas..." In this case, simply push the [Y/+ ] key to initiate the calibration.

### **Extra Warm-Up Time for Select MultiRAE Family and ToxiRAE Pro Sensors**

MultiRAE and ToxiRAE Pro electrochemical sensors with part numbers: C03-XXXX-XXX with no bias require up to 6 hours of warm-up time after installation.

**Note:** The SensorRAE 4R+ sensor warming station can keep these sensors ready for immediate use after installation and calibration.