

## 4.4 Calibration of MultiRAE PLUS Monitor

### **CALIBRATION WARNINGS:**

**The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is used or put into service.**

**For maximum safety, the accuracy of the MultiRAE PLUS should be checked by exposing the sensor(s) to known concentration calibration gas before each day's use.**

In programming mode, the user may re-calibrate the sensors in the MultiRAE PLUS monitor. This is a two-point calibration process using “fresh air“ and the standard reference gas. First, a “fresh air” which contains 20.9% oxygen and no detectable VOC, toxic or combustible gases is used to set the zero point for each sensor. Then a standard reference gas, which contains a known concentration of a given gas, is used to set the second point of reference (also known as span gas). The two-point calibration procedure is detailed below. Table 4.3 shows the sub-menus for calibration operations.

Table 4.3

**Calibration Sub-Menu**

Fresh Air Calibration?

Multiple Sensor Calibration?

Single Sensor Calibration?

Modify Span Gas Value?

Change LEL/VOC Span Gas?

The preferred calibration method for monitors with pumps is to place the calibration gas in a gas sample bag (Tedlar® bag). Connect the bag to the MultiRAE PLUS gas inlet port when you are ready to perform the calibration. Users may find it more convenient to connect the MultiRAE PLUS directly to the gas bottle using a flow-on-demand type regulator. Calibration through such a regulator will produce similar results to the sample bag method with most gases, but flow-on-demand regulators are not recommended with H<sub>2</sub>S. In an emergency, the MultiRAE PLUS can also be calibrated directly from a fixed flow regulator with a flow rate between 0.5 and 1.0 liters per minute.

MultiRAE PLUS diffusion monitors must be calibrated using a fixed flow regulator with a flow rate between 0.5 and 1.0 liters per minute. Diffusion monitors are supplied with a special calibration adapter that covers the gas diffusion port.

The calibration adapter links up the inlet port of the MultiRAE PLUS Monitor to the gas sample bag (see Figure 4-1).



Figure 4-1 Connection of Calibration Gas

MultiRAE PLUS diffusion monitors must be calibrated using a fixed flow regulator with a flow rate between 0.5 and 1.0 liters per minute. Diffusion monitors are supplied with a special calibration adapter that covers the gas diffusion port.

#### 4.4.1 Fresh Air Calibration

This procedure determines the zero point of the sensor calibration curve. To perform fresh air calibration, the calibration adapter and a bottle of “fresh” air (optional) are required. The “fresh” air is clean dry air with 20.9 % oxygen concentration and without any organic, toxic or combustible gases or impurities. If such an air bottle is not available, any clean ambient air without detectable contaminant can also be used. A charcoal filter should be used if one is not sure of the ambient air’s purity.

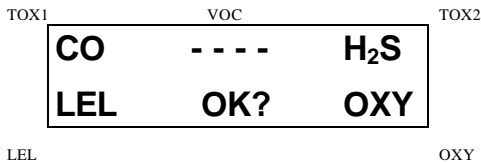
1. “Calibrate Monitor?” is the first menu item in Table 4.1. Press **[Y/+]** to perform calibration. The first sub-menu shows: “Fresh Air Calibration?”
2. If the “fresh” air bottle is available, twist on the calibration adapter over the inlet port of the **MultiRAE PLUS** Monitor and connect the other end of the tube to the fresh gas bottle. If the “fresh” air bottle is not available, simply leave the monitor in an area free of any detectable vapor.
3. Press the **[Y/+]** key to start “fresh air calibration” of the monitor. The display shows “zero ...in progress” followed by the name of each sensor and the message “zeroed”. The display should show a reading of “20.9” for the oxygen sensor and “0.0”, or a very small number, for all other sensors.
4. After about a 5 second pause, the display will show the message “Zero Cal Done!” and move to the next sub-menu “Multiple Sensor Calibration?”

### 4.4.2 Multiple Sensor Calibration

This function simultaneously determines the second point of calibration curves for multiple sensors in the monitor.

Mixed standard reference gases is needed to perform this procedure. The user can choose several gas mixtures to be used in multiple-sensor calibration. Connect the tube to the sampling bag filled with mixed gas as shown in Figure 4-1.

1. Continuing from Step 4 of the previous Section, the display should show “ Multiple Sensor Calibration?” Press the **[Y/+]** key. The display shows all the pre-selected gases for the sampling bag filled with mixed gas and “OK?” question. Press **[Y/+]** key to accept the multiple sensor selection and start the calibration, or press the **[N/-]** key to modify the sensor selection and go to Step 7.



2. Turn on the valve of the sampling bag to start the flow of the span gas. Display shows “Apply Mixed Gas” and will wait for the calibration gas to reach the sensor. When the calibration gas has reached the sensor the display will show “calibration in progress... 60” with the countdown timer shows the number of remaining seconds while the monitor performs calibration. When the countdown timer reaches 0, the display shows the name of each sensor, the message “cal’ed!” and the calibrated values for each gas. If no gas has reached the sensor after 60 seconds, the display will show “No gas flow...” and abort the calibration.

Note: the readings should be very close to the span gas values. After about 5 seconds pause, the display will show the message “Span Cal Done! Turn Off Gas”

3. This completes the multiple sensor calibration procedure and moves to the next sub-menu item.
4. Turn off the flow of gas. Disconnect the calibration adapter from the **MultiRAE PLUS** Monitor.
5. If the sensor failed the calibration, the sensor name and an error message “failed, continue?” will appear. Press the **[N/-]** or **[MODE]** key to abort the calibration and move directly to the next sub-menu item. Press the **[Y/+]** key to continue the next sensor calibration. In either case, the calibration data for the current sensor is not changed.
6. From Step 1, if the **[N/-]** key is pressed, the display shows all the sensor names which are selected for multiple sensor calibration with the cursor blinking at the first sensor location.

TOX1	VOC	TOX2
<b>CO*</b>	- - - -	<b>H<sub>2</sub>S*</b>
<b>LEL*</b>	<b>OK?</b>	<b>O<sub>2</sub></b>
LEL		OXY

Press the **[Y/+]** key to select the sensor and the **[N/-]** key to de-select the sensor. A previously selected sensor will show an “\*” next to the sensor name. A previously de-selected sensor will not show an “\*” next to the sensor name.

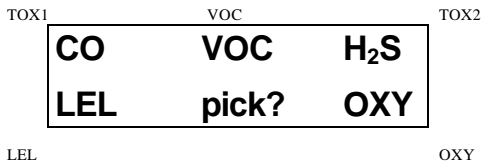
7. Press the **[MODE]** key momentarily to move from one sensor location to the next one. Repeat Step 7 until all of the sensors which need to be calibrated during multiple sensor calibration are selected. Press and hold the **[MODE]** key for 1 second to save the new sensor selection.
8. The display shows “Save?” To confirm the new selection, press the **[Y/+]** key to accept the change and continue on with Step 2. Press the **[N/-]** key or the **[MODE]** key to discard the change and to continue on with Step 2.

**Cross Sensitivity:** Some sensors may show cross sensitivity to other gases. Therefore, it is important to choose the gas mixture carefully for the multiple sensor calibration to avoid erroneous calibration due to cross sensitivity. For example, some VOC gases are known to cause erroneous readings by the CO sensor. In general, it is recommended to calibrate the two toxic sensors, combustible and oxygen sensor with a bottle of mixed gas using the multiple sensor calibration procedure and to calibrate the PID sensor with a bottle of a single VOC gas.

### 4.4.3 Single Sensor Calibration

This procedure determines the second point of the sensor calibration curve for a single sensor. A standard reference gas (span gas) is needed to perform this procedure. Table 2.2 shows the standard calibration gas which is typically used as the span gas in the factory (connect the tube to the sampling bag filled with the standard gas as shown in Figure 4-1).

1. Continuing from Step 4 or Step 6 of the previous section, the display should show “Single Sensor Calibration?” Press **[Y/+]** key. The display shows all the installed sensors in the monitor with the cursor blinking at the first sensor location. Press **[Y/+]** key to select the high-lighted sensor and start the calibration, or press **[MODE]** key momentarily to move to the next sensor location.

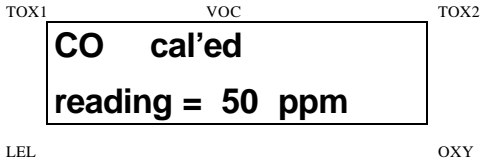


2. Turn on the valve of the CO gas bottle to start the flow of the span gas. Display shows “Apply CO Gas” and will wait for the calibration gas to reach the sensor. When the calibration gas has reached the sensor the display will show “calibration in progress...60” with the countdown timer shows the number of remaining

seconds while the monitor performs calibration. When



the countdown timer reaches 0, the display shows the sensor name and the calibrated value:



If no gas has reached the sensor after 60 seconds, the display will show "No gas flow..." and abort the calibration.

Note: The reading should be very close to the span gas value. After about 5 seconds pause, the display will show the message "Span Cal Done! Turn Off Gas"

3. This completes the single gas calibration procedure for one sensor. The display shows the single gas calibration sub-menu for a user to select another sensor or move to next calibration sub-menu.
4. Turn off the flow of gas. Disconnect the calibration adapter from the **MultiRAE PLUS** Monitor.
5. Repeat Step 1 to Step 5 to calibrate the next sensor.
6. Press the **[MODE]** key any time during Step 2 to reduce waiting time. If the sensor failed the calibration, the sensor name and an error message "failed, continue?" will appear. Press **[N/-]** or **[MODE]** key to abort the calibration and move directly to the next sub-menu item. Press **[Y/+]** key to continue single gas calibration. In

either case, the current calibration data will not be changed.

### Oxygen Sensor Calibration

The oxygen sensor calibration is slightly different from all other sensors. The oxygen sensor measures a range from 0 to 30% of oxygen in the air. During “fresh” air calibration, the oxygen sensor is calibrated to fixed 20.9% of oxygen. During single sensor calibration, the user can supply a pure nitrogen gas so that the oxygen sensor can be calibrated to 0% of oxygen. The user can also supply other span concentration of the oxygen, e.g. 19.5%, to calibrate the oxygen sensor. A question “0% oxygen?” will be asked. Enter [Y/+] key if the pure nitrogen gas is used to calibrate the oxygen sensor. Otherwise, enter [N/-] key to calibrate oxygen sensor to other span oxygen value. During both single or multiple sensor calibration, the oxygen sensor will be calibrated to the span value defined in Section 4.4.4.

**Note:** After a “0% oxygen” calibration, the user must perform a fresh air calibration to ensure that the oxygen sensor is calibrated correctly.

### Calibration Time Stamp

When a single or multiple sensor calibration is performed, a time stamp will be stored in the non-volatile memory. This information will be included in the datalogging report.

#### 4.4.4 Modify Span Gas Value

This function allows the user to change the span values of the standard calibration gases.

1. “Modify Span Gas Value?” is the next sub-menu item in Table 4.3.
2. Press **[Y/+]** key. Display shows:

TOX1	VOC	TOX2
50	100	25
50	span	20.9

LEL

OXY

The cursor is blinking at the first digit of the first Span value. If the user wants to modify any one of the span gas value, go to Step 3. Otherwise, press and hold the **[MODE]** key for 1 second to accept the previously stored span gas value and move to the next calibration sub-menu.

3. Starting from the left-most digit of the span gas value, use **[Y/+]** or **[N/-]** key to change the digit value and press **[MODE]** key momentarily to advance to next digit, the cursor will move to the next digit to the right. Repeat this process until all span gas values are entered. Press and hold the **[MODE]** for 1 second to save the new calibration gas value.
4. The display shows “Save ?” To confirm the new value press the **[Y/+]** key to accept the change. Press the **[N/-]** key or the **[MODE]** key to discard the change and move to the next calibration sub-menu.

#### 4.4.5 Change LEL/VOC Span Gas

This function allows the user to select a specific LEL or VOC gas to be used as the span gas during LEL or VOC gas calibration.

1. “Change LEL/VOC Span Gas?” is the next sub-menu item in Table 4.3.
2. Press **[Y/+]** key. If LEL sensor is installed and enabled, the display shows:

TOX1	VOC	TOX2
<p><b>LEL Span = ?</b></p> <p><b>methane</b></p>		
LEL		OXY

Otherwise, the message “No LEL installed” will appear.

3. If the user does not want to change the LEL span gas, press **[Y/+]** key to accept the current selection and exit this sub-menu.
4. If the user wants to select a different LEL span gas, press **[N/-]** key. Then use **[Y/+]** or **[N/-]** key to scroll through a list of gas names until a desired gas name appears in the LCD display, then press **[MODE]** key to select the new gas name.
5. The display shows “Save?” To confirm the new gas selection, press the **[Y/+]** key to accept the change. Press the **[N/-]** key or the **[MODE]** key to discard the change and move to the next display.
6. If the VOC sensor is installed and enabled, the display shows:

TOX1	VOC	TOX2
------	-----	------

<b>VOC Span = ?</b> <b>isobutylene</b>
---

LEL

OXY

Otherwise, the message “No VOC installed “ will appear.

7. If the user does not want to change the VOC span gas, press **[Y/+]** key to accept the current selection and exit this sub-menu.
8. If the user wants to select a different VOC span gas, press **[N/-]** key first then use **[Y/+]** or **[N/-]** key to scroll through a list of gas names until a desired gas name appears in the LCD display, then press **[MODE]** key to select the new gas name.
9. The display shows “Save?” To confirm the new gas, press the **[Y/+]** key to accept the change. Press the **[N/-]** key or the **[MODE]** key to discard the change and return to the first calibration sub-menu.