

# ENSURING MEASUREMENT ACCURACY AND CONSISTENCY OF THE PPBRAE BY CALIBRATING WITH A RAE SYSTEMS SINGLE-USE VOC ZEROING TUBE

## GENERAL

The RAE Systems ppbRAE is the world's most sensitive handheld photoionization detector (PID). Our patented PID sensing technologies and unique engineering design make real-time low parts-per-billion (ppb) level volatile organic compound (VOC) monitoring practical. This Technical Note describes improvements in the measurement accuracy and consistency of the ppbRAE in the low ppb range by upgrading the firmware to the latest version (V1.20 or later) and zero-calibrating the ppbRAE with the new single-use VOC zeroing tube.



## Zeroing Scheme Difference between the Earlier Versions and V1.20 (or Newer) Firmware

An appropriate zeroing scheme is extremely important for the ppbRAE to deliver good measurement consistency between different units and to detect accurately in the low ppb range.

When the ppbRAE was introduced, there were some concerns about the variability and availability of portable cylinders of high-grade VOC-free air. As a result, prior firmware versions (earlier than V1.20) used an "electronic zero." The electronic zero refers to the signal when the lamp is powered off. This former zeroing scheme works well with measurement concentrations in the parts-per-million (ppm) range, because the matrix gas signal is negligible, compared with the signal of the gas of interest. It was found that when the concentration is in the low ppb range, multiple units have some variability when measuring the same ambient air after the same calibration. This is because the matrix gas signal with the lamp powered on becomes significant and varies from unit to unit, and the zeroing scheme in the firmware versions earlier than V1.20 did not effectively cancel this out.

Versions 1.20 and later firmware versions utilize "zero gas" to zero the unit, thereby canceling both the electronic blank and matrix gas signal. This now provides measurement consistency between different units, and the accuracy of readings in the low ppb range is markedly improved.

An appropriate zero gas is now required for zero calibration with V1.20 and higher firmware version. The lower the concentration of the VOC in the zero gas, the better the accuracy of the measurement in the low ppb range. Any zero gas for the ppbRAE zeroing should have less than 10 ppb total hydrocarbons (other than methane or ethane) and must have the same matrix as the measurement gas. For example, if the ppbRAE is used to measure ppb-level VOCs in air, the instrument must be zeroed with "ultra zero" air that consists of 79% nitrogen and 21% oxygen.

## New Single-use VOC Zeroing Tube

The VOC zeroing tube is the best choice of the various options for zeroing the ppbRAE. Regardless of their size cylinders must have a dedicated regulator to prevent cross contamination from span gases. Also, bottle gases may not be able to represent the true background humidity, oxygen level, or other matrix components. Clean outdoor air is often a good source of VOC-free air, but there is no simple way to ensure <10 ppb VOC levels.

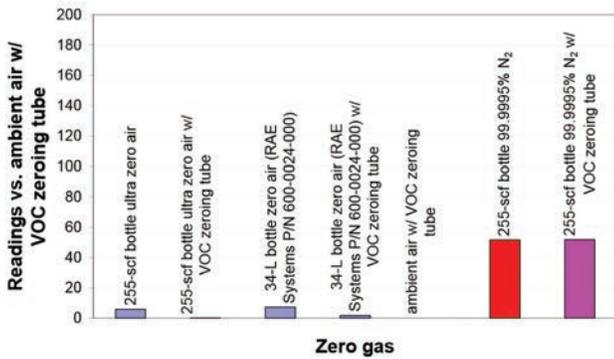


RAE Systems has developed a single-use VOC zeroing tube (p/n 025-2000-010, as shown below) that purifies ambient air drawn through it to well below 10 ppb of VOCs.

The figure on the next page summarizes the typical results with various zero sources. The data show that the VOC zeroing tube provides a new and improved zero standard. The VOC zeroing tube also offers portability for field use. The VOC zeroing tube provides a lower zero level than a conventional multiple-use organic vapor zeroing filter (RAE Systems p/n 490-0006-000) because the glass tube is tightly sealed, and it is for single use only. The organic vapor zeroing filter should be used only as a last resort when no other methods are available, recognizing that it may cause tens of ppb background to be subtracted.

The consistency among different VOC zeroing tubes is very good ( $\pm 1$  ppb among five VOC zeroing tubes zeroing in ambient air). The flow resistance of the VOC zeroing tube only causes 30 to 40

**Zero gas comparison**



mL/min. (ca. 5%) sample flow rate reduction on the ppbRAE. The VOC zeroing tube absorbs largely propane, propene and higher hydrocarbons, but not ethane, ethylene or methane.

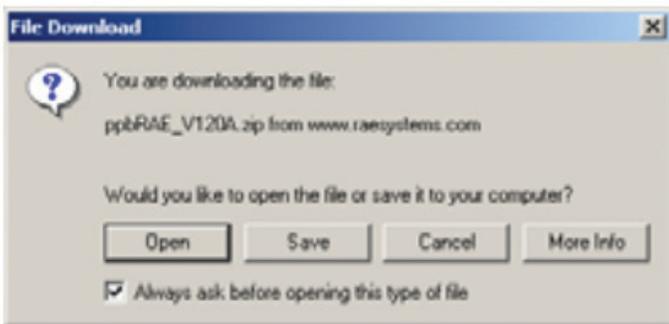
Calibrated with the single-use VOC zeroing tube and 10 ppm isobutylene (air balanced), the ppbRAE presents good measurement consistency and accuracy in the low ppb range, as shown in the table below:

Gas type	Isobutylene standard		Ambient air
	<200 ppb	>200 ppb	
Maximum variation of 6 ppbRAEs	±10% or ±15 ppb	±6%	±10% or ±20 ppb

**UPGRADING THE FIRMWARE TO V1.20 (OR THE LATEST VERSION)**

**Download**

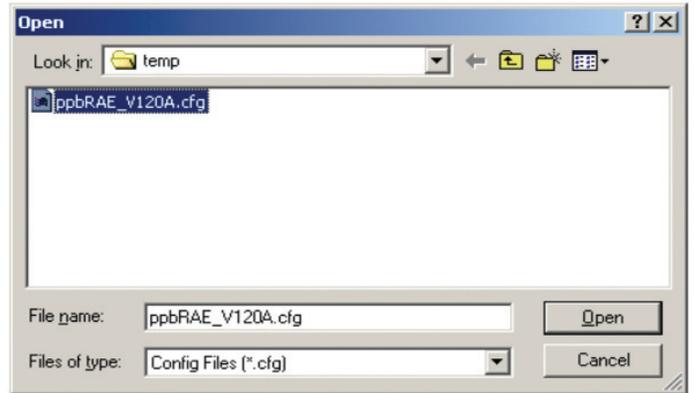
1. Visit [www.raesystems.com](http://www.raesystems.com). Click Downloads under Support; fill out the Software Download Registration form, and hit the button "Take me to the download page."
2. Click the product "ppbRAE," and the following dialog box will pop up:



3. Click "Save" button to save the zip (compressed) file "ppbRAE\_V120A.zip" to a local folder and use WinZip to extract the two files: ppbRAE\_V120A.A07 and ppbRAE\_V120A.cfg.

**Install**

1. Connect the ppbRAE to the serial port of the PC with the RS232 cable (RAE systems P/N 008-3003-000) and place the unit in PC communication ready mode.
2. Open the program ProRAE Suite 2.91 (or the latest version; if the computer is not installed with it, follow the above steps to download and install).
3. Use ProRAE Suite to open the cfg file. (If necessary, use "Configuration" under the "Edit" tab to edit the cfg file.) Use "Configure all" under the "Option" tab to configure the unit for the new firmware.



4. Close the cfg file.
5. Click on "Load firmware" under "Option" tab and the following window will pop-up; select the a07 file and click the "Open" button.
6. Follow the instructions provided by the software to install the new firmware. When finished, the ppbRAE unit turns off automatically.

**ZEROING THE PPBRAE WITH THE VOC ZEROING TUBE**

Note that the user of the ppbRAE must have the Flex-I-Probe (RAE Systems P/N 021-2400-100, as shown in the following picture) in order to use the VOC zeroing kit (RAE Systems p/n 025-3002-100, includes: one box of VOC zeroing tubes and a tube adapter). It is easy and straightforward to replace the old sample probe with the Flex-I-Probe.





The procedure for using the VOC zeroing tube to zero the ppbRAE is:

- 1.** Connect the tube adapter to the Flex-I-Probe by inserting the tip of the sample probe into the smaller end.
- 2.** Break the two ends of a VOC zeroing tube using the side hole of the tube adapter
- 3.** Insert one end of the open VOC zeroing tube into the bigger end of the adapter (the arrow indicates the right direction).



- 4.** Run the zeroing calibration procedure of the instrument to zero the unit.
- 5.** Discard the used VOC zeroing tube (single use only) and put the tube adapter back to the VOC zeroing kit container.

For more information on ppbRAE zeroing, please refer to TN-150: Understanding And Operating The ppbRAE. It can be found at [www.raesystems.com](http://www.raesystems.com).