

## Carbon Monoxide Sensor Calibration and Verification

### Introduction

The Veris Industries G Series carbon monoxide (CO) gas sensor line is used primarily in parking garages to control ventilation, preventing unhealthy levels of CO gas. The products' replaceable elements are based on metal oxide semiconductor (MOS) technology. The main unit and the sensor are calibrated and verified, both individually and as a unit, ensuring the highest accuracy and functionality.

MOS technology has many characteristics that make it ideal for measuring CO in parking garages. For example, although there is no published accuracy specification, reports and internal testing suggest the error is estimated to be  $\pm 20\%$ . MOS is also resistant to poisoning, especially upon product verification. Additionally, MOS has a long life expectancy that is estimated to exceed five years.

### Calibration and Verification at the Factory

#### Replaceable Sensor Element Calibration

The calibration process for the replaceable element begins with a 48 hour "burn in" process. During this phase, the elements are powered and the internal heater cycles every 60 seconds. This drives away excess moisture and contaminants from the element that may have been absorbed during shipping and processing.

Next, the element is placed in a vacuum chamber. Vacuum is drawn, and then the chamber is filled with a humidity-controlled 200 ppm ( $\pm 2\%$ ) calibration gas. The sensor soaks in this gas for ten minutes, and a reading is taken. The chamber is then evacuated and filled with a second, lower concentration (50 ppm) of calibration gas. After another ten minute soaking time, a second reading is taken. These calibration points are stored in the sensor's on-board memory.

#### Main Unit Calibration

The main unit also goes through a thorough calibration and verification process, beginning with programming the on-board microcontroller. Once programmed, the analog output circuitry is calibrated at both zero and full scale (0-10 V or 4-20 mA, depending on the model), then verified at a third point to ensure successful calibration.

Next, the alarm and relay outputs are tested and verified to be functional. At this time, the main unit and the sensor elements can move on to the final test.

#### Final Test and Verification

During the final test, the main unit and the sensor element are tested together to verify that the combined unit functions to its published specifications. After the sensing element has been inserted into the main board, the unit is powered up. Calibration gas is applied to the unit. During this test, analog outputs are measured and checked, the relay is checked for correct operation, and the alarm buzzer operation is confirmed. If all three are within tolerance, the unit is packaged and ready to ship.

### Field Testing the Sensors

Testing the function of the G-Series carbon monoxide sensors in the field requires a few steps:

1. First, ensure the green LED is not flashing prior to performing this test. A flashing green LED indicates the sensor has expired and needs to be replaced.
2. The gas being dispensed through portable cylinders is extremely dry. It must be hydrated to prevent drying out the sensor head, which can cause erroneous readings. Hydrated air more closely resembles real-life conditions.
3. The Occupational Safety and Health Administration (OSHA) has established minimum ventilation limits for CO sensors at 35 ppm. Due to the characteristics of MOS technology, including its sensitivity and accuracy, Veris has set the relay contacts to change state at 25 ppm, the optimum level for MOS. However, when verifying functionality of the carbon monoxide sensor's relay operation, it is recommended that a higher concentration of CO gas be used to compensate for the dilution of gas by ambient air.
4. In the final verification step, it is necessary to allow gas to flow over the sensor head for approximately seven minutes. The MOS sensor head cycles through its burning and measuring phase every three minutes.
5. To verify proper sensor operation, compare the analog output to the desired setting or verify that the sensor's relay has changed state. Expect to see approximately 50% response to the test gas, since it is not possible to evacuate all the air from the sensor during a field validation test.

### Field Testing the Local Alarm

Generally, due to ambient air conditions, it is very difficult to obtain a constant  $>100$  ppm CO concentration in a field-mounted G series device for the required 30 minutes to validate local alarm functionality. In laboratory conditions, however, it is possible to remove air completely by pulling a vacuum in the G Series housing and then backfilling with a proper CO gas concentration (typically 50 ppm for relay verification and 200 ppm for local alarm verification).