TN-011-2, Dec'00.

Calibration Procedure

A hands-on guide for SenseAir IR gas sensors

SCOPE:

This note is to support anyone intending to verify sensor readings, or do calibrations, by exposing the sensors to some known gases.

ASSOCIATED DOCUMENTS:

TN-010	*Theory of Calibration*
TN-001	*Function test of sensor/controllers model family 2001VT*
ieF0005	*Service bag model F0005 (User's manual)*
ieVT-UIP	*User interface program for VT (User's manual)*

INTRODUCTION

SenseAir infrared (IR) technology for gas sensing is well proven, stable, and reliable. All sensors are tested and fully calibrated at the factory before delivery, where each individual sensor, based on its serial number, has a data file of its own with all relevant parameters stored.

Figure 1: Test gas tube connected to the sample cell test gas input nipple.

In the factory the sensors are calibrated in closed gas chambers where the sensor environment is fully controlled. After installation, the most precise way to expose the sensors to test gases is to adapt a gas tube directly onto the sample cell *(see figure 1).* How to do this in the most exact way will be described in this technical note.

AUTOMATIC SELF CORRECTION

Sensor aging might affect the *zero point constant* (see TN-010 for theoretical explanations), but the internal intelligence *Automatic Baseline Correction (ABC, see TN-012)* automatically compensate for this. Therefore**, sensors for fixed installation are maintenance free**, and do not require any further calibration when used in normal indoor air applications.

Exceptions are in closed confined spaces, and certain process control applications, and portable units, where *perhaps* the *ABC* feature cannot be applied for long term stability. Here, the zero point needs to be checked annually to verify the sensor calibration.

The sensor *span constant* does not change with time. Therefor, **provided that the zero point is correct SenseAir can guarantee the sensor accuracy over the full measurement range**.

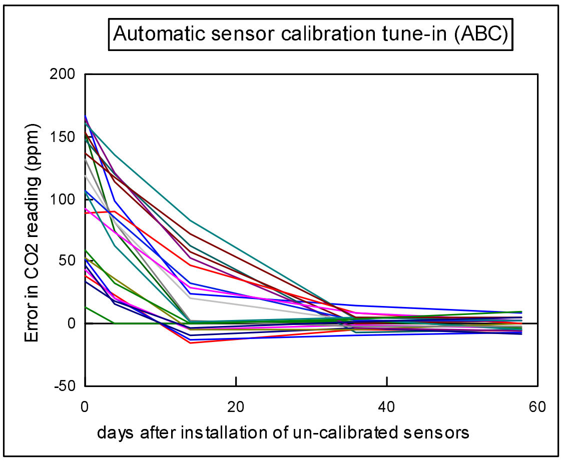

Diagram 1: This test demonstrates that even very poorly calibrated sensors will automatically adjust themselves as times goes by. Therefore, verification tests shall not be performed directly after installation.

Delivery inspections and performance verification tests concerning sensor reading accuracy shall not be performed directly after installation. One must allow some time to pass for the sensor to adapt to possible transportation/installation damages that automatically will heal in a couple of weeks. The maximum rate of automatic baseline correction is of the order of 1%FS/week *(see diagram 1).*

GAS HANDLING PROCEDURE

If any calibration is to be performed, always start with ZERO calibration first! Only thereafter, a SPAN check may be performed *(see diagram 2).* The actual test gas exposure is performed as follows:

1. Adapt to the sample cell test gas inlet a flex tube prepared in accordance to *figure 2*. Often a blue cap that needs to be removed protects the gas inlet nipple.

2. Flow the test gas at a rate of 0.2 liters/minute (use a flow meter if available) until the sensor reading has stabilized to the new reading. Even though the sensor reading is close to its final value already within a minute, there will be a tail in the response for yet another minute.

3. If the flow rate is not known, vary the flow some 50% to verify that there is no flow rate dependence on the readings.

4. Depending on your mission - make your note, or perform a calibration. For ZERO calibration, a push-button operation may be activated (OP#2 or CAL), or a PC may be used together with the *UIP* software.

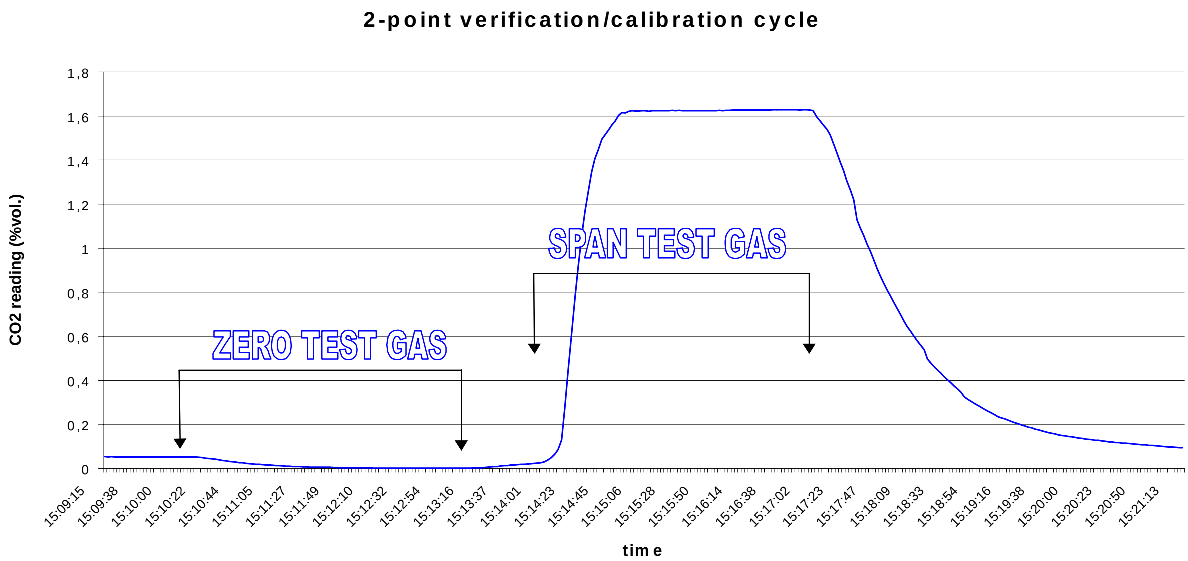

Diagram 2: A ZERO and SPAN test gas sequence illustrating the sensor response time at 0.2 liters/minute flow rate, as well as the back diffusion rates seen after the test gas valves were closed.

PRECAUTIONS

When applying gas to the sensor there are two issues one has to consider – *pressure build-up* and *back diffusion* from surrounding air via the membrane covered ventilation holes at the cell bottom (not visible).

The sensor reading is proportional to gas pressure, so a *pressure build-up* will introduce an error in a SPAN calibration, but will not affect a ZERO calibration. Static over pressure, as well as oscillating gas cylinder pressure/flow regulators, will degrade the span measurement accuracy.

The influence of *back diffusion* depends on the difference between the ambient and the test gas concentrations. Normally, this makes SPAN calibrations more sensitive than ZERO calibrations. The influence from back diffusion is reduced with increasing test gas flow rate, but on the other hand increased test flow rate means increased risk of pressure build-up in the sensor cell.

In summary, one can say that a ZERO calibration is easier and more reliable to perform compared to a SPAN calibration or verification at high gas concentration!

To prevent back diffusion from influence the result a flow rate of 0.2 liters/minute is recommended when test gas is to be applied to the sample cell. In order to minimize the risk for pressure build-up, a slit in the tubing shall be cut close to the sample cell *(see figure 2).* This will act as an over pressure valve. When finished with gas exposure tests, replace the blue cap on the gas inlet nipple to protect the sample cell from dust to enter.

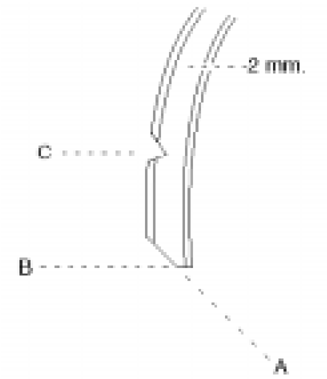

Figure 2: Prepare a 2 mm inner diameter plastic tube for the test gas by ***A)*** *cutting the edge to be connected to the sample cell at 45 degrees, and* ***B)*** *cut away the resulting top edge. This will make the tube fit nicely on the sample cell test gas inlet nipple.* ***C)*** *cut open a small hole about 1 mm^2 that will prevent an over pressure build-up.*

ZERO POINT VERIFICATION

The ZERO point tests are very much immune to errors. It is not sensitive at all for pressure variations, and not so sensitive to flow rates either – in particular when the background levels are close to zero and back diffusion does not disturb much. Extreme high flow rates could disturb the sensor thermal equilibrium, with an erroneous result as a consequence. Our zero calibration bags (model F0005) cannot generate such errors. That is why we always recommend concerned customers to **use our handy ZERO point checking tools and only make SPAN point readings as qualitative function checks!**

Any error in the sensor zero point constant will generate an increasingly larger error in the readings with higher concentrations *(see diagram 3)*. **Knowing the error at the zero point one can calculate the error at all concentrations** via the internal calibration tables.

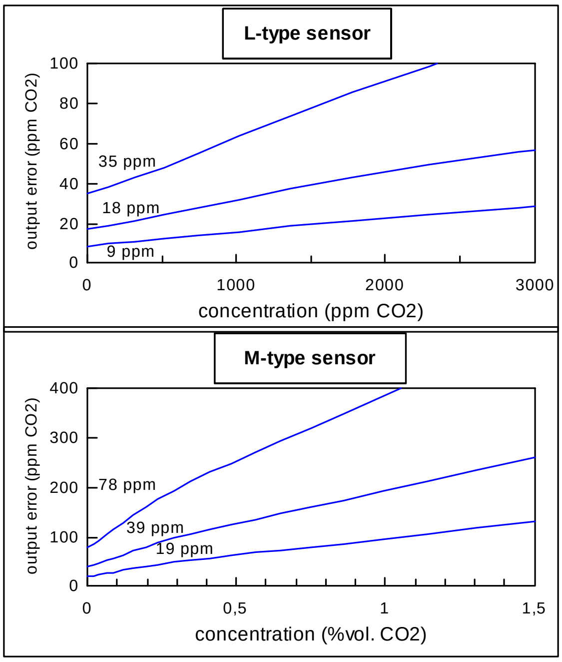

Diagram 3: Correlation curves for zero constant errors 1%, 0.5%, and 0.25%, with the respective zero point error indicated to the left.