The aim of this procedure is to present the experimental setup required to calibrate the Cairsens gas sensors for the measurement of concentrations of pollutants in ambient air.

1. Exposure chamber for laboratory calibration

First of all, an exposure chamber shall be used in order to calibrate the Cairsens gas sensors in laboratory controlled conditions. The generated air mixture containing the required gas concentration to be tested shall pass through this exposure chamber with sufficient volume capacity.

In order to make the best calibration of the Cairsens gas sensors, the metrological characteristics of the exposure chamber shall be controlled according to the intended field application. If nothing special is required for the shape or structure of the chamber, it must meet a number of requirements, which are listed below:

- the chamber shall be built from inert materials such as glass, polytetrafluoroethylene (PTFE), or stainless steel, so as to limit interactions on the walls depending on the gas to be tested;

- the volume of the chamber must be consistent with the quantity of sensors to be tested simultaneously and the volume of gas that can be generated;

- the chamber shall allow the passage of the sensor supply cables, gas inlet and outlet tubes and other required cable management while maintaining the best tightness;

- a ventilation system can be added into the chamber in order to homogenize the air if the volume is large

- the exposure chamber shall be equipped with devices able to measure (i.e. reference gas analysers), control and change the flow rate of the generated mixture and so the concentration of the gas to be tested, as well as probe for the measure of temperature and relative humidity

For single injections of a defined concentration of pollutant through the gas inlet, the exposure chamber shall be perfectly sealed.

For dynamic and continuous generation of air mixture, that’s what we advise, the exposure chamber shall include at least one inlet and one outlet connecter either to the system of generation either to an exhaust. The time to reach a stable concentration will depend on the

"hermetic" volume of the exposure chamber as well as the air flow generated. Avoid too high air flow compared to the volume of the exposure chamber, to avoid excessive pressure inside the system.

2. Generation and control of gas mixtures

Devices are needed for the generation and control, such as mass flow controllers, of the gas mixtures at variable ratio of the gas to be tested. If possible reference gas analysers able to measure the concentration of the tested gas inside the exposure chamber shall be included to the system, as well as probe for the measure of relative humidity and temperature. The sampling outlet shall be located as close as possible of the tested sensors.

Dilution shall be performed using standard gas cylinder of the target species to be tested mixed with complementary gas coming from synthetic air or filtered air in order to eliminate gaseous interference with a level of purity that does not affect sensors values. The generated air for the test shall be humidified, avoid dry air.

3. Calibration conditions

First of all, absolutely avoid dry air for the test of Cairsens sensors, they must be contained in a humidified atmosphere. Too long exposure to dry air will degrade the sensor, loss of sensitivy, decrease of the total lifetime. We advise to perform the calibration under standard condition around 50 % RH, favour a stabilized relative humidity of the mixture around 40 to 60 % RH; for the temperature we advise to perform the test around 20 °C (18-22 °C) or at least at stable temperature near the ambient conditions.

Typically, the first step is to plug the Cairsens to the power supply, let the signal stabilized, around 15 min, it will depend on the time for the mixture condition to stabilized inside the exposure chamber and the last time the Cairsens were used. Blow only synthetic filtered air to perform the “zero” concentration point.

Then we advise to perform 3 different calibration point in order to test the sensors, we usually perform the mixture ratio at 25 %, 50 % and 75 % of the full scale of the sensor range. If it can’t be experimentally done, make calibration point as close as the concentration measured in the application field. For each calibration point, let the sensor signal be as stable as possible to take the Cairsens value. Again this time will depend on the volume of the exposure chamber and the flow rate of the generated air mixture.