

## Advice for minimising failure and destabilisation of Alphasense B4 range electrochemical sensors

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The electrochemical sensors used in AQMesh contain a dilute electrolyte which is held behind a gas-permeable membrane. Like all electrochemical sensors, they are highly sensitive to sudden changes in temperature, extreme high temperature and sustained high relative humidity, particularly at cooler temperatures. There are no absolute rules, as many sensors remain unaffected by combinations of these factors, when other sensors fail. The guidance below is intended to minimise the risk of sensor failure. The two potential outcomes of not understanding and managing these risks are sensor failure and sensor destabilisation.

### Sensor failure vs sensor destabilisation

Sensor destabilisation is different to sensor failure:

Sensor failure is where the sensor ruptures and electrolyte is lost, as a result of over-absorption of water vapour, even if this is not apparent from external inspection. Output may even appear to return to normal but the sensor is irreversibly damaged and must be replaced. A sensor failure of this sort can be identified from the raw output and an alert triggered. A 12-hour period is currently used to confirm that a failure has occurred and to ensure no false alerts are triggered by AQMesh pods in use in extreme but normal conditions.

Sensor destabilisation is a reversible effect on the sensor – rapid changes in temperature and/or relative humidity can disrupt the sensor output temporarily, at a level outside the limits of our algorithm corrections.

The AQMesh algorithm is designed to correct for the changes in environmental conditions experienced by an AQMesh pod in a fixed position in a natural environment, within the extremes offered by nature, eg: changing direct sunlight, temperatures, morning mists, fog, etc. Destabilisation occurs during sudden, man-made, changes in environmental conditions, including moving a pod or sensor:

- From a warm building or vehicle to cold outdoor conditions, or in the opposite direction
- Moving a pod or sensor from a cold / air-conditioned environment, eg: an office or car, to hot outdoor conditions, or in the opposite direction

### Risks

AQMesh is designed to be used for outdoor ambient air quality monitoring in all global environmental conditions. The conditions which present a risk are generally limited to:

1. Man-made / sudden changes to temperature and humidity
2. Sustained high relative humidity and cool temperatures: typically 4+ days at RH% > 90% and ambient temperature below 16 degrees C / 60 degrees F. This risk is hardest to avoid in normal deployment, in certain climates.

The following are scenarios which offer the sort of sudden change in environmental conditions which can cause sensor destabilisation or even failure. Moving a pod or sensor:

- From a warm building or vehicle to cold outdoor conditions, or in the opposite direction
- Moving a pod or sensor from a cold / air-conditioned environment, eg: an office or car, to hot outdoor conditions, or in the opposite direction
- Testing heating and ventilation equipment which can stress test at high temperatures

## Minimising risk of sensor failure or destabilisation

It is best to avoid the conditions which cause sensor failure or destabilisation, by:

1. Where pods are mounted for monitoring, try to avoid any direct source of moisture, such as:
  - a. Spray from hosepipes, dust mitigation systems, etc.
  - b. Splash from puddles, sea spray
  - c. Evaporation from a surface below the pod
  - d. (NB: AQMesh is designed to cope with even extreme rainfall and should be mounted with a clear path for air to circulate around the pod: do not over-enclose)
2. When new pods or sensors are shipped by AQMesh they will have been packed in such a way as to minimise the risk of failure during shipping: ensuring that sensors have not been exposed to high humidity without having enough time to recover before packing
3. The risk sensor failure / destabilisation can be minimised from the start by taking precautions to minimise environmental shock, including:
  - Exposing the AQMesh pods (and individual sensors) to gentle changes in environmental conditions and / or small steps. For example, move the pods from a cold truck to a cold storage room, changing both temperature and humidity as gently as possible.
4. When pods are moved:
  - When pods are brought in from a humid environment, particularly when also cold, handle them very gently and leave in a drier environment at a similar temperature for 24 hours. Sensors which are laden with additional moisture absorbed from the environment (high humidity) makes the sensors particularly fragile. They need to return to a normal level of electrolyte before normal handling is appropriate. The only way to be sure of this is to leave sensors exposed to air at RH% < 60% for at least 24 hours. Such changes to the electrolyte, caused by high humidity, do not cause a quantifiable / un-correctable change in sensor performance, as long as the sensor is not exposed to further shocks; the risk relates to sensor failure, not performance.
  - When moving pods over relatively short distances, avoid using transportation which introduces a dramatic change in temperature or humidity, such as a vehicle with air conditioning or heating: open-backed trucks, cars with windows open, bicycles or walking are best.

## Warranty

During 2018, all failed sensors are replaced under warranty. This may be reviewed after 2018.