ENGLISH HERITAGE

Pollution Measurement

Designing representative measurements and interpreting the results

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Introduction

- Ideally environments should be designed or altered to remove the presence of pollutants, for example Oddy testing materials that will be within showcases.
- However much work is done there is often a need to measure pollutant concentrations, which can be quite simple to carry out.
- Two main methods:
  - Active
  - Diffusive
- However without careful consideration interpretation of results can be significantly flawed

ISO 16000-1:2004

- **ISO 16000 -1:2004 "Indoor Air Part 1: General aspects of sampling strategy"** covers pollution measurement, and the parameters that need to be considered

- It states:

  - 'An inappropriate monitoring strategy can contribute to the overall uncertainty of the measurement result'

  - 'long term sampling methods do not detect short-term peaks in concentration'

  - 'due to cost, the number of measurements is usually small. There is a tendancy to take the result of one measurement as representative of the whole space. It is essential to provide as much information as possible about those parameters that can influence the result'

Factors that impact on pollution

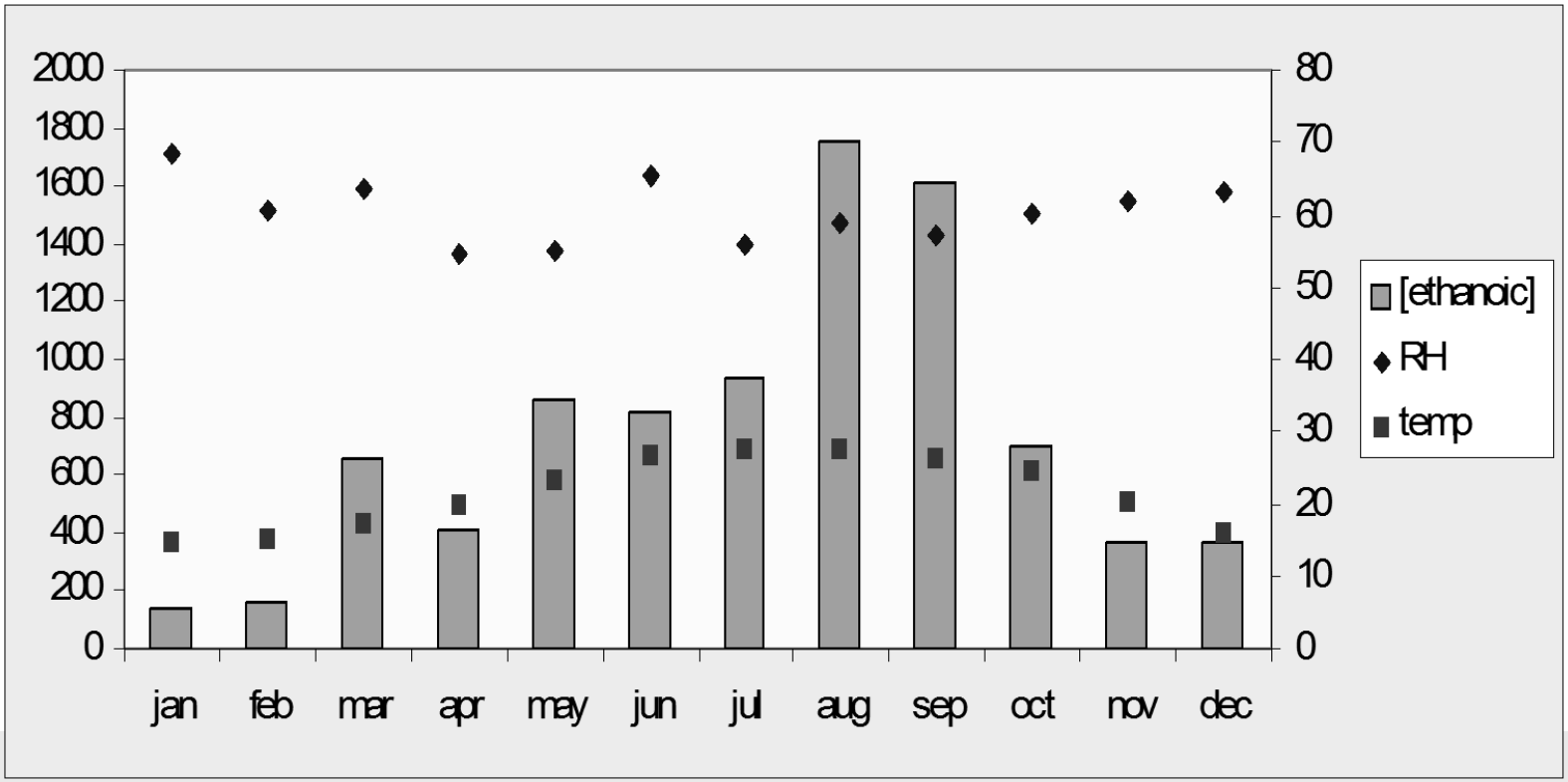
- Indoor environments are rarely constant
- Pollutant concentration could be altered by:
  - Strength of the source (dependent on T/RH, air movement)
  - Ventilation rate (i.e AER of enclosure)
  - Climatic conditions (i.e T/RH)
  - Chemical reactions
  - Sinks (i.e sorption)

Factors that impact on pollution

- Heritage environments are complex, and variable with location and time
- Therefore it is critical to understand how different variables effect pollution measurements
- And design experiments to take these into account
- Or understand how these have had an impact on the measurement and take these into consideration when analysing the result
- Here we consider a number of these variables, in relation to active measurements and perform experiments to further our understanding, and help improve experimental design

Strength of Source: Time of year

- ISO 16000-1 “Important to plan the time of monitoring carefully”
- It is well documented that temperature has an effect on pollution concentrations



Strength of Source: Time of day

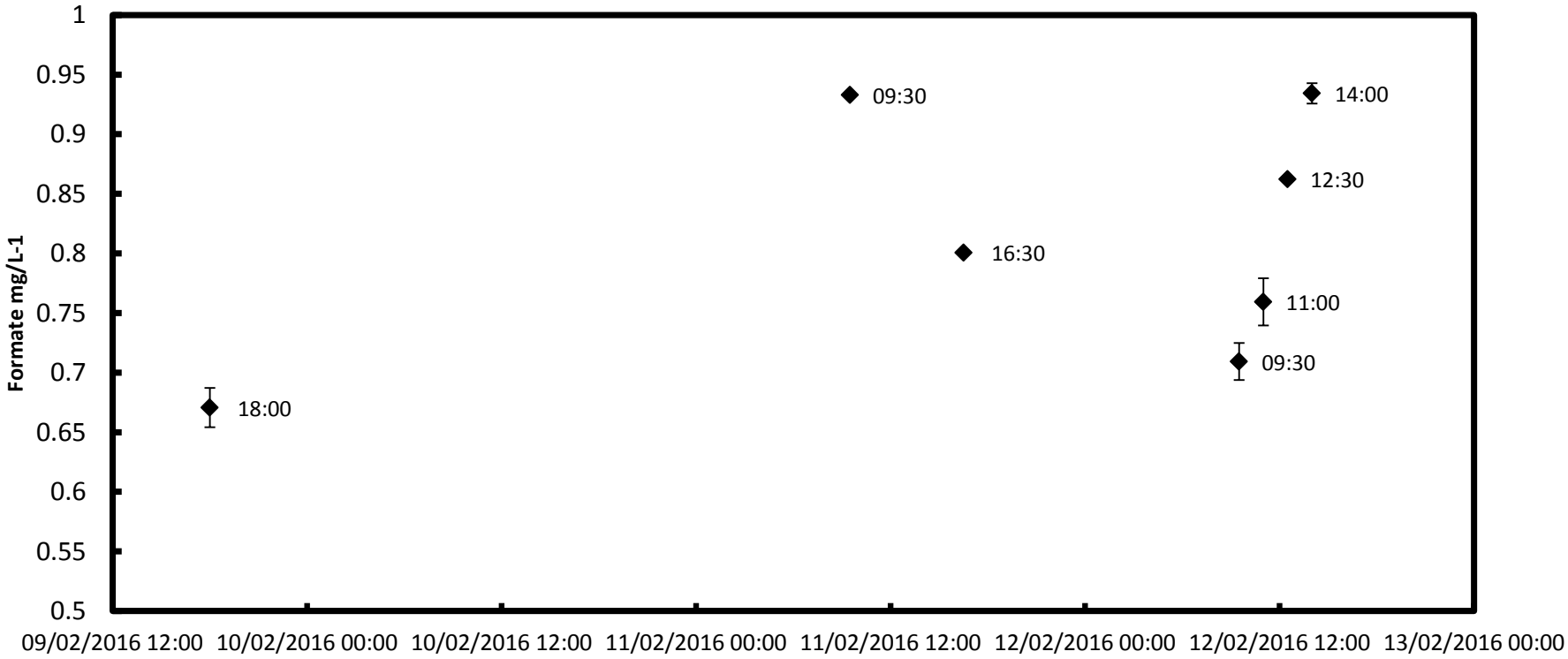
- However little work has been carried out to look at the effect that time of day can have on active measurements.
- Experiments have been carried out using a test showcase and active measurements to determine the impact on the time of day on pollutant concentrations.
- Only relevant to active measurements as diffusive are measured over periods that will take any variation into account

Method of experiments

- Oak + humidified to 75% RH to increase emission rate
- Small pump set up to, so that the showcase didn't need opening
- As Schieweck (2009), 120L of air was sampled at a flow rate of 2L/min, using potassium hydroxide to capture the organic acids.
- Solutions were extracted and analyzed with Ion Chromatography

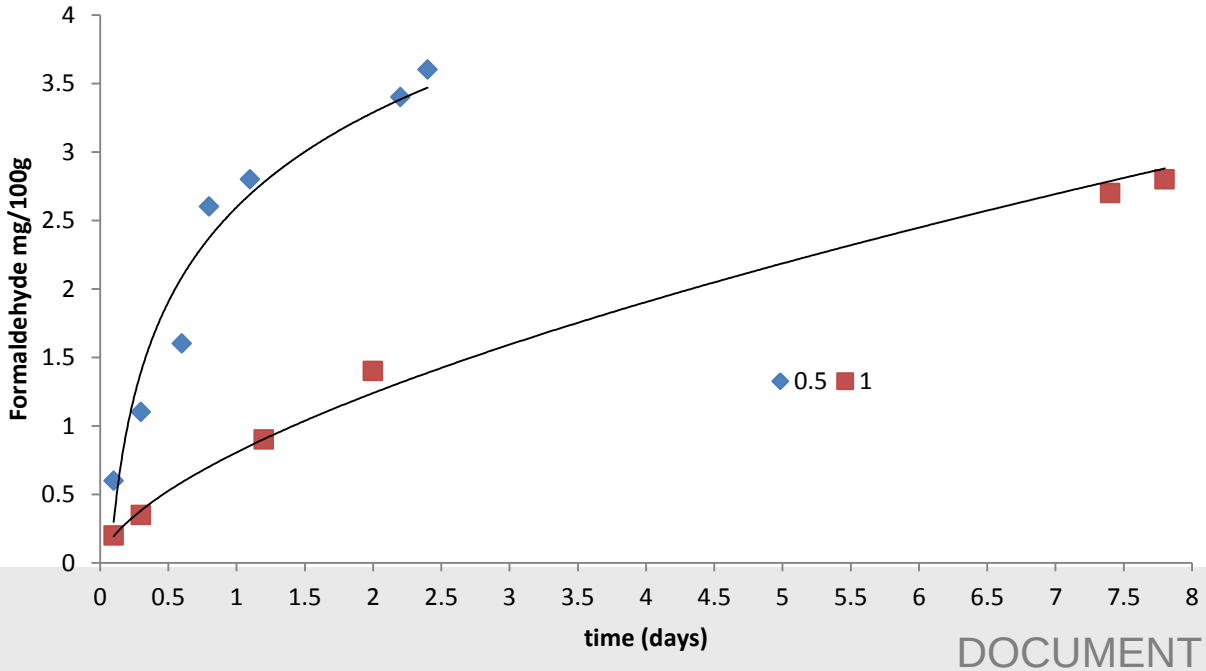
Strength of Source: Time of day results

- Preliminary results – further work required to understand precise reasons behind differences



Strength of Source: Air Movement - Effect on material emission rate

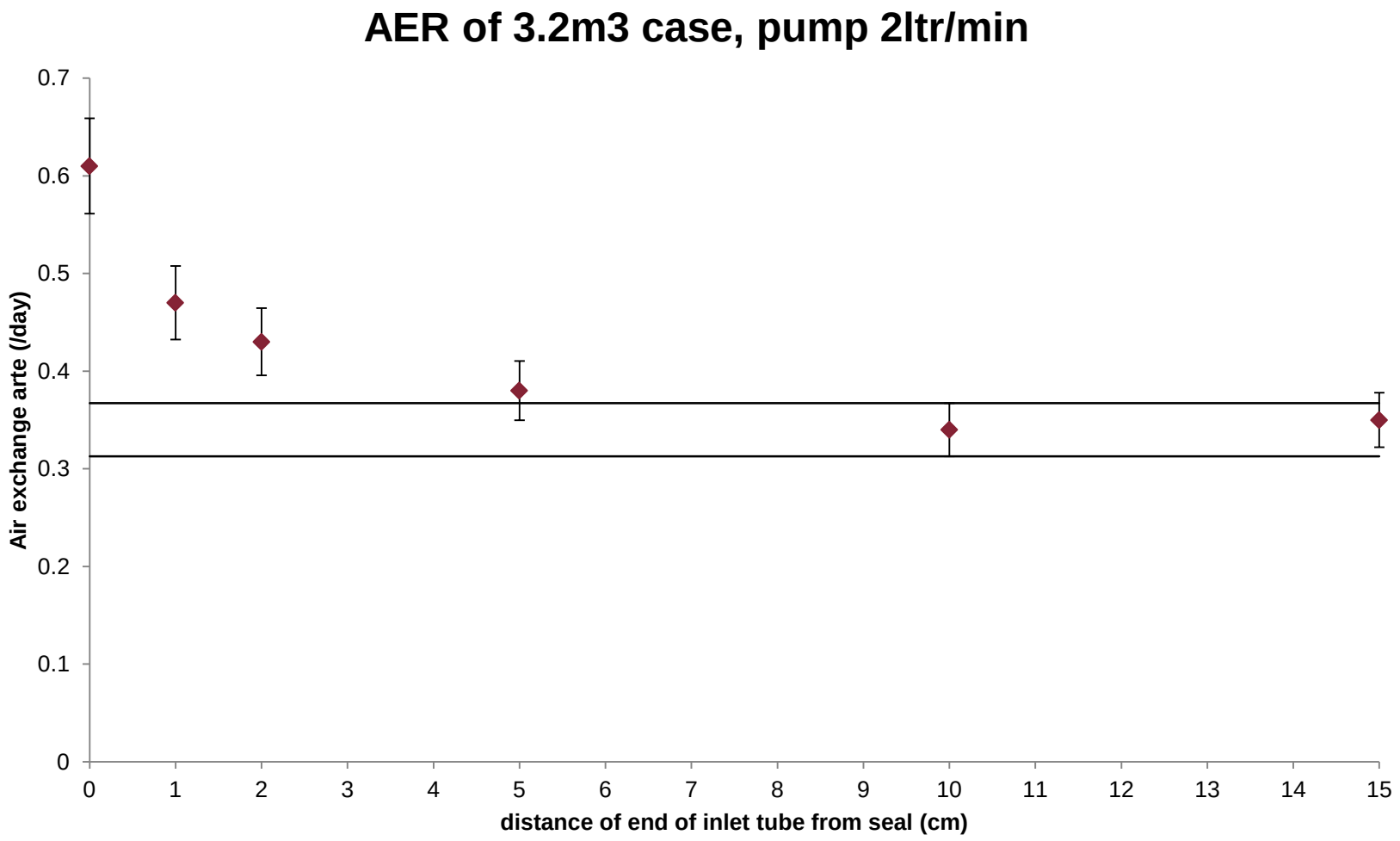
- Active sampling increases the airflow within the showcase, work elsewhere has shown that increasing the airflow over a surface can increase the emission rate of materials
- Experiment carried out at two different flow rates
- 0.5 L/min
- 1L/min
- formaldehyde



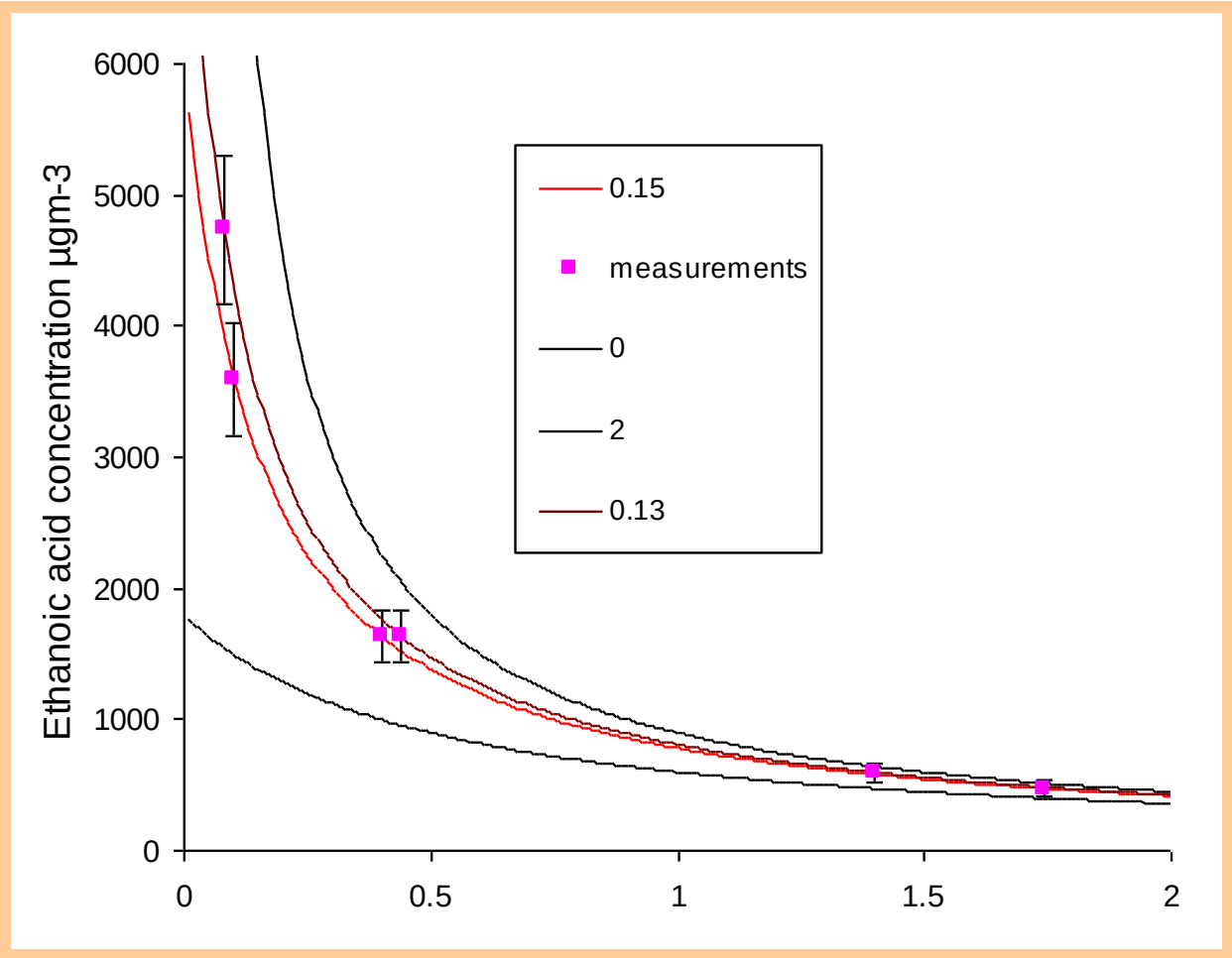
Ventilation Rate: Air Exchange Rate (AER)

- Not known how active sampling will impact upon the AER
- Experiment, in a different showcase, to determine the effect when the sampling is carried out at different distances from the seal
- Method:
  - Active pump running into case, with inlet end able to be moved with a magnet
  - Different distances away from bottom door seal tested

Ventilation Rate: Air Exchange Rate (AER)

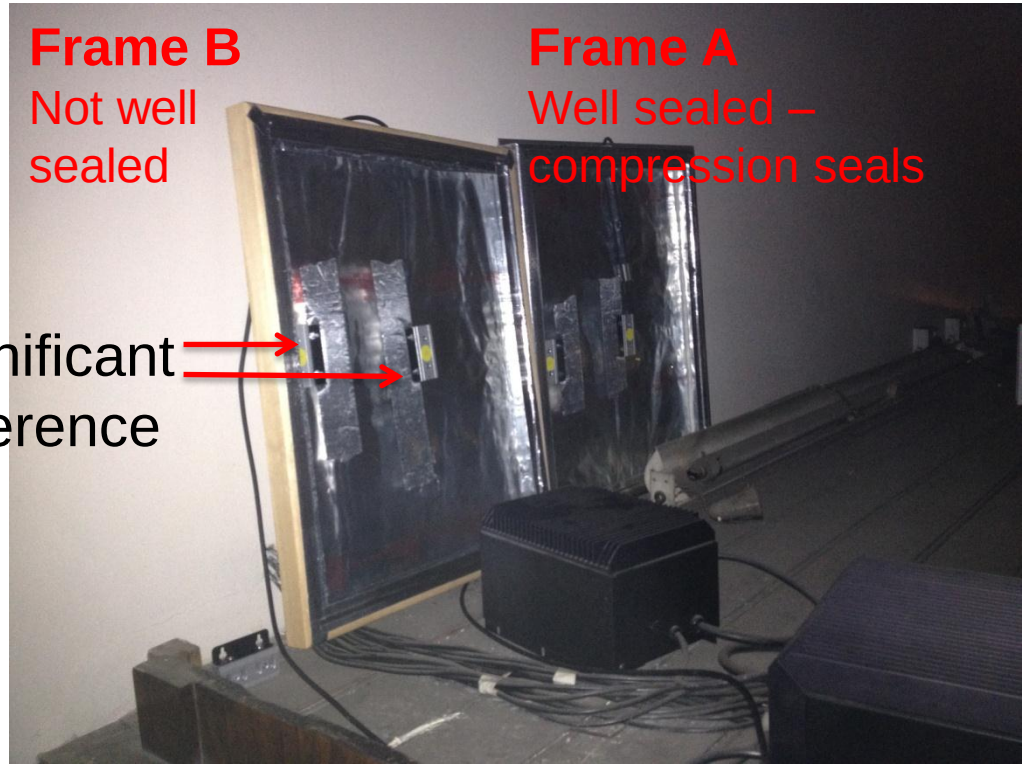


Ventilation Rate: Air Exchange Rate (AER)



Measurement location: Picture Frames

- 2 painting frames (sealed differently) and 1 print frame.
- Measuring external pollutants



Measurement at edge 50% reduction from room

85% reduction from room

Measurement Location: Summary

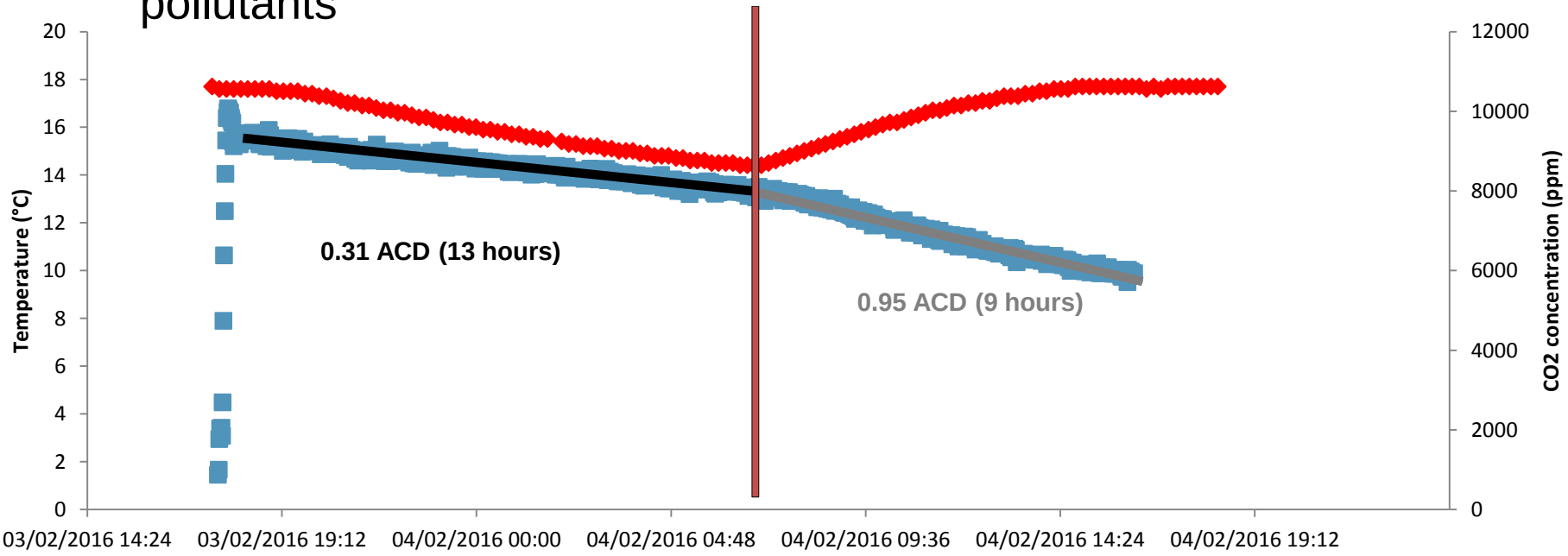
- **In picture frames:**
- Where well sealed, i.e. Low air exchange rate, and expectation of lower pollution, location is not important
- Where air exchange rate is higher, allowing for ingression of pollutants the edge measurement is higher than the centre
- Aesthetically cant measure in centre of frame, important to consider that edge may give higher measurement than object receives, or that edge of image degrades faster.

Measurement location: Showcases Test

- Oak as source of organic acids, high RH initially
- Controlled and uncontrolled environments
- Shelves created – different gap size:
  - 25mm+15mm
- Diffusive measurements at each level, front and back
- Results:
- Controlled – no difference
- Bottom to middle – no difference
- Bottom to top – significant difference (@ 90% CI)

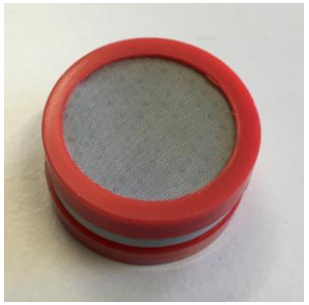
Climatic Conditions: Temperature effect on AER

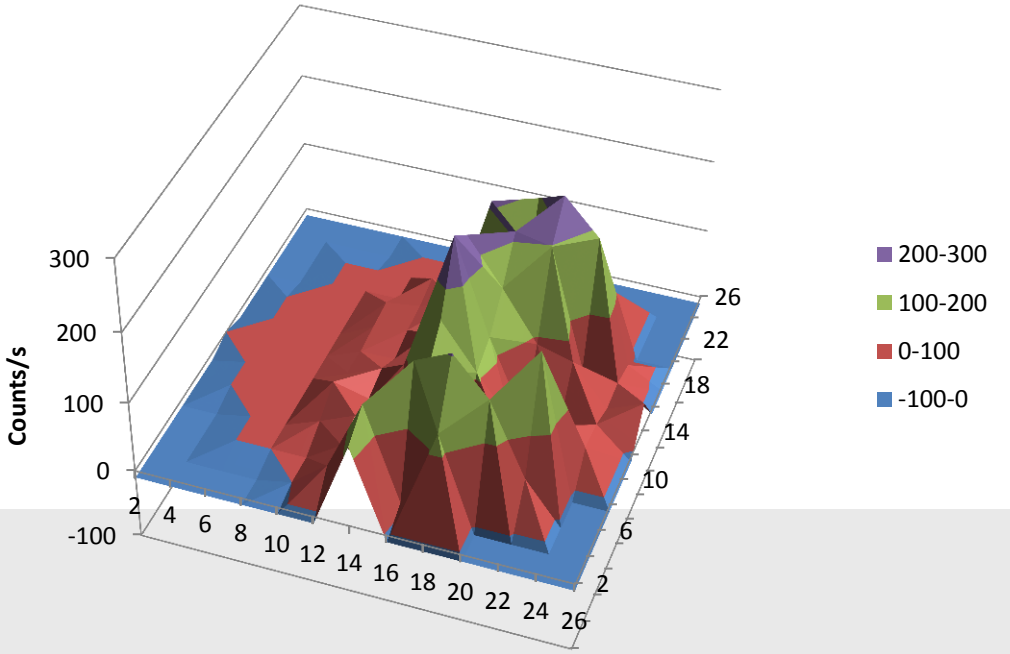
- Air exchange rate test setup to run overnight with heating coming on at 0730
- Important as has an effect to dilute concentration of internal pollutants



Diffusive dosimeter XRF

- Investigated why there might be a reason for significant differences between duplicate measurements
- Inside is filter with Potassium hydroxide to capture organic acids
- Carried out XRF in a grid over the filter





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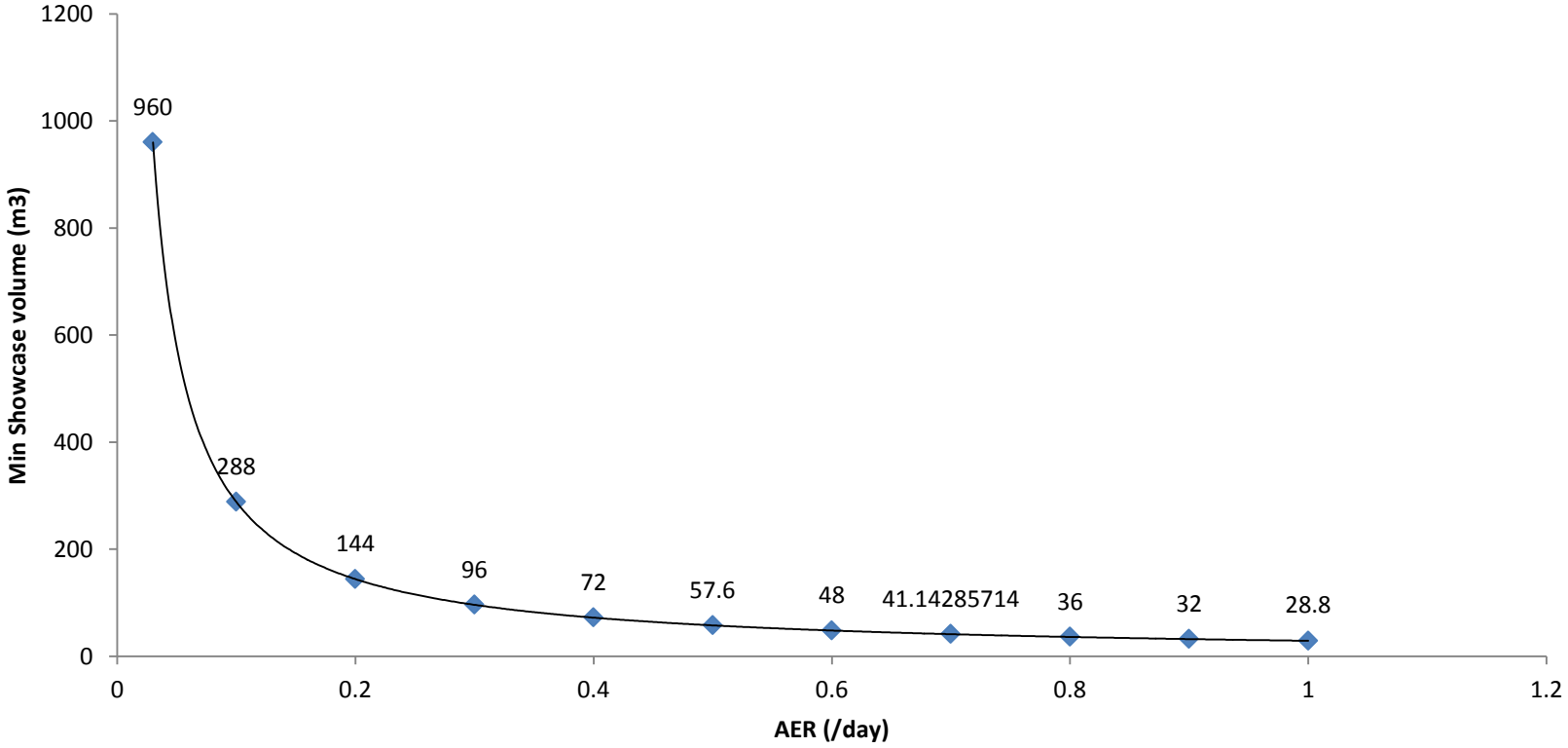
ISO16000-1:2004

- Also states that:
- “sample volume should be less than 10% of the ventilation rate”



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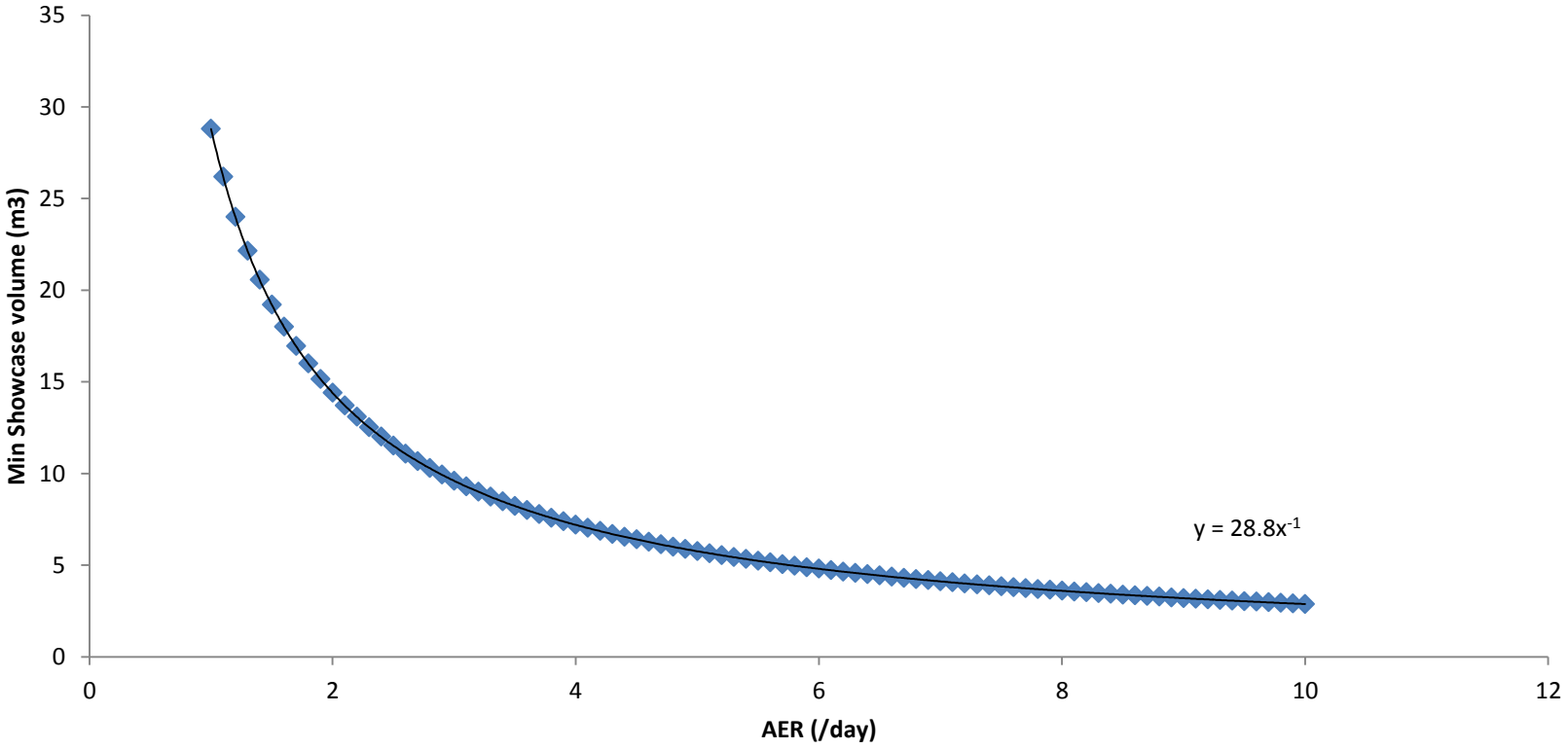

Summary

- What variables to consider when designing pollutant measurements and interpreting the results?
  - Why?
  - Environment – T/RH
  - Date and time
  - Type of monitoring – diffusive/active
  - Location of sampling – both local to the measurement, within building and rural/urban etc
  - Ventilation – enclosure doors – equipment in use (active control)
  - Materials present – i.e potential sources/sinks

Summary

- Understand why? What concerns? What pollutants to measure?
- Location: If you are worried about one specific object – close to object
  - Otherwise in a representative location – similar location of objects
- Diffusive measurements better – summer would be better for indoor pollutants to give a worst case scenario
- Tools available on MEMORI website to help understand when conditions may give highest concentrations
- If concerned about multiple enclosures (of same construction) choose depending upon AER and displayed objects
- Same setup as when objects displayed, i.e mount materials included, active control switched on, both in case and room.

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Thank you
Any Questions?

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www.english-heritage.org.uk/learn/conservation/

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