Allowing for Contaminated Gas Standards Within the Measurement Ratification Process

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Analyser Calibrations

• Response of analysers quantified by regular calibrations
• Fortnightly calibrations of gas analysers usually appropriate
• Calibration sources traceable to National Metrological Standards
• Each ambient measurement linked to a calibration value
• In turn traceable to a primary standard
Scaling of NO\textsubscript{x} Measurements

- Uses NO\textsubscript{x} & NO readings from a NO span gas test
- Uses NO\textsubscript{x} & NO readings from a zero test
- Scaling Factors for NO\textsubscript{x} & NO measurement channels calculated:

\[
\text{NO Scaling Factor} = \frac{\text{NO conc cylinder}}{\text{NO span} - \text{NO zero}}
\]

\[
\text{Scaling Factor} = \frac{400}{202-2} = 2
\]

- NO\textsubscript{x} & NO Scaling Factors applied to ‘raw’ measurements
- NO\textsubscript{2} calculated from Scaled NO\textsubscript{x} – Scaled NO
Point Scaling of Measurements
Linear Scaling of Measurements
Problems with NO Gas Cylinders

- Oxidation of some of the cylinder’s NO to NO\(_2\)
- Unquantified drop in the cylinder’s NO concentration
- NO\(_x\) concentration usually unchanged

- Alternatively cylinder contents may degrade gradually
- Reductions in both NO\(_x\) and NO concentrations

- Loss of traceability in both scenarios
Effects on Measurement Scaling

- Reduced response on NO channel during calibration
- Corrected for by applying a falsely elevated NO Scaling Factor
- $\text{NO}_x$ Scaling Factor unaffected
- NO scaling error results in under-reporting of $\text{NO}_2$
- Effect most apparent during pollution episodes
Provisional Measurements from a west London Roadside Site
Ratified Measurements from a west London Roadside Site
Ratification Case Studies
Case 1: Roadside Site, SW London

• Scaling Factors indicated cylinder oxidation at installation
• Problem detected and cylinder replaced after 8 weeks
• Occurred during unbroken analyser operation
• Regular calibration programme in place
Change in Scaling Factors with Cylinder Oxidation
Measurement Scaling at Ratification

![Graph showing measurement scaling factors over time]

- NOx Scaling Factor
- NO Scaling Factor

X-axis: Jan, Feb, Mar, Apr, May, Jun
Y-axis: Scaling Factor
Case 2: Background Site, SW London

• Scaling Factors indicated cylinder contamination at installation
• But not detected due to long-term communications problem at site
• Audit 5 months after cylinder installation
• Had cylinder been stable between installation & audit?
Change in Scaling Factors with Cylinder Oxidation

![Graph showing change in scaling factors with cylinder oxidation]
Measurement Scaling at Ratification

![Graph showing scaling factors over time with different lines representing different scaling factors.](image)
Case 3: Roadside Site, south London

- Scaling Factors indicated contamination on installation
- 4 month interval between installation & audit
- Had cylinder been stable over this period?
Change in Scaling Factors with Cylinder Oxidation

![Graph showing change in scaling factors with cylinder oxidation]
Measurement Scaling at Ratification

![Scaling Factor Graph](chart.png)

- **NOx Scaling Factor**
- **Original NO Scaling Factor**
- **Recalculated NO Scaling Factor**

*Presented by King's College London*
Summary

• Problems typically occur when air within a regulator mixes with the contents of a NO cylinder

• Only a small proportion of cylinders affected

• Normally possible to rescale measurements

• But relies on long-term calibration histories and audits
The Pressure Systems Safety Regulations (PSSR)
What Is PSSR?

• PSSR covers a wide range of devices which are pressurised above 0.5 bar

• Regulations aim to minimise the risk of uncontrolled pressure releases

• PSSR focuses upon the ‘physical’ hazards of uncontrolled pressure releases – such as injury from flying debris or explosion blast

• Any risk of injury from inhaling escaped gases is covered by other regulations – not PSSR
Pressurised Devices on the LAQN

• Gas Cylinders
  not covered by PSSR, but users have a responsibility to store and use them correctly

• Calibration Lines
  generally under very low pressure, with limited risk of injury in the event of failure

• Regulators
  operate at high pressures, principal safety device in the gas delivery system, covered by PSSR
Regulators

• Suppliers have a responsibility to provide safety information on their products – for example, stating maximum inlet and outlet pressures

• Owners must ensure that regulators are either:
  replaced
  or inspected
  every 5 years

• ERG experience suggests that inspection / repair is generally more cost-effective than replacement
5 Yearly Regulator Inspections

- Regulators must be inspected by a reputable organisation
- Regulator inspection typically entails:
  - disassembly & cleaning of major parts
  - pressure test to 220 bar
  - leak test
  - calibrate / replace gauges
  - determine safe inlet & outlet pressures

- Inspection and repair can normally be completed between fortnightly calibration visits
LSO Regulator Inspections

- Visual and basic functionality checks of regulators can be performed by LSOs
- Not a specific requirement of PSSR, but is recommended as good practice
- LSO checks should be performed either annually or with each gas cylinder exchange
Outlet gauge. Check:
- Needle at 0 psi
- Lens secure & undamaged
- Back plate secure & undamaged

Inlet stem. Check:
- Connection free from cracks, etching & contamination
- Washer / filter in place
- Inlet nut rotates freely on stem
Further Information

• Further information on PSSR, regulator inspections & gas safety training provided in the seminar pack

• SOPs being written for the:
  
  safe exchange of gas cylinders
  LSO inspection of regulators
  flushing of regulators to prevent NO oxidation

• The SOPs will be freely available from ERG in due course and reflect the various equipment setups on the LAQN