



KING'S
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Allowing for Contaminated Gas Standards Within the Measurement Ratification Process

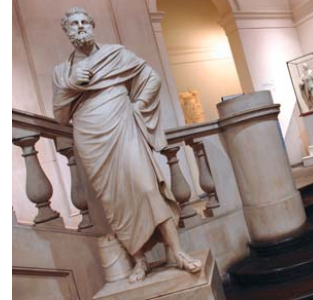
Paul Johnson, King's College London

7th July, 2007



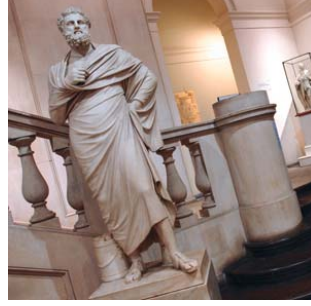
Contents

- Calibrations and measurement scaling
- Problems with NO gas standards
- Ratification case studies
- The Pressure Systems Safety Regulations
- Further Safety Information



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



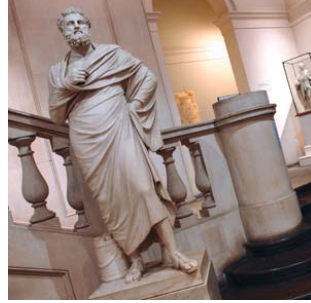
Scaling of NO_x Measurements

- Uses NO_x & NO readings from a NO span gas test
- Uses NO_x & NO readings from a zero test
- Scaling Factors for NO_x & NO measurement channels calculated:

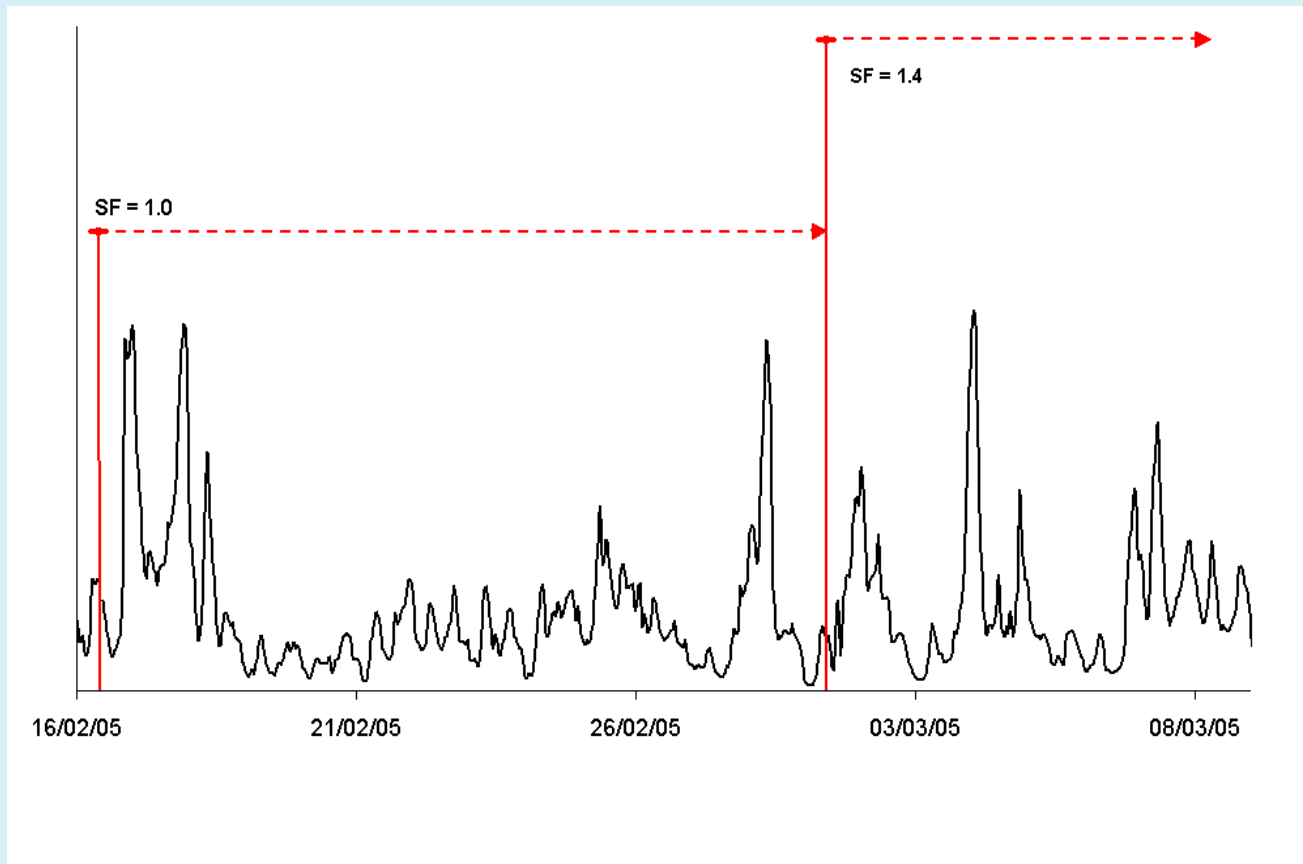
$$\text{NO Scaling Factor} = \text{NO conc cylinder} / (\text{NO span} - \text{NO zero})$$

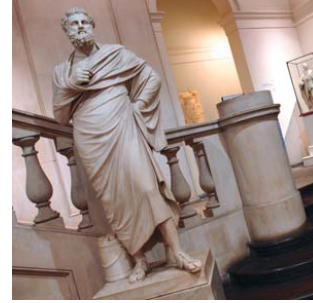
$$\text{Scaling Factor} = 400 / (202 - 2) = 2$$

- NO_x & NO Scaling Factors applied to 'raw' measurements
- NO₂ calculated from Scaled NO_x – Scaled NO

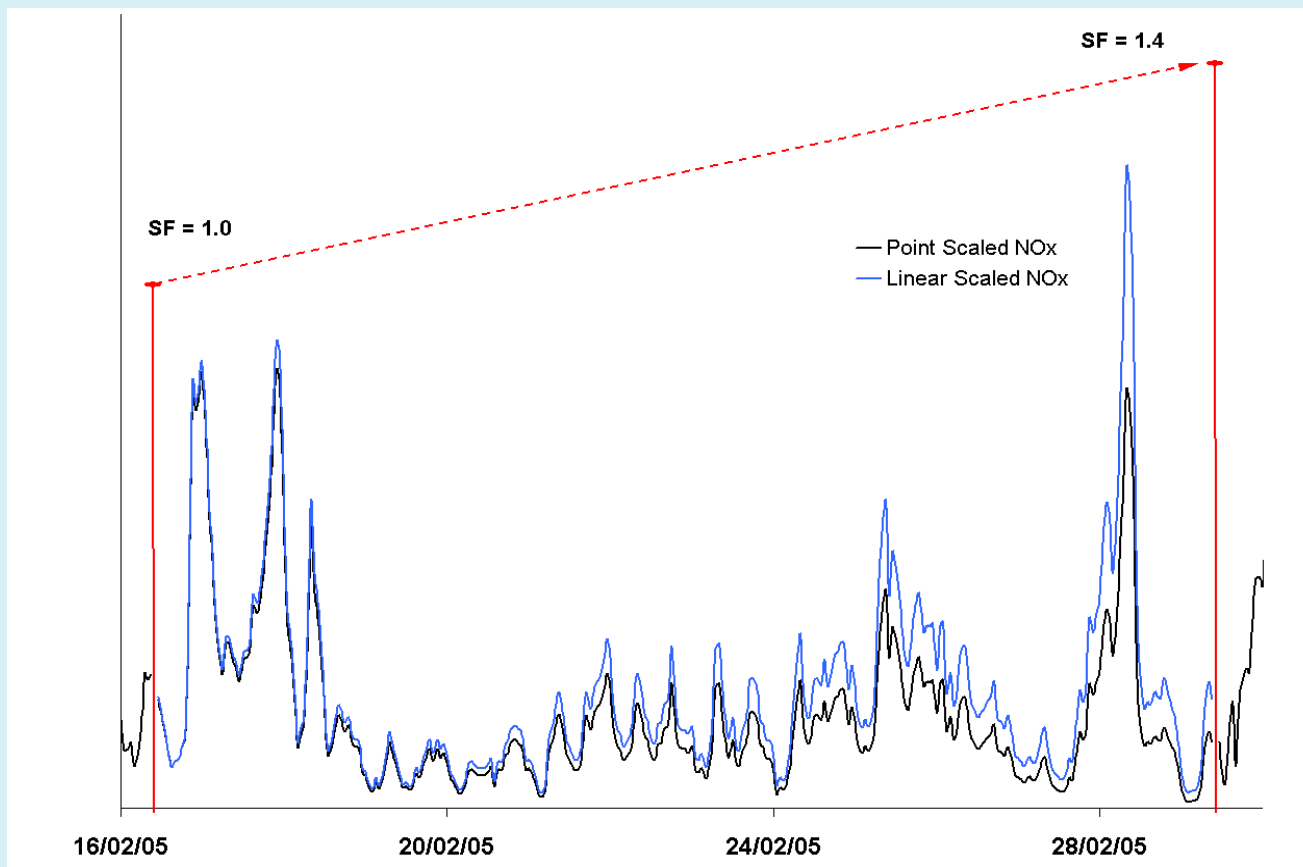


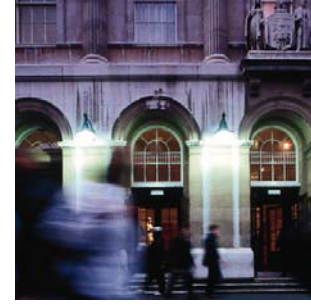
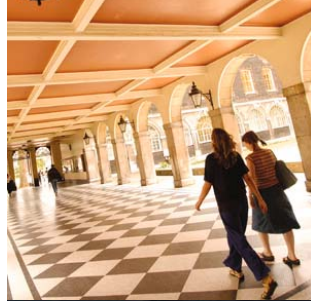
Point Scaling of Measurements





Linear Scaling of Measurements



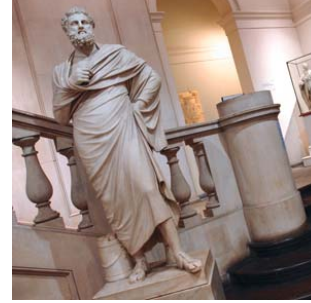


Problems with NO Gas Cylinders

- Oxidation of some of the cylinder's NO to NO₂
- Unquantified drop in the cylinder's NO concentration
- NO_x concentration usually unchanged

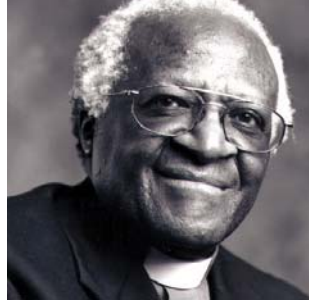
- Alternatively cylinder contents may degrade gradually
- Reductions in both NO_x and NO concentrations

- Loss of traceability in both scenarios

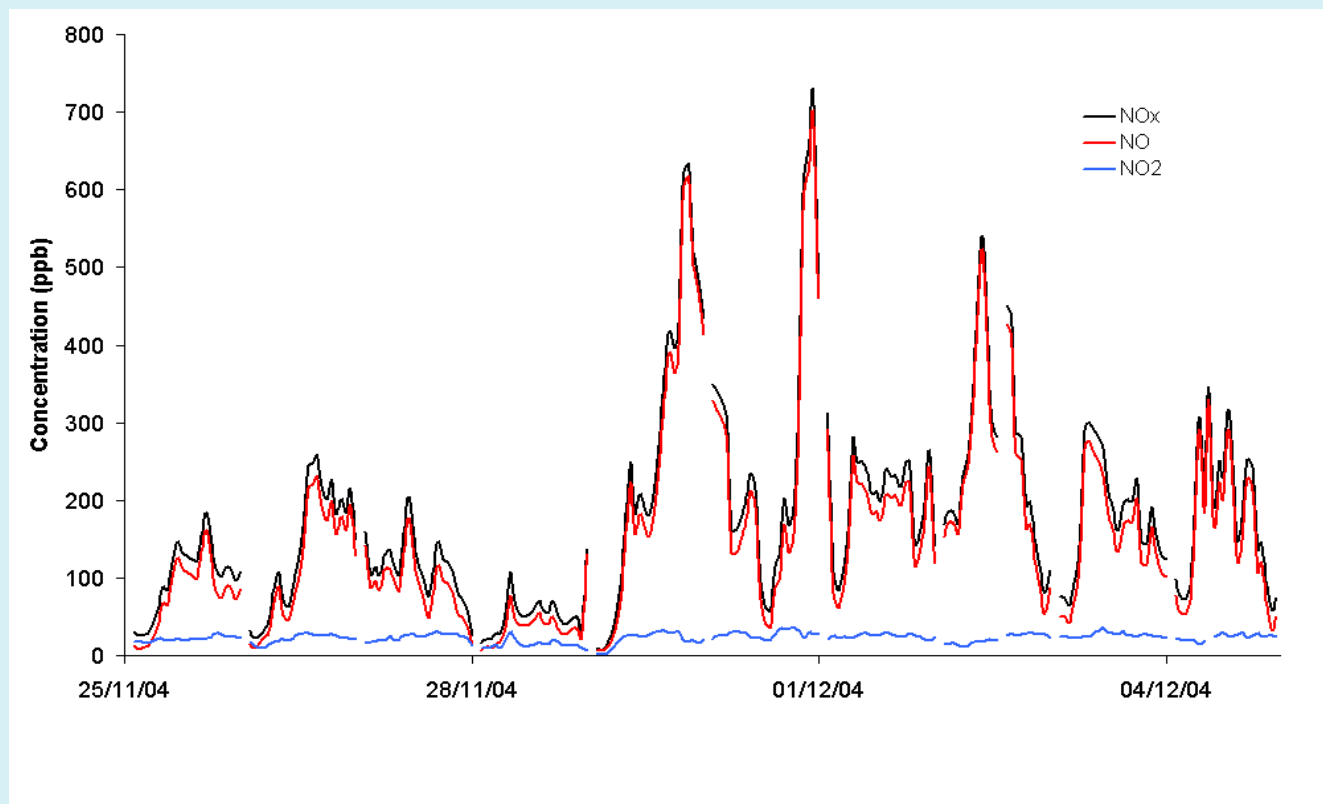


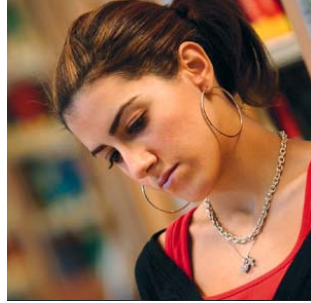
Effects on Measurement Scaling

- Reduced response on NO channel during calibration
- Corrected for by applying a falsely elevated NO Scaling Factor
- NO_x Scaling Factor unaffected
- NO scaling error results in under-reporting of NO₂
- Effect most apparent during pollution episodes

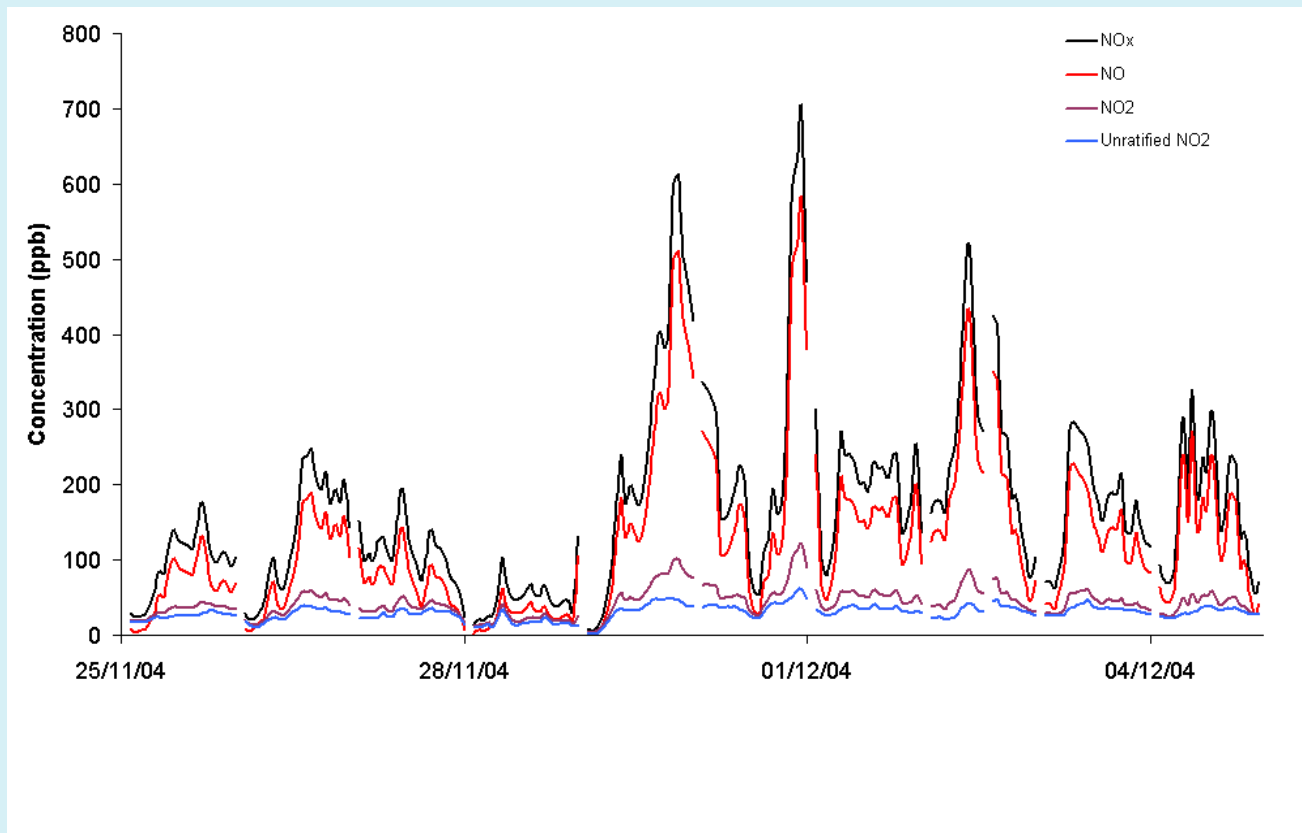


Provisional Measurements from a west London Roadside Site





Ratified Measurements from a west London Roadside Site





Ratification Case Studies

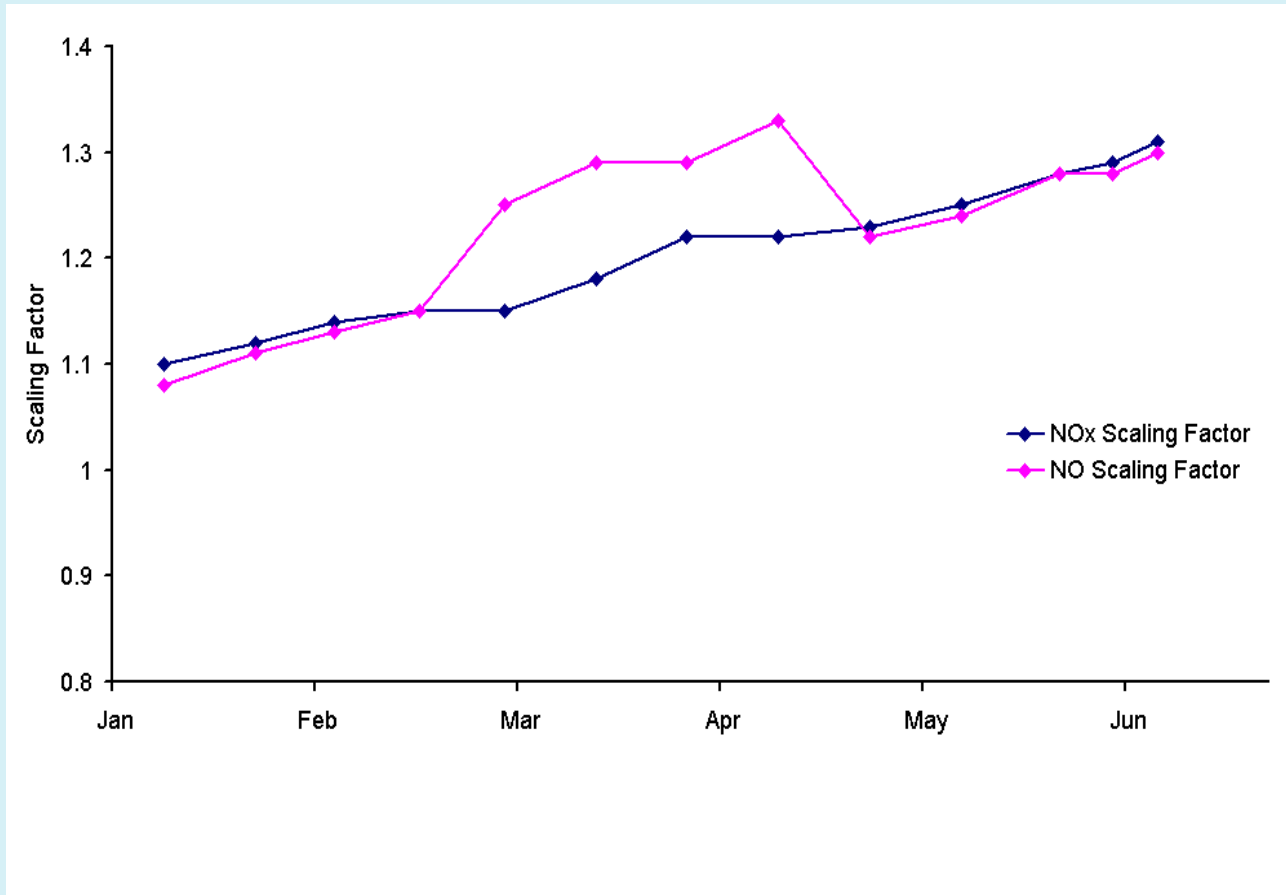


Case 1: Roadside Site, SW London

- 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

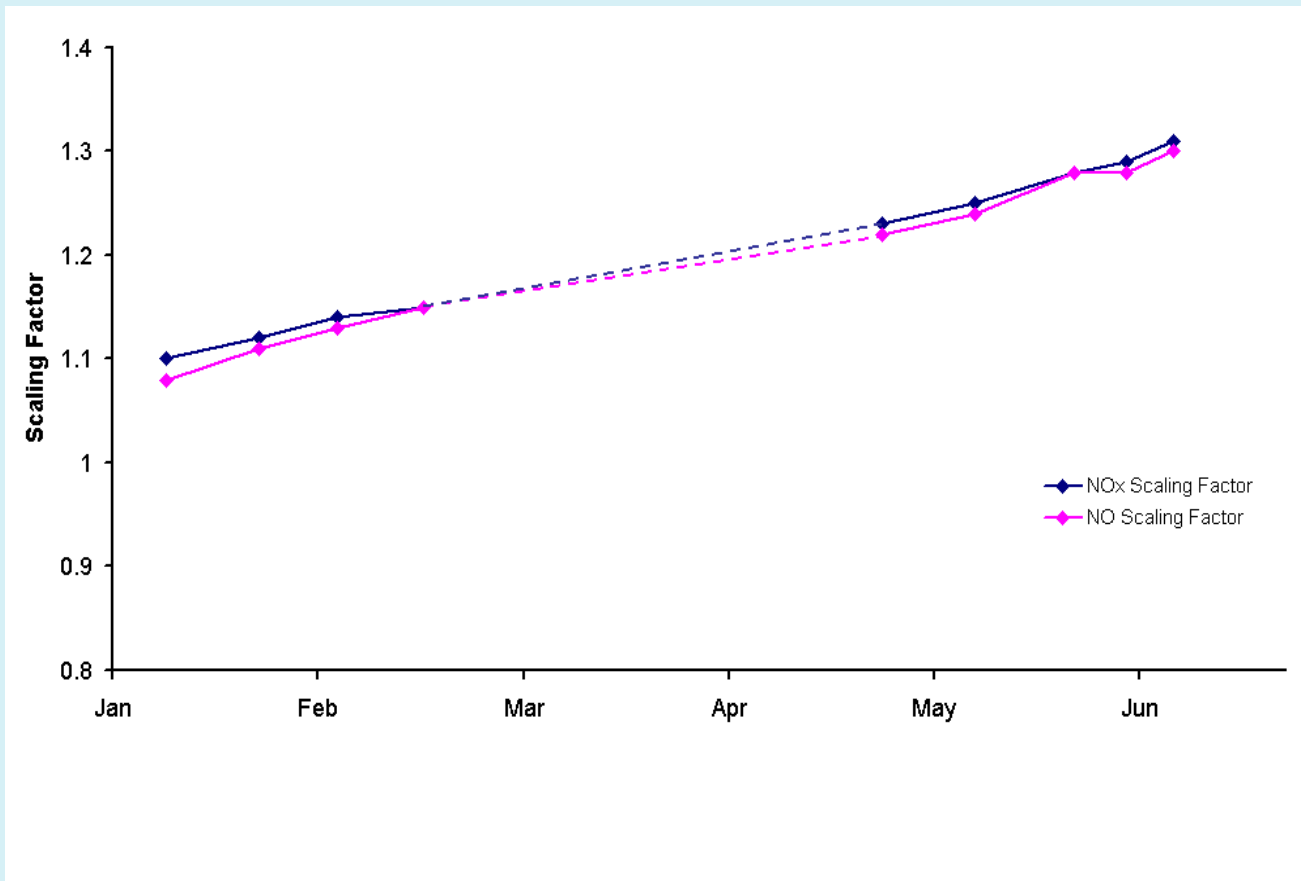


Change in Scaling Factors with Cylinder Oxidation





Measurement Scaling at Ratification



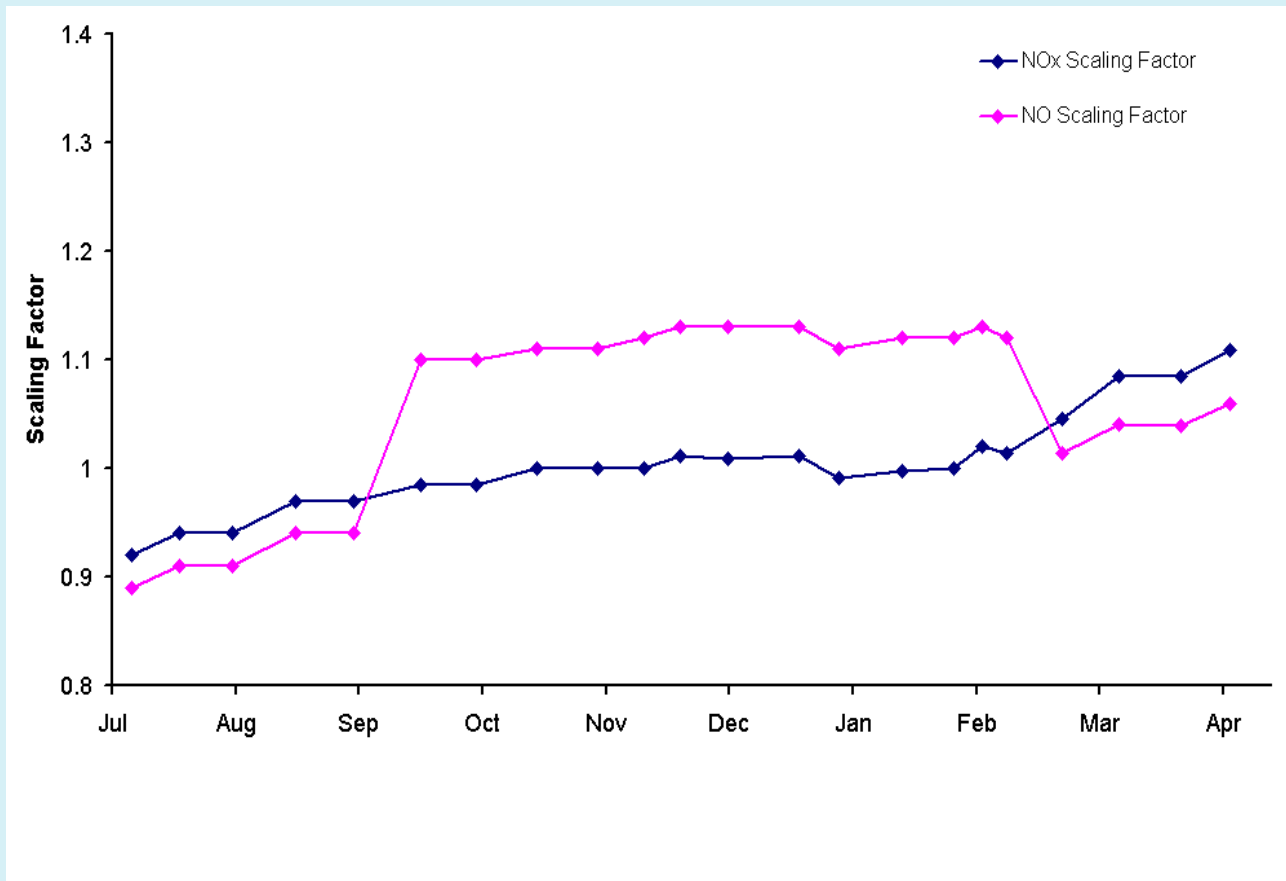


Case 2: Background Site, SW London

- 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 ?

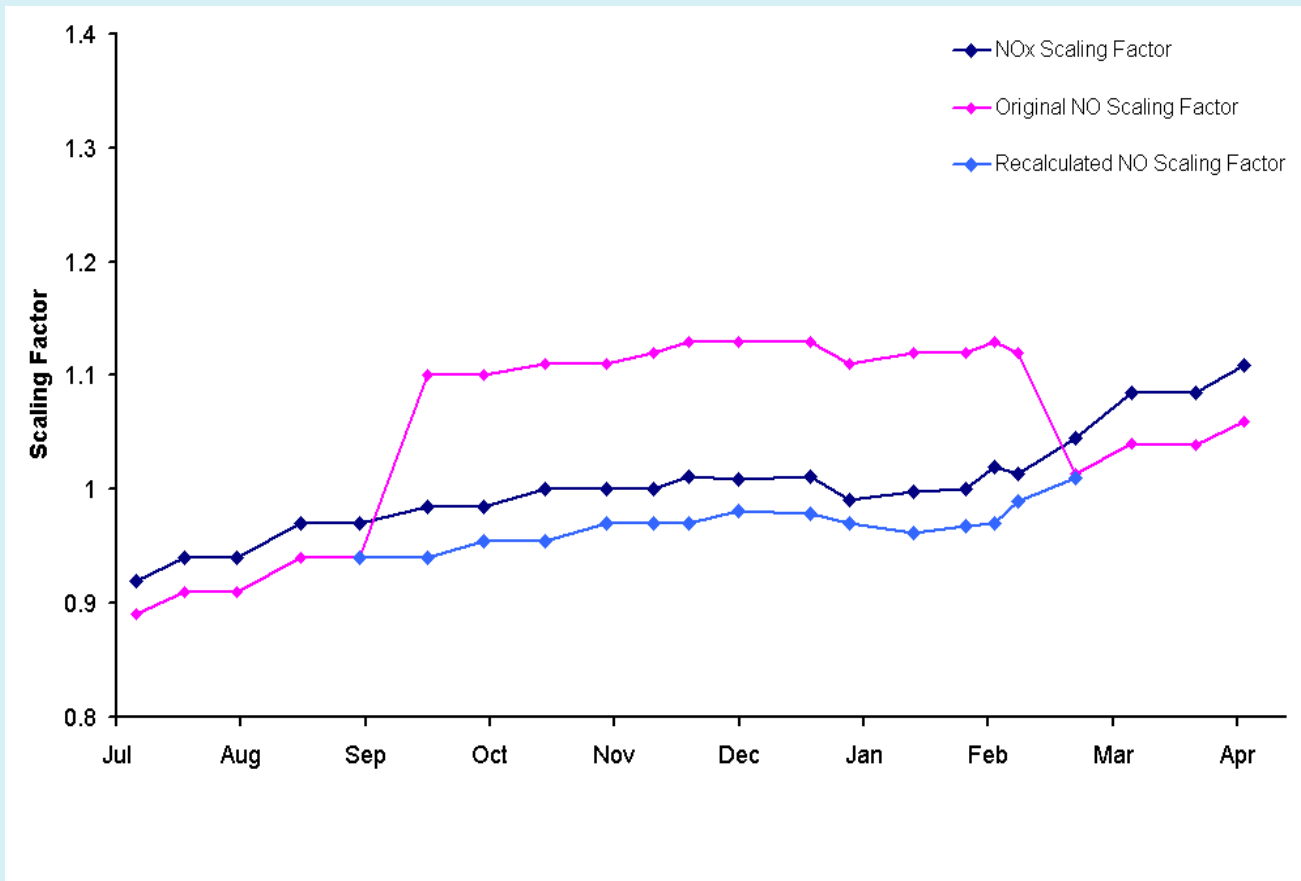


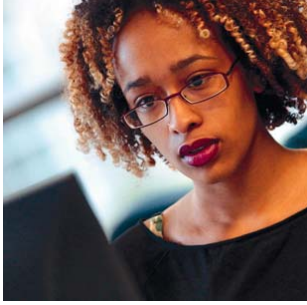
Change in Scaling Factors with Cylinder Oxidation





Measurement Scaling at Ratification



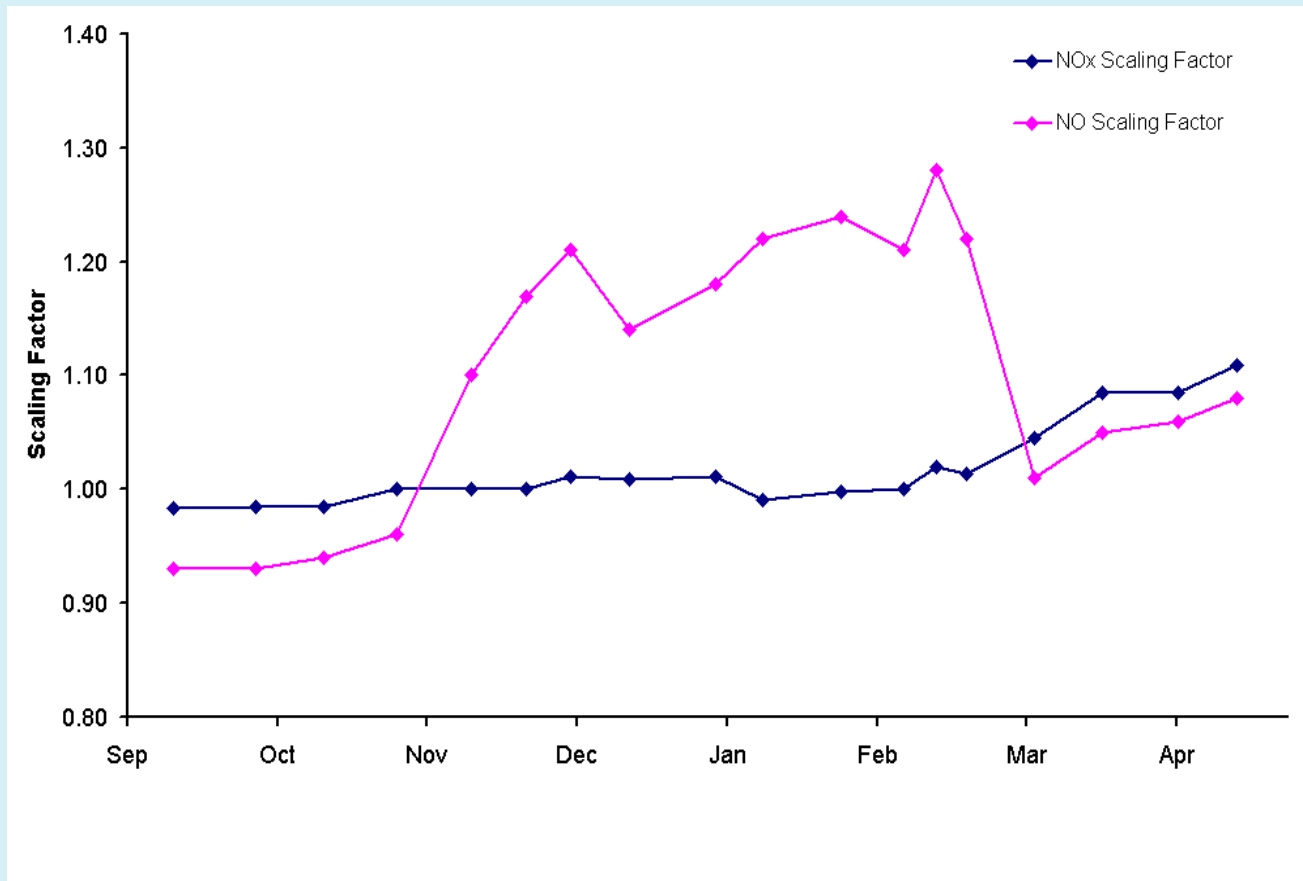


Case 3: Roadside Site, south London

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

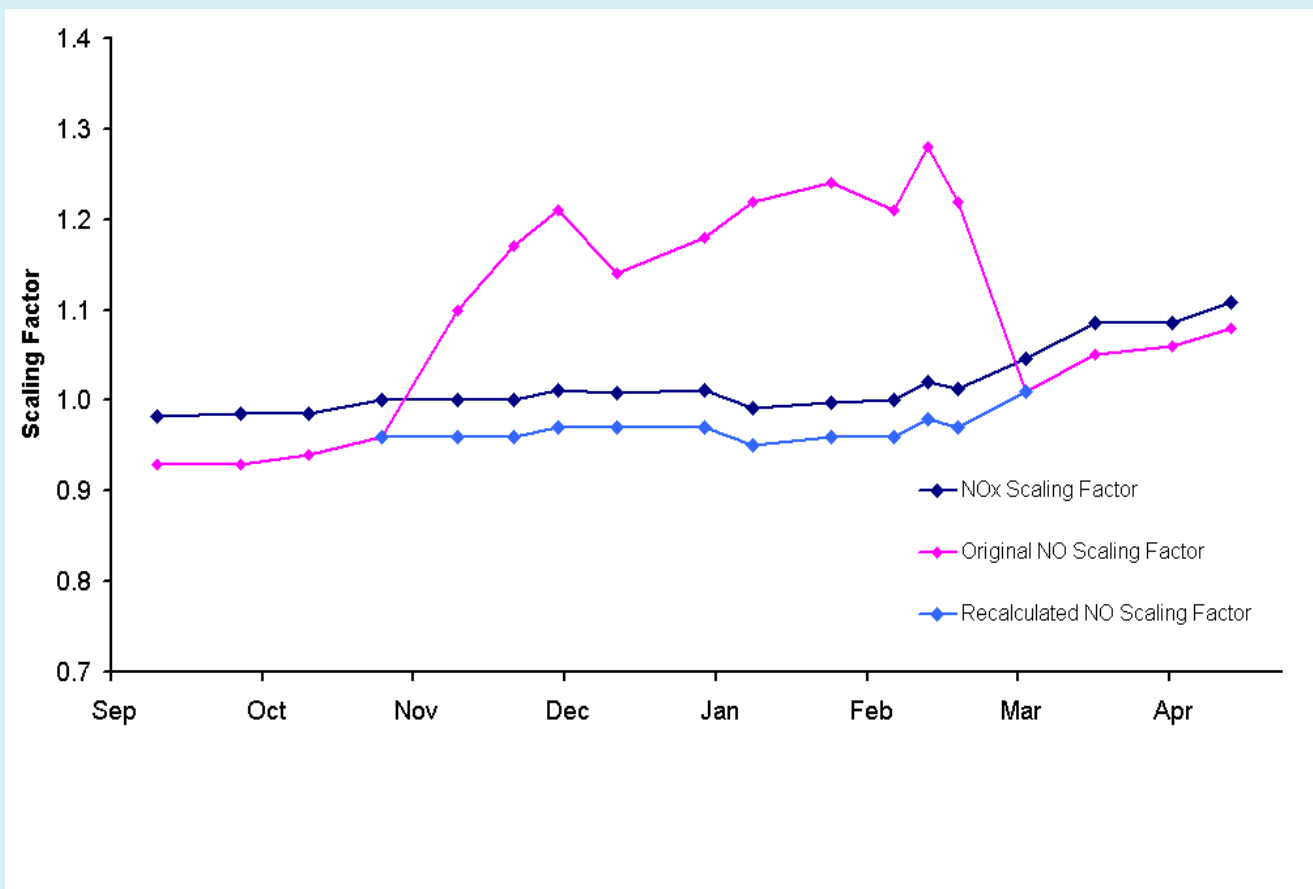


Change in Scaling Factors with Cylinder Oxidation





Measurement Scaling at Ratification





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



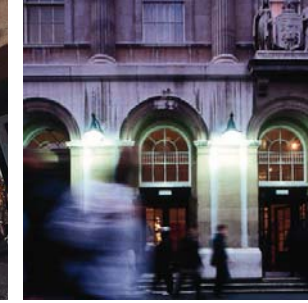
5 Yearly Regulator Inspections

- 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

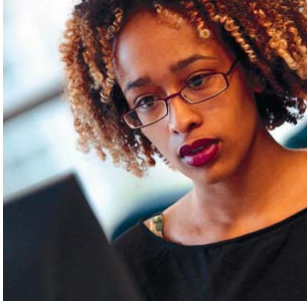


Outlet gauge. Check:

- 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