

Certificate of calibration

For: Prof James Lee
WACL
National Centre for Atmospheric Science
University of York
Heslington
York
YO10 5DD
United Kingdom

Date: 19th January 2018

Serial Number of
Instrument: Ozone5

Results: **OZONE_5 49i Ozone nmol/mol = 1.0126 NCAS
Primary Standard nmol/mol – 1.4196 nmol/mol**

Uncertainty at amount fractions greater than 100
nmol/mol = $\pm 3\%$ of value. Uncertainty at amount
fractions between 0 and 100 nmol/mol = 3nmol/mol.

Carried out and authorised
by: Dr Katie Read
NCAS Scientist
University of York
York, UK

Signed:



Reference to NIST Scale

The NCAS Primary Standard (TE49i) is calibrated annually at the National Physical Laboratory against the NIST Standard Reference Photometer SRP 20, quality assured and controlled by independent audit procedures. The calibration performed relates the output from the NCAS TE49i analyser front panel to the ozone amount fractions determined by the SRP.

The most recent calibration (2nd September 2016) of the NCAS Primary Standard reported: -

$$\text{TE49i nmol/mol} = 1.004 \text{ SRP20 nmol/mol} + 0.3 \text{ nmol/mol}$$

Measurement procedure

The visiting instrument is calibrated in the same way. The sample line used, had previously been conditioned at an amount fraction of 1000 nmol/mol of ozone for over an hour.

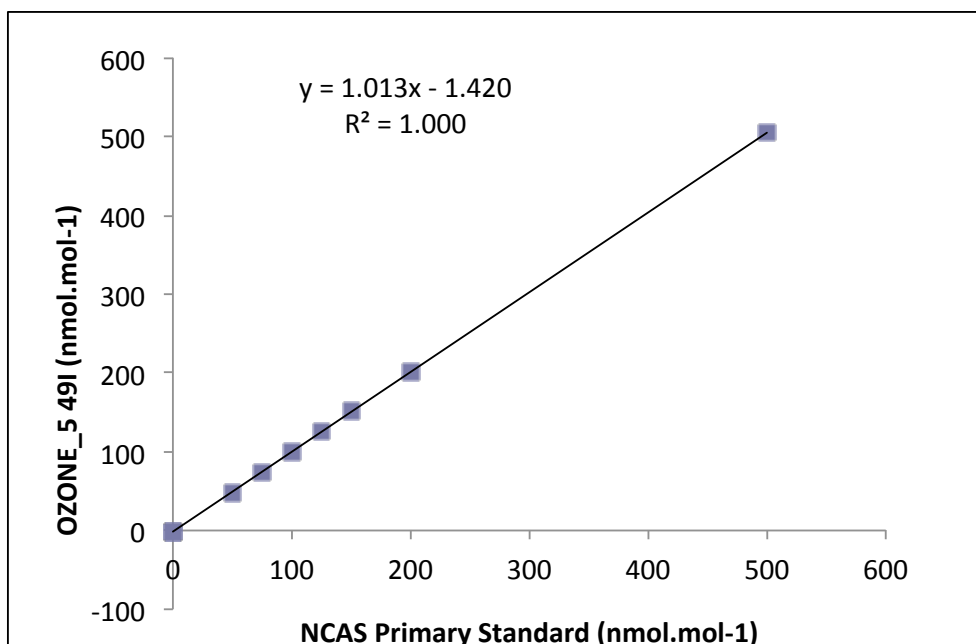
The last two of three calibrations were used to generate the calibration data.

$$\text{FAAM 49C Ozone output in nmol/mol} = \mathbf{m} \text{ NCAS Primary Standard nmol/mol} + \mathbf{c}$$

where: **m** is the gradient determined as the ratio of the visiting instrument reading for ozone to the TE49i reading for ozone and **c** is the zero intercept expressed in nmol/mol.

Results

NCAS Primary Standard (nmol.mol ⁻¹)	FAAM 49C (nmol.mol ⁻¹)	Standard deviation (nmol.mol ⁻¹)
0	-1.565	0.142
50	48.880	0.146
100	99.592	0.139
150	150.392	0.264
200	200.958	0.124
75	74.744	0.236
125	125.330	0.231
500	504.947	0.252
0	-0.970	0.094



OZONE_5 49I Ozone nmol/mol = 1.013 NCAS PS nmol/mol -1.420 nmol/mol

The above equation is only valid in the amount fraction range 0-1000 nmol/mol.

Uncertainty is generally quoted as $\pm 3\%$ for amount fractions greater than 100 nmol/mol and 3 nmol/mol for amount fractions between 0 and 100 nmol/mol.

These uncertainties contain components arising from the uncertainty in the ozone absorption cross section, the purity of the air supply used in the calibration, any non-linearity in the analytical instrumentation, and bias in the primary standard used (based on the results of international intercomparisons).

Precision of the instrument has been calculated using the zero data and by applying the following formula:-

Precision = $\sqrt{2 \times \text{standard deviation of } 10 \times 1 \text{ minute data points}}$

The precision is 0.43 nmol/mol for this instrument.

We recommend that you carry out calibrations at least annually to verify the stability of your analyser.

This work was carried out in the COZI-Lab in the Wolfson Atmospheric Chemistry laboratories (WACL) at the University of York. The COZI-Lab is principally funded through the National Centre for Atmospheric Science (NCAS).