



NATIONAL PHYSICAL LABORATORY

Teddington Middlesex UK TW11 0LW Telephone +44 20 8977 3222

NPL Management Ltd – Registered in England and Wales No 2937881



0478

# Certificate of Calibration

## OZONE TRANSFER STANDARD

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units, to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes, or to other internationally recognised standards. This certificate may not be reproduced other than in full, unless permission for the publication of an approved extract has been obtained in writing from NPL Management Ltd. The data included in this certificate applies only to those items specifically listed as tested, calibrated or sampled and cannot be used to assign any attributes beyond those shown by the data.

**FOR:** University of York,  
National Centre for Atmospheric Science (NCAS),  
Department of Chemistry,  
Heslington, York, YO10 5DD  
United Kingdom

**DESCRIPTION:** Calibration of Ozone Transfer Standard

**IDENTIFICATION:** TE79i-PS S/N 0703820527

Certified response of TE49i-PS:  
 $\text{TE49i-PS nmol mol}^{-1} = 0.991 \text{ SRP20 nmol mol}^{-1} + 0.8 \text{ nmol mol}^{-1}$

Uncertainty at amount fractions greater than 100  $\text{nmol mol}^{-1} = 3\%$  of value.

Uncertainty at amount fractions between 0 and 100  $\text{nmol mol}^{-1} = 3 \text{ nmol mol}^{-1}$ .

**DATE(S) OF CALIBRATION:** 07th October 2025

**UNCERTAINTIES:** The reported uncertainties are based on a standard uncertainty multiplied by a coverage factor,  $k = 2$ , providing a level of coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

**Reference:** UniYork2025090268Oct25

**Page 1 of 3**

**Date of Issue:** 09 October 25

**Signed:** *David Butterfield* (Authorised Signatory)

**Checked by:** JS

**Name:** D M Butterfield

**on behalf of** NPLML

## 1. MEASUREMENT PROCEDURE

The National Physical Laboratory (NPL) has calibrated an ozone transfer standard. The traceable NPL calibration standard used was NIST Standard Reference Photometer SRP 20, quality assured and controlled by independent audit procedures. The calibration performed relates the transfer standard RS232 output to the ozone amount fractions determined by the SRP. The ozone cross-section used in the SRP software, and hence the value to which the results of these calibrations are traceable, is that given by CCQM.O3.2019, i.e.  $1.1329 \times 10^{-17} \text{ cm}^2 \text{ molecule}^{-1}$ .

The transfer standard was calibrated, having first conditioned the sample lines at an amount fraction of approximately  $541 \text{ nmol mol}^{-1}$  of ozone for over an hour.

Ten calibration runs were carried out, each covering ten ozone amount fractions in the range zero to  $543 \text{ nmol mol}^{-1}$ . Each constituent data point consisted of ten determinations of ozone amount fraction measured by both the SRP and the transfer standard. The data were combined to produce linear regressions in the form:

Transfer standard output in  $\text{nmol mol}^{-1} = \mathbf{m}$  SRP20 reading in  $\text{nmol mol}^{-1} + \mathbf{c}$ ,

where:  $\mathbf{m}$  is the gradient determined as the ratio of the transfer standard reading for ozone in  $\text{nmol mol}^{-1}$  to the SRP reading for ozone in  $\text{nmol mol}^{-1}$

$\mathbf{c}$  is the zero-intercept expressed in  $\text{nmol mol}^{-1}$ .

The mean values for  $\mathbf{m}$  and  $\mathbf{c}$ , over the ten calibration runs, were calculated and are shown below.

During these tests, the ozone "slope", i.e. the transfer standard' "span" setting, was set to 1.011.

## 2. RESULTS

The results of the calibration were as follows:

$$\text{TE49i-PS nmol mol}^{-1} = 0.991 \text{ SRP20 nmol mol}^{-1} + 0.8 \text{ nmol mol}^{-1}$$

The above equation is only valid in the amount fraction range 0 to 543 nmol mol<sup>-1</sup>.

The standard error of the residuals of the linear regressions was 0.3 nmol mol<sup>-1</sup>.

The uncertainty in the values predicted by this equation is 3.0% at amount fractions greater than 100 nmol mol<sup>-1</sup>, and 3 nmol mol<sup>-1</sup> at amount fractions between 0 and 100 nmol mol<sup>-1</sup>.

The above overall uncertainties contain components arising from:

- Uncertainty in the ozone absorption cross section
- Purity of the air supply used in the calibration
- Non-linearity in the analytical instrumentation
- Bias in the primary standard used, based on the results of international intercomparisons

The overall uncertainty has been determined according to the Guide to the expression of Uncertainty in Measurement published by the International Organisation for Standardisation in association with the Comité International des Poids et Mesures (CIPM). The uncertainties consist of CIPM classification type A uncertainties, evaluated by statistical methods, combined with CIPM classification type B uncertainties, evaluated by other means.

## 3. VALIDITY

No tests were carried out on the long-term stability of the transfer standard. It is our experience that ozone photometers operating on the UV absorption principle are likely to remain stable for periods of up to 6 months.