



National Institute of Standards & Technology

# Certificate of Analysis

Standard Reference Material<sup>®</sup> 2738

Nitric Oxide in Nitrogen

(Nominal Amount-of-Substance Fraction 1000 nmol/mol)

*This certificate reports the certified values for Lot 2738-AL-XX.*

This Standard Reference Material (SRM) is a primary gas mixture for which the amount-of-substance fraction, expressed as concentration [1], may be related to secondary working standards. This SRM is intended for the calibration of instruments used for nitric oxide determinations and for other applications.

This SRM mixture is supplied in a DOT 3AL-specification aluminum (6061 alloy) cylinder with a water volume of 30 L. Mixtures are shipped with a nominal pressure exceeding 11.0 MPa (1600 psig). The cylinder is the property of the purchaser and is equipped with a CGA-660 stainless steel valve, which is the recommended outlet for this nitric oxide mixture.

**Certified Values:** This SRM mixture has been certified for nitric oxide (NO) concentration. The certified values given below applies to the identified cylinder and NIST sample number.

Nitric Oxide Concentration:	SAMPLE nmol/mol $\pm$ 15 nmol/mol
Cylinder Number: SAMPLE	NIST Sample Number: SAMPLE
Hydrotest Date: January 2001	Blend Date: June 2001

A NIST certified value is a value for which NIST has the highest confidence in its accuracy in that all known or suspected sources of bias have been investigated or taken into account [2]. The uncertainty of the certified value includes the estimated uncertainties in the NIST standards, the analytical comparisons to the lot standard (LS), and the uncertainty of comparing the LS with each of the mixtures comprising this lot. The uncertainty is expressed as an expanded uncertainty  $U = ku_c$  with  $u_c$  determined by experiment and a coverage factor  $k = 2$ . The true value for the nitric oxide amount-of-substance fraction is asserted to lie in the interval defined by the certified value  $\pm U$  with a level of confidence of approximately 95 % [3].

**Expiration of Certification:** The certification of SRM 2738 Lot No. 2738-AL-XX is valid, within the measurement specified, from the certification date of <<Certification Date>> until <<Expiration Date (2 years from certification date)>>, provided the SRM is handled and stored in accordance with the instructions given in this certificate (see "Cylinder and Gas Handling Information"). The certification is nullified if the SRM is damaged, contaminated, or otherwise modified.

**Cylinder and Gas Handling Information:** NIST recommends the use of a high-purity, two-stage pressure regulator with a stainless steel diaphragm and CGA-660 outlet to safely reduce the pressure and to deliver this SRM mixture to the instrument. The regulator should be purged to prevent accidental contamination of the SRM by repeatedly (minimum three times) opening the valve and pressurizing the regulator, then closing the valve and releasing the pressure safely into a vent line. This SRM should not be used after the internal pressure drops below 0.7 MPa (100 psig). This SRM should be stored under normal laboratory conditions within the temperature range of 15 °C to 30 °C.

Overall direction and coordination of the technical work required for certification of this SRM were performed by F.R. Guenther of the NIST Chemical Sciences Division.

Carlos A. Gonzalez, Chief  
Chemical Sciences Division

Gaithersburg, MD 20899  
Certificate Issue Date: 22 August 2016  
*Certificate Revision History on Last Page.*

Steven J. Choquette, Director  
Office of Reference Materials

Analytical measurements leading to the certification of the current SRM lot were performed by W.J. Thorn III of the NIST Chemical Sciences Division.

Statistical evaluation of the data was performed by S.D. Leigh of the NIST Statistical Engineering Division.

Support aspects involved in the issuance of this SRM were coordinated through the NIST Office of Reference Materials.

**Traceability:** The measurand for nitric oxide is the total concentration of nitric oxide in nitrogen and the certified value is metrologically traceable to the derived SI unit of nanomoles nitric oxide per total moles of nitric oxide and nitrogen.

**Maintenance of SRM Certification:** Periodic analyses of SRM units from this lot are performed at NIST to monitor stability. If significant changes occur that affect the certification before the expiration of this certificate, NIST will notify the purchaser. Registration (see attached sheet or register online) will facilitate notification.

**Mixture Preparation:** The gas mixtures comprising this SRM lot were prepared in accordance with NIST technical specifications by a commercial specialty gas vendor under contract to NIST. NIST acknowledges that this SRM was made possible through the donation of the candidate gas mixtures by the American Industry/Government Emissions Research (AIGER)<sup>(1)</sup> consortium.

**Homogeneity Analysis:** Each of the nitric oxide mixtures that comprise this SRM lot was compared to the LS using chemiluminescence. A statistical analysis of the analytical results indicated that sample-to-sample nitric oxide concentration differences were statistically significant. Therefore, each cylinder comprising this SRM lot has been assigned a certified concentration.

**Analytical Methods:** Analyses of the nitric oxide and total oxides of nitrogen concentrations for this lot of cylinders were conducted by comparing each cylinder mixture to a representative cylinder chosen from the lot, the LS, using chemiluminescence. Assignment of the nitric oxide and total oxides of nitrogen concentrations to the LS was accomplished by comparison to NIST working standards using chemiluminescence. The NIST working standards were value assigned using two independent methods. The first method used was dilution of permeating nitrogen dioxide from a permeation tube, with a known flow of nitrogen. The second method used was dynamic dilution of a higher concentration nitric oxide primary standard.

**Nitric Oxide Concentration Value Assignments:** The nitric oxide and total oxides of nitrogen concentrations for this SRM lot were computed from the assigned concentration for the LS and the homogeneity analysis.

**CAS Registry Numbers:** This SRM is certified for nitric oxide in nitrogen. The relevant CAS Registry numbers for these components are: nitric oxide CAS Registry 10102-43-9; nitrogen CAS Registry 7727-37-9. A reference value is reported for total oxides of nitrogen in nitrogen; the CAS Registry for total oxides of nitrogen is 11104-93-1.

**Reference Concentration Value:** The result for the additional analysis performed during the certification process is given below. The concentration reported is a **NOT** certified value. A NIST reference value is a noncertified value that is the best estimate of the true value based on available data; however, the value does not meet the NIST criteria for certification [1] and is provided with associated uncertainties that may reflect only measurement reproducibility, may not include all sources of uncertainty, or may reflect a lack of sufficient statistical agreement among multiple analytical methods [2].

Table 1. Reference Value for Total Oxides of Nitrogen

Constituent	Concentration <sup>(a)</sup> (nmol/mol)	Method
Total Oxides of Nitrogen (NO <sub>x</sub> )	SAMPLE ± 15	Chemiluminescence

<sup>(a)</sup> Traceability: The measurand is the concentration of the total oxides of nitrogen in nitrogen as determined by the method indicated and the reference value is metrologically traceable to the derived SI unit of nanomoles for total oxides of nitrogen per moles of total oxides of nitrogen and nitrogen.

<sup>(1)</sup> Certain commercial equipment, instruments, or materials are identified in this certificate to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

## REFERENCES

- [1] Thompson, A.; Taylor, B.N.; *Guide for the Use of the International System of Units (SI)*; NIST Special Publication 811; U.S. Government Printing Office: Washington, DC (2008); available at <http://www.nist.gov/pml/pubs/sp811/index.cfm> (accessed Aug 2016).
- [2] May, W.; Parris, R.; Beck, C.; Fassett, J.; Greenberg, R.; Guenther, F.; Kramer, G.; Wise, S.; Gills, T.; Colbert, J.; Gettings, R.; MacDonald, B.; *Definitions of Terms and Modes Used at NIST for Value-Assignment of Reference Materials for Chemical Measurements*; NIST Special Publication 260-136, U.S. Government Printing Office; Washington, DC (2000); available at <http://www.nist.gov/srm/upload/SP260-136.PDF> (accessed Aug 2016).
- [3] JCGM 100:2008; *Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement (GUM 1995 with Minor Corrections)*; Joint Committee for Guides in Metrology (2008); available at [http://www.bipm.org/utis/common/documents/jcgm/JCGM\\_100\\_2008\\_E.pdf](http://www.bipm.org/utis/common/documents/jcgm/JCGM_100_2008_E.pdf) (accessed Aug 2016); see also Taylor, B.N.; Kuyatt, C.E.; *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*; NIST Technical Note 1297; U.S. Government Printing Office: Washington, DC (1994); available at <http://www.nist.gov/pml/pubs/index.cfm> (accessed Aug 2016).

**Certificate Revision History:** 22 August 2016 (Updates cylinder pressure; editorial changes); 18 September 2014 (Editorial changes); 03 November 2009 (Updated certified concentration values; editorial changes); 26 January 2006 (Original certificate date).

*Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the SRM Program: telephone (301) 975-2200; fax (301) 948-3730; e-mail [srminfo@nist.gov](mailto:srminfo@nist.gov); or via the Internet at <http://www.nist.gov/srm>.*