



Certificate of Analysis

Standard Reference Material[®] 1681b Carbon Monoxide in Nitrogen

(Nominal Amount-of-Substance Fraction 1000 $\mu\text{mol/mol}$)

This certificate reports the certified values for Lot 1-L-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 carbon monoxide determinations and for other applications.

This SRM mixture is supplied in a DOT 3AL-specification aluminum (6061 alloy) cylinder with a water volume of 6 L. Mixtures are shipped with a nominal pressure exceeding 12.4 MPa (1800 psig), which provides the user with 0.73 m³ (25.8 ft³) of useable mixture. The cylinder is the property of the purchaser and is equipped with a CGA-350 brass valve, which is the recommended outlet for this carbon monoxide mixture.

Certified Value: This SRM mixture has been certified for carbon monoxide concentration. The certified value given below applies to the identified cylinder and NIST sample number.

Carbon Monoxide Concentration: 993.1 $\mu\text{mol/mol} \pm 2.1 \mu\text{mol/mol}$

Cylinder Number: SAMPLE NIST Sample Number: SAMPLE
Hydrotest Date: January 2013 Blend Date: August 2013

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 carbon monoxide 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 1681b Lot No. 1-L-XX** is valid from this certificate issue date, within the measurement uncertainties specified, until **30 September 2027**, 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-350 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 J.T. Hodges of the NIST Chemical Sciences Division.

Carlos A. Gonzalez, Chief
Chemical Sciences Division

Gaithersburg, MD 20899
Certificate Issue Date: 15 January 2021
Certificate Revision History on Last Page
SRM 1681b

Steven J. Choquette, Director
Office of Reference Materials

Analytical measurements leading to the certification of the this SRM lot were performed by W.R. Miller of the NIST Chemical Sciences Division.

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

Traceability: The measurand is the total concentration of carbon monoxide in nitrogen and the certified value is metrologically traceable to the SI unit of micromoles of carbon monoxide per total moles of carbon monoxide 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. The specifications stipulate that each SRM mixture be identical in carbon monoxide concentration and stable with time.

Analytical Methods: Analyses of the carbon monoxide concentration for this lot of cylinders were conducted by comparing each cylinder mixture to a representative cylinder chosen from the lot, the lot standard (LS), using gas chromatography with methanation and flame ionization detection (GC/Meth/FID). Assignment of the carbon monoxide concentration to the LS was accomplished by comparison to primary gravimetric standards using GC/Meth/FID.

Homogeneity Analysis: Each of the carbon monoxide mixtures that comprise this SRM lot was compared to the LS using gas chromatography with GC/Meth/FID. A statistical analysis of the analytical results indicated that sample-to-sample carbon monoxide concentration differences were not statistically significant. This indicates that, within the precision of the NIST measurements, all of the cylinders comprising this SRM lot have identical carbon monoxide concentrations. Therefore, one concentration has been assigned to the entire SRM lot.

Carbon Monoxide Concentration Value Assignment: The certified carbon monoxide concentration for this SRM lot was computed from the assigned concentration for the lot standard and the homogeneity analysis.

CAS Registry Numbers: This SRM is certified for carbon monoxide in nitrogen. The relevant CAS Registry numbers for these components are: carbon monoxide CAS Registry 630-08-0; nitrogen CAS Registry 7727-37-9.

Information Values: Results for additional analyses performed during the certification process are given below. The concentrations reported are NOT certified values. These values are given for informational purposes only. An information value is considered to be a value that will be of interest to the SRM user, but for which insufficient information is available to assess adequately the uncertainty associated with the value, or only a limited number of analyses were performed [3]. Information values cannot be used to establish metrological traceability.

Constituent	Concentration/Method	CAS Registry
Carbon dioxide	< 1 $\mu\text{mol/mol}$ (as determined by the vendor using FTIR)	124-38-9
Water	< 1 $\mu\text{mol/mol}$ (as determined by P_2O_5)	7732-18-5
Methane	< 50 nmol/mol (as determined by GC/FID)	74-82-8
Total hydrocarbons (expressed as Methane)	60 nmol/mol (as determined by THC Analyzer)	74-82-8
Nitrogen	Balance	7727-37-9

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 <https://www.nist.gov/pml/special-publication-811> (accessed Jan 2021).
- [2] Beauchamp, C.R.; Camara, J.E.; Carney, J.; Choquette, S.J.; Cole, K.D.; DeRose, P.C.; Duewer, D.L.; Epstein, M.S.; Kline, M.C.; Lippa, K.A.; Lucon, E.; Phinney, K.W.; Polakoski, M.; Possolo, A.; Sharpless, K.E.; Sieber, J.R.; Toman, B.; Winchester, M.R.; Windover, D.; *Metrological Tools for the Reference Materials and Reference Instruments of the NIST Material Measurement Laboratory*; NIST Special Publication 260-136; U.S. Government Printing Office: Washington, DC (2020); available at <https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-136-2020.pdf> (accessed Jan 2021).
- [3] JCGM 100:2008; *Evaluation of Measurement Data — Guide to the Expression of Uncertainty in Measurement* (ISO GUM 1995 with Minor Corrections); Joint Committee for Guides in Metrology (2008); available at https://www.bipm.org/utls/common/documents/jcgm/JCGM_100_2008_E.pdf (accessed Jan 2021); 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 <https://www.nist.gov/pml/nist-technical-note-1297> (accessed Jan 2021).

Certificate Revision History: 15 January 2021 (Change of expiration date; editorial changes); 25 February 2014 (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 at: telephone (301) 975-2200; e-mail srminfo@nist.gov; or via the Internet at <https://www.nist.gov/srm>.