NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

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Standard Reference Material® 2659a
Oxygen in Nitrogen
(Nominal Amount-of-Substance Fraction 21 % mol/mol)
Lot 71-E-XX

CERTIFICATE OF ANALYSIS

Purpose: The certified value delivered by this Standard Reference Material (SRM) is intended for use in producing metrologically traceable secondary standards for the calibration of instruments used for oxygen determinations.

Description: This SRM is a primary gas mixture 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 m^3 (25.8 ft^3) of useable mixture. The cylinder is the property of the purchaser and is equipped with a CGA-590 stainless-steel valve, which is the recommended outlet for this oxygen mixture.

Certified Value: A NIST certified value is a value for which NIST has the highest confidence in that all known or suspected sources of bias and imprecision have been accounted [1]. This SRM mixture has been certified for oxygen amount-of-substance fraction (mole fraction, sometimes termed "molar concentration"). This certified value is traceable to the International System of Units (SI) through the gravimetric primary standards and procedures used in the preparation of this mixture. The certified value given below applies to all cylinders in this lot.

Oxygen Mole Fraction: 20.863 % mol/mol ± 0.021 % mol/mol[(a)]

[(a)] The certified value is expressed as $x \pm U_{95\,\%}(x)$, where x is the value and $U_{95\,\%}(x)$ is the expanded uncertainty of the value. The true value of the analyte lies within the interval $x \pm U_{95\,\%}(x)$ with 95 % confidence. The uncertainty is expressed as an expanded uncertainty $U = ku_c$ with u_c determined by experiment and a coverage factor $k = 2$. For guidance in propagating this uncertainty, see reference 2.

Additional Information: Appendix A contains a table of all cylinder Sample Numbers and their associated information for this lot. Appendix B contains values of potential interest to users.

Period of Validity: The certified value delivered by **SRM 2659a**, **Lot No. 71-E-XX** is valid within the measurement uncertainty specified until **27 August 2033**, provided the SRM is handled and stored in accordance with the instructions given in this certificate (see "Storage" and "Cylinder and Gas Handling Information"). The certification is nullified if the SRM is damaged, contaminated or otherwise modified, or if the internal pressure drops below 0.7 MPa (100 psig).

Maintenance of Certified Value: NIST will monitor this SRM over the period of its validity. If substantive technical changes occur that affect the certification, NIST will issue an amended certificate through the NIST SRM website (https://www.nist.gov/srm). Before making use of any of the values delivered by this material, users should verify they have the most recent version of this documentation, available through the NIST SRM website (https://www.nist.gov/srm).

Marcela Najarro, Acting Chief
Chemical Sciences Division

Steven J. Choquette, Director
Office of Reference Materials

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Safety: Consult the Safety Data Sheet (SDS) for hazard information.

Storage: This SRM should be stored under normal laboratory conditions within the temperature range of 15 °C to 30 °C.

Cylinder and Gas Handling Information: NIST recommends the use of a high purity, two stage pressure regulator with a stainless-steel diaphragm and CGA-590 outlet to safely reduce the pressure and to deliver this 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.

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 oxygen mole fraction and stable with time.

Analytical Method: Analyses of the oxygen mole fraction for this lot of cylinders were conducted by comparison to a representative cylinder chosen from the lot, designated as the SRM lot standard (LS). The LS was compared to NIST primary gravimetric standards using oxygen paramagnetism. Each of the oxygen mixtures that comprise this SRM lot was then compared to the LS using oxygen paramagnetism. Within the precision of the NIST measurements, all the cylinders comprising this SRM lot have identical oxygen mole fractions.

CAS Registry Numbers: This SRM is certified for oxygen in nitrogen. The relevant CAS Registry numbers for these components are: oxygen CAS Registry 7782-44-7; nitrogen (balance gas) CAS Registry 7727-37-9.

NOTICE TO USERS

NIST strives to maintain the SRM inventory supply, but NIST cannot guarantee the continued or continuous supply of any specific SRM. Accordingly, NIST encourages the use of this SRM as a primary benchmark for the quality and accuracy of the user's in house reference materials and working standards. As such, the SRM should be used to validate the more routinely used reference materials in a laboratory. Comparisons between the SRM and in house reference materials or working measurement standards should take place at intervals appropriate to the conservation of the SRM and the stability of relevant in house materials. For further guidance on how this approach can be implemented, contact NIST by email at srms@nist.gov.

REFERENCES

[1] 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.; Molloy, J.; Nelson, M.A.; Phinney, K.W.; Polakoski, M.; Possolo, A.; Sander, L.C.; Schiel, J.E.; Sharpless, K.E.; 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 (NIST SP) 260-136, 2021 edition; U.S. Government Printing Office: Washington, DC (2021); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-136-2021.pdf (accessed Feb 2026).

[2] Possolo, A.M; *Evaluating, Expressing, and Propagating Measurement Uncertainty for NIST Reference Materials*; NIST Special Publication (NIST SP) 260-202; U.S. Government Printing Office: Washington, DC (2020); available at https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.260-202.pdf (accessed Feb 2026).

If you use this SRM in published work, please reference:

Cecelski C, Harris K, Goodman C, Kimes W, Liu Q, Miller W, Carney J (2021) Certification of NIST Gas Mixture Standard Reference Materials. (National Institute of Standards and Technology, Gaithersburg, MD), NIST Special Publication (SP) 260-222. https://doi.org/10.6028/NIST.SP.260-222

Certificate Revision History: 25 February 2026 (Change of period of validity; updated format; editorial changes); **06 September 2018** (Change of expiration date; editorial changes); **08 November 2013** (Original certification date).

Certain commercial equipment, instruments, or materials may be identified in this Certificate of Analysis 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.

Users of this SRM should ensure that the Certificate of Analysis in their possession is current. This can be accomplished by contacting the Office of Reference Materials 100 Bureau Drive, Stop 2300, Gaithersburg, MD 20899-2300; telephone (301) 975-2200; e-mail srminfo@nist.gov; or the Internet at https://www.nist.gov/srm.

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APPENDIX A

The table contains all cylinder Sample Numbers and their associated information for this lot.

Sample Number	Cylinder Number	Hydrostat Date	Fill Date
71-E-03	FF18290	September 2012	July 2013
71-E-04	FF22300	May 2013	July 2013
71-E-05	FF18279	September 2012	July 2013
71-E-06	FF18276	September 2012	July 2013
71-E-07	FF22214	May 2013	July 2013
71-E-08	FF22210	May 2013	July 2013
71-E-09	FF22303	May 2013	July 2013
71-E-10	FF22204	May 2013	July 2013
71-E-11	FF22213	May 2013	July 2013
71-E-12	FF18273	September 2012	July 2013
71-E-13	FF22220	May 2013	July 2013
71-E-14	FF22249	May 2013	July 2013
71-E-16	FF22237	May 2013	July 2013
71-E-18	FF22222	May 2013	July 2013
71-E-19	FF22331	May 2013	July 2013
71-E-20	FF22310	May 2013	July 2013
71-E-21	FF22248	May 2013	July 2013
71-E-22	FF18329	September 2012	July 2013
71-E-23	FF18266	September 2012	July 2013
71-E-24	FF18300	September 2012	July 2013
71-E-25	FF22304	May 2013	July 2013
71-E-26	FF22291	May 2013	July 2013
71-E-27	FF22295	May 2013	July 2013
71-E-28	FF22305	May 2013	July 2013
71-E-29	FF22234	May 2013	July 2013
71-E-30	FF18268	September 2012	July 2013
71-E-31	FF22194	May 2013	July 2013
71-E-32	FF22297	May 2013	July 2013
71-E-33	FF22157	May 2013	July 2013
71-E-34	FF18246	September 2012	July 2013
71-E-35	FF22182	May 2013	July 2013
71-E-36	FF18299	September 2012	July 2013
71-E-37	FF22202	May 2013	July 2013
71-E-39	FF18327	September 2012	July 2013
71-E-40	FF22166	May 2013	July 2013

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APPENDIX B

Values of Potential Interest to Users: A NIST value of potential interest to users is a value that will be of interest and use to the SRM user, but insufficient information is available to assess adequately the uncertainty associated with the value or only a limited number of analyses were performed [1]. A NIST value of potential interest is provided for information purposes only. Results for additional analyses performed during the certification process are given below.

Constituent	Concentration	CAS Registry
Argon	90 µmol/mol	7440-37-1
Water	<1 µmol/mol	7732-18-5
Total hydrocarbons	<0.1 µmol/mol (as Methane)	74-82-8
Nitrogen	Balance	7727-37-9

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