



**UNITED STATES DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
Earth System Research Laboratory  
Global Monitoring Division  
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## Certificate of Analysis

### NOAA Earth System Research Laboratory

Certificate Number: **CB11039-A**  
Issue Date: **17 December 2014**  
Material: Modified Natural Air, Compressed  
Intended Use: For the calibration of instruments for determining the mole fractions of trace gases in air  
Last Analysis: **December 2014**  
Prepared by: **Thomas Mefford**

Results are based on analysis performed by the WMO Central Calibration Laboratories located at the NOAA Earth System Research Laboratory. WMO mole fraction scales are maintained by ESRL, and are traceable to the SI via national standards for mass, temperature, and pressure (National Institute for Standards Technology, NIST). For more information on calibration scales and analysis methods, see <http://www.esrl.noaa.gov/gmd/ccl>. For isotopic ratio or other informational values, if applicable, see <http://www.esrl.noaa.gov/gmd/dv/ccg/refgas/>.

**Cylinder ID: CB11039**

#### Results

	Mole Fraction <sup>1</sup>	Reproducibility <sup>2</sup>	Unit <sup>3</sup>	Method	Period of Validity	Calibration Scale <sup>4</sup>
<b>CH<sub>4</sub></b>	<b>1658.50</b>	0.38	nmol mol <sup>-1</sup>	GC-FID	6 yr	WMO-CH <sub>4</sub> -X2004
<b>CO</b>	<b>56.44</b>	0.8	nmol mol <sup>-1</sup>	OA-ICOS	2 yr	WMO-CO-X2014
<b>CO<sub>2</sub></b>	<b>355.47</b>	0.056	μmol mol <sup>-1</sup>	NDIR	3 yr	WMO-CO <sub>2</sub> -X2007

<sup>1</sup> mole fraction in dry air

<sup>2</sup> expected long-term variation of analysis results assuming no cylinder drift (coverage factor k=2)

<sup>3</sup> μmol mol<sup>-1</sup> = ppm ; nmol mol<sup>-1</sup> = ppb ; pmol mol<sup>-1</sup> = ppt

<sup>4</sup> WMO CCL scale spans;

CO<sub>2</sub> 250 to 520 μmol mol<sup>-1</sup>

CH<sub>4</sub> 300 to 2600 nmol mol<sup>-1</sup>

CO 40 to 500 nmol mol<sup>-1</sup>

N<sub>2</sub>O 100 to 360 nmol mol<sup>-1</sup>

SF<sub>6</sub> 1 to 12 pmol mol<sup>-1</sup>

Recalibrations are highly recommended (see WMO/GAW report #206 for more information about recalibration intervals). At a minimum, it is recommended to perform a final calibration at the end of the cylinder's term of use (pressure ≥ 24 atm.)

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## Terms

GC-ECD:	gas chromatography with electron capture detection
GC-FID:	gas chromatography with flame ionization detection
OA-ICOS:	off-axis integrated cavity absorption spectroscopy
NDIR:	non-dispersive infrared spectroscopy

## References

- CH<sub>4</sub>: Dlugokencky, E. J. et al., Conversion of NOAA atmospheric dry air CH<sub>4</sub> mole fractions to a gravimetrically prepared standard scale, *J. Geophys. Res.*, 110, D18306, 2005.
- CO: Novelli, P. C., K. A. Masarie, P. M. Lang, B. D. Hall, R. C. Myers, and J. W. Elkins, Reanalysis of tropospheric CO trends: Effects of the 1997–1998 wildfires, *J. Geophys. Res.*, 108(D15), 4464, doi:10.1029/2002JD003031, 2003
- CO<sub>2</sub>: Zhao, C. L., P. P. Tans, and K. W. Thoning, A high precision manometric system for absolute calibrations of CO<sub>2</sub> in dry air, *J. Geophys. Res.*, 102, D5, pp. 5885-5894, 1997.  
Zhao, C. L. and Tans, P. P., Estimating the uncertainty of the WMO mole fraction scale for carbon dioxide in air, *J. Geophys. Res.*, 111, D08S09, doi:10.1029/2005JD006003, 2006.
- N<sub>2</sub>O: Hall, B. D., G. S. Dutton, and J. W. Elkins, The NOAA nitrous oxide standard scale for atmospheric observations, *J. Geophys. Res.*, 112, D09305, doi:10.1029/2006JD007954, 2007.
- SF<sub>6</sub>: Hall, B. D. et al., Improving measurements of SF<sub>6</sub> for the study of atmospheric transport and emissions, *Atmos. Meas. Tech.*, 4, 2441-2451, 2011.
- GAW Report No. 206: 16<sup>th</sup> WMO/IAEA meeting of experts on carbon dioxide, other greenhouse gases and related tracers measurement techniques, (Wellington, New Zealand, 25-28 October 2011), Geneva, Switzerland, 2012.  
[http://www.wmo.int/pages/prog/arep/gaw/documents/Final\\_GAW\\_206\\_web.pdf](http://www.wmo.int/pages/prog/arep/gaw/documents/Final_GAW_206_web.pdf)

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Amended certificates will not be issued following calibration scale updates. Results are available at <http://www.esrl.noaa.gov/gmd/ccl>

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Compressed gas cylinders are regulated by U.S. Law under CFR Title 49, parts 106-179. Users should ensure safe handling and storage