UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Earth System Research Laboratory
Global Monitoring Division
325 Broadway - David Skaggs Research Center
Boulder, CO 80305-3328

Report of Analysis

NOAA Global Monitoring Division (GMD)

Report Number:	CB12264-A
Issue Date:	30 October 2017
Material:	Air, compressed, in an aluminum gas cylinder, nominal pressure 13.6 MPa (2000 psi)
Intended Use:	For the calibration of instruments determining mole fractions of trace gases in air. Experience has shown that high flow applications may lead to changes in mole fraction. For high precision measurement, flow should be less than 0.5 liters per minute.
Caution:	Cylinders calibrated on extended scales do not establish traceability to the WMO/GAW scales.
Use and Storage:	Cylinders should be used under normal laboratory conditions (room temperature). For storage, we recommend -30° to 40° C.
Period of Analysis:	October 2017
Prepared by:	Thomas K. Mefford

Cylinder ID: CB12264

Results are based on analyses performed by the WMO/GAW Central Calibration Laboratories (CCL) located at the NOAA Global Monitoring Division (GMD). Results reported on this Report of Analysis are outside the WMO/GAW scale ranges for the species of interest. Measurements outside the WMO/GAW scale ranges are calibrated against extended scales. Extended scales are designed to be consistent with the WMO/GAW scales through the use of similar techniques, but are not routinely investigated with quality control procedures and do not establish traceability to the WMO/GAW scales. For more information on calibration scales and analysis methods, see http://www.esrl.noaa.gov/gmd/ccl.

Results

	Mole Fraction[1]	Reproducibility[2,3,4,6]	Unit	Method	Calibration Scale
CO_2	205.74	Out of scale range	μmol mol^{-1}	LASER SPECTROSCOPY	CO2_X2007_EXTENDED

Informational Values

	Value	Reproducibility[2,3,4]	Unit	Method	Calibration Scale
CO_2 $\delta^{13}C$ [5]	2.8	Out of scale range	per mil	LASER SPECTROSCOPY	VPDB-CO_2
CO_2 $\delta^{18}O$ [5]	20.6	Out of scale range	per mil	LASER SPECTROSCOPY	VPDB-CO_2

[1] Mole fraction in dry air, expressed on an extension of the WMO/GAW mole fraction calibration scale.
($\mu mol\ mol^{-1}$ = ppm, $nmol\ mol^{-1}$ = ppb, $pmol\ mol^{-1}$ = ppt)

[2] Expected long-term variation of analysis results assuming no cylinder drift (95% confidence level).

[3] The reproducibility estimate given here was determined for the ranges of the WMO/GAW scale. Reproducibility outside the WMO/GAW scale range has not been explicitly determined, but is expected to be similar.

[4] The reproducibility of the laser spectroscopy system is based on approximately one year of target tank data. This is not a long enough time period to fully quantify this term. A conservative estimate is used at this time and the value will be updated as more information becomes available.

[5] The reported CO_2 isotopic values are informational only. They are not to be used as a substitute to having cylinders directly measured by IRMS when isotopic standards are required. They are designed to be used only for making isotopic corrections to measurements of atmospheric CO_2 on instruments that are sensitive to isotopic differences between standards and samples. The values for reference materials used to determine instrument response was provided by the University of Colorado, Boulder, Institute of Arctic and Alpine Research (INSTAAR). Isotopic values are reported as 'delta' values, in per mil units, relative to a standard reference material. The 'delta' notation is (for ^{13}C for example):
$\delta^{13}C = [\ (^{13}C/^{12}C)_{sample} / (^{13}C/^{12}C)_{reference} - 1\ ] \times 1000$
For carbon and oxygen isotopes, the reference is VPDB-CO2 (Coplen 1995). The current scale at INSTAAR was set using NBS-19 and NBS-20 (carbonates) and VSMOW, GISP and SLAP (waters).

[6] The CH_4 reproducibility reported here was determined for the GC-FID CH_4 calibration system. The current CRDS system is expected to be more consistent but has not run long enough to determine a new reproducibility value. The value will be updated as more information becomes available.

Period of Validity
Recalibrations are highly recommended (see WMO/GAW Report No. 229 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.). Mole fractions shown are valid for a period of 3 years. The more reactive analyte Carbon Monoxide typically has measurable drift within 2 years.

Thomas K. Mefford
Associate Scientist III, CIRES
Ph: +1-303-497-6051 Fax: +1-303-497-6290 E-Mail: thomas.mefford@noaa.gov

Terms
LASER SPECTROSCOPY:	generalized method indicating the application of CRDS with OA-ICOS or QC-TILDAS for making total CO_2,$\delta^{13}C$, and $\delta^{18}O$ measurements. See http://www.esrl.noaa.gov/gmd/ccl/co2_calsystem.html and Tans et al. (2017) for details
CRDS:	cavity ring-down spectroscopy
OA-ICOS:	off-axis integrated cavity absorption spectroscopy
QC-TILDAS:	quantum cascade tunable infrared laser differential absorption spectroscopy
GC-FID:	gas chromatography with flame ionization detection
WMO/GAW:	World Meteorological Organization, Global Atmosphere Watch

References

CO_2:	Tans, P. P., Crotwell, A. M., and Thoning, K. W.: Abundances of isotopologues and calibration of CO2 greenhouse gas measurements, Atmos. Meas. Tech., 10, 2669-2685, doi:10.5194/amt-10-2669-2017, 2017. Zhao, C. L., P. P. Tans, and K. W. Thoning, A high precision manometric system for absolute calibrations of CO_2 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.
$CO_2\delta^{13}C$ and $CO_2\delta^{18}O$:	Coplen, T.B., Reporting of stable carbon, hydrogen, and oxygen isotopic abundances, in Reference and intercomparison materials for stable isotopes of light elements. Vienna, International Atomic Energy Agency, IAEA-TECDOC-825, p. 31-34, 1995.
WMO/GAW:	18th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases and Related Tracers Measurement Techniques (GGMT-2015), La Jolla, CA, USA, 13-17 September 2015, World Meteorological Organization, Global Atmosphere Watch Report Series No. 229, available at http://www.wmo.int/pages/prog/arep/gaw/gaw-reports.html.

- Regulators can be purchased directly from the manufacturer. We use Scott Gas model 51-14C-590 or Airgas Y12-C144B590. For mass spectrometer measurement of the stable isotopes of CO_2 we use Airgas model Y11-C444A590. The listing of part numbers here does not constitute an endorsement.
- Amended reports will not be issued following calibration scale updates. Results are available at http://www.esrl.noaa.gov/gmd/ccl
-
- Compressed gas cylinders are regulated by U.S. Law under CFR Title 49, parts 106-179. Users should ensure safe handling and storage. Cylinders should not be exposed to temperatures above 130 deg C. (http://www.luxfercylinders.com/support/temperature-exposure)