Report from the CCQM Gas Analysis Working Group (April 2025 – April 2026)

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1. CCQM-GAWG meetings

The 51st and 52nd CCQM-GAWG meetings were held as hybrid meetings on 8th and 9th April 2025 at the BIPM and on 21st and 22nd October 2025 at the National Metrology Institute of Italy (INRiM), respectively. The 51st meeting was attended by 74 delegates (43 in person) from 41 institutes and the 52nd meeting was attended by 85 delegates (32 in person) from 39 institutes. A two-day workshop was organised alongside the 52nd meeting on passivation chemistry for enhanced stability of gas reference materials. Motivated by a recommendation from the 2022 BIPM–WMO Climate Workshop, the event provided a forum for exchanging knowledge on adsorption and reactive losses of greenhouse gases and other challenging components on metal surfaces, including those treated with passivation chemistries. Emphasis was placed on applications involving high-pressure gas cylinders and sampling systems. The workshop also addressed modelling and theoretical approaches to support empirical observations of gas-phase behaviour at interfaces. In addition, research contributions were presented on innovative methods for passivating metal surfaces to enhance the stability of high-pressure gas mixtures.

Five additional virtual meetings were organised in the last year by the CCQM-GAWG to discuss the draft A reports for CCQM-K82.2023, CCQM-K77.2023, CCQM-K93.2023, CCQM-K185, CCQM-P237 and CCQM-P239.

2. Demonstrating and documenting the global comparability of measurements

At the 30th meeting of the CCQM, BIPM.QM-P5 (ongoing key comparison on CO_2 in air scales), CCQM-K26a.2025 (track C comparison on ambient NO in nitrogen), CCQM-K201 (track C comparison carbon, capture, utilisation and storage), CCQM-K201 (track C comparison on SF_6 in nitrogen) and CCQM-K65.2025 (sulfurous odorants in methane) were approved.

Reports from the following key comparisons were published: BIPM.QM-K1 (Ozone) and BIPM.QM-K2 (CO_2 in air) with several laboratories, CCQM-K175 (HCl in nitrogen), CCQM-K10.2018.1 (BTEX in nitrogen) and CCQM-K3.2019.1 (automotive gases). Figure 1 shows the list of active key comparisons and pilot studies.

		Track	Coordinator	Guidance	Participants	Registered	Model
K82.2023	Ambient CH_4	C	BIPM	*NIST*	NPL, UME, LNE, NOAA, NIST, NPLI, VSL, NMISA, VNIIM, KRISS, NMIJ, NIMT, NIM	2023	2
P236	Ambient CH_4	C	BIPM	*NIST*	ICOS	2023	2
K185	Particle charge and number	C	NPL	NMIJ	KRISS, LNE, METAS, NIM, A*STAR, NMIJ, NPLI, PTB, NRC	2023	-
P237	Particle charge and number	C	NPL	-	TROPOS, UBA	2023	-
K164	H_2 purity	C	NPL	VSL	KRISS VSL NIM NMIA BAM NMISA	2019	1
K174	Oxygenated VOCs	C	VSL	METAS	NPL NIM METAS LNE NMISA CMI	2020	1
K77.2023	Refinery gas	C	VSL	*NMISA*	NPL, CMI, NIM, NMISA, INMETRO, BFKH	2023	2
K26b.2019	SO_2 in air	C	NPL	*KRISS*	UBA NMISA FMI LNE KRISS VSL NIM VNIIM EAA JRC CERI CHMI UME	2019	1
K93.2023	Ethanol in nitrogen	C	NPL	*IPQ*	VSL, SMU, LNE, CMI, INMETRO, NIST, NMISA, IPQ, KRISS, BFKH, UME, CERI, UKR, NIMT, NIM	2023	2
P239	C and O isotope ratio (CO_2 in air)	D	BIPM	-	IAEA, INRiM, KRISS, NIM, NIST, A*Star, NMIJ, NPL, UME, VNIIM, CSIRO, BGC-ISOlab, INstAAR, RUG, ECCC	2023	2
K118.1	Natural gas	C	VSL	-	BAM, VSL, KRISS	2023	1
K71.2024	Stack gases	C	VSL	tbc	IPQ, NPL, KRISS, INMETRO, SMU, CENAM, NIM, NMISA, VNIIM, LATU, NIST, NIMT, UME	2025	1
K65.2025	Odorants (sulfurous components in CH_4)	C	VSL	tbc	NPL, NIM, VNIIM, UKR, KRISS?	2025	1
K76.2026	SO_2 in nitrogen	A	NIM	tbc	NMIA, KRISS, NPL, NIST, CENAM, INMETRO, VSL, NMISA, VNIIM, CERI, NPLI	2025	2
K200	Emissions SF_6	C	KRISS	tbc	VNIIM, NIM	2025	1
K26a.2025	Ambient NO	C	NPL	tbc	tbc	-	1
K201	CCUS	C	NPL	tbc	VSL, KRISS, PTB, BAM, IPQ, RISE, NIM, NMISA and NMIA.	2025	1
K84.2024*	Ambient CO in air	C	NOAA	tbc	KRISS, VSL, NIST, LNE, NIM, VNIIM, NPL, FMI, NOAA, EAA, UBA(D)? NMIJ?	-	1
K171	*CO in N_2*	*A*	*VNIIM*	*tbc*	*VSL, NPL, BAM, UKR, NMIJ, NIM, KRISS, INMETRO, CENAM, NIST, NMISA*	*2020*	*1*

Figure 1 Active CCQM-GAWG comparisons (green – draft B, yellow – draft A, orange – measurements, red – planning).
*Requires approval by the CCQM.

The track A key comparison on carbon monoxide in nitrogen (CCQM-K171) is postponed until further notice due to current embargoes on the transport of cylinders from the coordinating laboratory. The working group will use BIPM.QM-K2 and CCQM.K76.2026 to support broad claims under track A. Figure 2 lists the planned comparisons in the strategic plan for 2026-2030.

Start			Track	Coordinator	Model
2007	BIPM.QM-K1	Ozone	C	BIPM	-
2022	BIPM.QM-K2	Ambient CO_2	A/C	BIPM	-
2024	BIPM.QM-K6	NO_2 in nitrogen	C	BIPM	2
2026	KXXX	Ozone precursors	C	VSL	-
2026	Pxxx	C and O isotope ratio from carbonates	D	BIPM	-
2026	K76.2026	SO_2 (100 µmol mol^{-1})	A	NIM	1
2026	BIPM.QM-P5	Ambient CO_2 in air scales	C	BIPM	-
2027	CCQM-K83.2027	Halocarbons	C	NIM	-
2027	K90.2027	Formaldehyde (1 µmol mol^{-1})	C	-	2
2027	Kxxx	Sulfur in hydrogen (4 nmol mol^{-1})	C	NPL	1
2028	K112.2028	Biogas	C	VSL	1
2028	BIPM.QM-P7	Ambient CH_4 in air scales	C	BIPM	-
2028	K116.2027	H_2O (10 µmol mol^{-1})	C	NPL	1
2028	Pxxx	Particle size	C	-	-
2028	K137.2027	NO (30 and 70 µmol mol^{-1})	C	NMISA	2
2028	BIPM.QM-K3	C and O isotope ratio in pure CO_2	C	BIPM	-
2028	K53.2028	O_2	A	-	2
2028	K117.2028	Ammonia in nitrogen	C	-	1
2029	K121.2029	Monoterpenes in nitrogen	C	-	2
2029	K119.2029	LPG	C	-	1
2029	K113.2029	Noble gases	C	-	1
2029	BIPM.QM-K4	C and O isotope ratio (CO_2in air)	C	BIPM	-
2030	K10.2030	BTEX	C	-	1
2030	K68.2030	Ambient N_2O	C	-	1

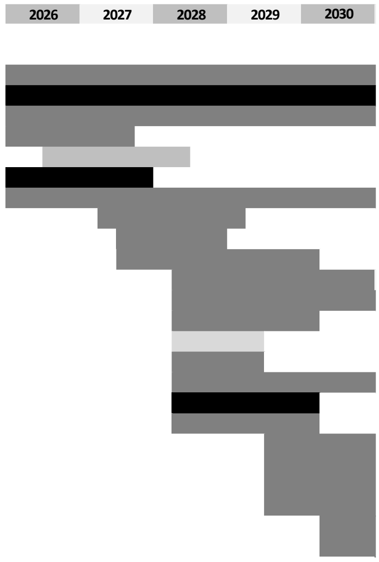


Figure 2 Planned comparisons for the period 2026 – 2030 (black – track A, dark grey – track C, light grey – track D).

3. Working group activities progressing the state of the art in measurement science

A workshop on passivation chemistry for enhanced stability of gas reference materials, addressed a long-standing challenge of chemical and physical interactions between trace gas components and the internal surfaces of high-pressure cylinders and valves. National Metrology Institutes and Designated Institutes have relied on proprietary commercial passivation treatments that lack transparency, exhibit varied performance, and pose risks to long-term capability if suppliers alter or discontinued their processes. Following concerns raised at the 2022 WMO–BIPM Metrology for Climate Action Workshop, a CCQM-GAWG task group on cylinder passivation chemistry has been established to advance understanding of gas–surface interactions and explore non-proprietary approaches to improving mixture stability. The workshop provided a forum for presenting empirical and theoretical research on adsorption and reactive losses, modelling of interfacial behaviour, and innovative surface treatments for high-pressure systems.

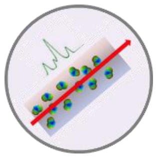
A pilot study (CCQM-P239) was conducted to evaluate the degree of comparability among laboratories in assigning $\delta^{13}C$ and $\delta^{18}O$ isotope-ratio values to CO_2 in air mixtures. Fourteen National Metrology Institutes, Designated Institutes, and expert atmospheric laboratories contributed two to four standards spanning relevant amount-fraction and isotopic ranges. All samples were measured at the BIPM using a validated cryogenic extraction system and dual-inlet IRMS calibrated to primary IAEA carbonate references. Participants employed a wide range of IRMS and IRIS methods and calibration schemes, reflecting global capability in CO_2 isotope-ratio metrology, including strong traceability chains based on JRAS-06. Preliminary results show good overall comparability. Laboratories linked to JRAS-06 exhibited excellent agreement with BIPM-assigned $\delta^{13}C$ and $\delta^{18}O$ values. Those traceable via IAEA-603 or calibrated CO_2 gases also performed well for $\delta^{13}C$, while $\delta^{18}O$ results showed greater dispersion, highlighting areas for improved harmonisation. All participants demonstrated traceability to the VPDB and VPDB-CO_2 scales, and the study identified opportunities to refine analytical and preparation methods.

4. Working group stakeholder engagement activities

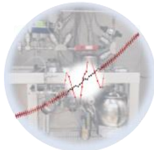
Work has continued with stakeholders via six task groups:

Ozone Cross-Section Change Management to develop a plan and timetable to allow a globally coordinated and universal implementation of the new consensus value of ozone absorption cross-section at 254 nm, CCQM.O3.2019 (J T Hodges *et al.*, Metrologia, 56 034001, (2019)). The work is now complete.

Advanced Spectroscopy to develop and validate accurate spectroscopic measurements of analyte number density and isotopic abundance to provide fit-for-purpose alternatives to traditional mass and manometric-based measurement techniques, which can be limited by the availability of consumable reference materials, sensitivity, portability, selectivity and dynamic response.



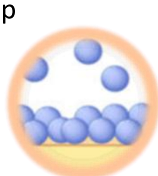
Greenhouse Gas Scale Comparisons to meet the future demand for gas reference materials that are traceable to the WMO scale, because of the requirement for multiple measurement sites for greenhouse gases around the world for evaluating a robust economic system based on their mitigation.



Isotope Ratio Metrology to build on current research advances, formalise the collaboration between NMIs and expert laboratories and provide a measurement infrastructure to underpin global measurements of source apportionment that will have enduring value.

Aerosol Metrology to engage with stakeholders to identify the metrology gaps, provide a framework to demonstrate capability required to meet future legislative and end user requirements.

Passivation Chemistry In response to the BIPM-WMO climate workshop recommendations to collate knowledge related to adsorption and reactive losses of greenhouse gas and other important components in high pressure gas cylinders and sampling systems. Connect to modelling and explanations for new knowledge and develop and study innovative cylinder passivation chemistries towards reference materials with enhanced stability.



Dissemination activities

- The new reference value for ozone absorption cross section was implemented, and the CMC review process is complete.
- The 2026 Gas Analysis Symposium was held in Paris. A session on Advances in Gas Metrology was chaired by Paul Brewer and featured lectures from members of the CCQM-GAWG. A round table discussion focussed on the future of gas analysis with breath analysis, atmospheric monitoring and decarbonisation featuring.
- The CCQM-GAWG and CCQM-IRWG approved a recommendation on the measurement scales for carbon and oxygen isotope delta measurements.
- CITAC Best Paper Award: Camin *et al.*, Stable Isotope Reference Materials and Scale Definitions—Outcomes of the 2024 IAEA Experts Meeting, Rapid Communications in Mass Spectrometry, 39, (2025).
- Publication: Brewer *et al.*, Twenty-Five Years of CIPM-CCQM Gas Analysis Key Comparisons, Analytical Chemistry (2026), which provides a foundation for improving the efficiency of future key comparisons for supporting CMCs.

5. Additional items from the working group meetings

- Christina Cecelski (NIST) will continue as CCQM-GAWG representative on the CCQM-KCWG.
- Adam Fleisher was appointed as the new chair of the Advanced Spectroscopy Task Group.
- The CCQM-GAWG will now only use uncertainty convention 2 for calibration and measurement capabilities.
- The CCQM-GAWG will revisit document GAWG/19-41 to develop the strategy and enhance the efficiency of using key comparisons to support CMCs.
- The CCQM-GAWG has nominated the following members to represent the group on the CCQM Task Group on Data Digitalization (CCQM-TG-DD): Adriaan van der Veen (VSL) for Task Team 1 on Unique Identifiers for Chem/Bio Data; Yuxi Cui (A*STAR/NMC) for Task Team 2 on the Digitalisation of CRM Certificates; and Christina Cecelski (NIST) for Task Team 3 on FAIR Principles in Chem/Bio Databases and the incorporation of AI.
- The 54th meeting of the CCQM-GAWG and a stakeholder workshop on capacity building and knowledge transfer will be hosted by LACOMET from 19th – 23rd October 2026.