

PROFICIENCY TESTING SCHEME: Technical quality report — Measurement of inorganic gaseous pollutants in filtered ambient air

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Abstract

This technical quality report documents the metrological infrastructure supporting the PT campaign for inorganic gaseous pollutants organised by ERLAP. It demonstrates the stability and traceability of the assigned values, the homogeneity of the test mixtures, the consistency of the reference with participant results, and the integrity of data handling. This document is intended for accreditation purposes (ISO 17043) and internal quality assurance; it complements the per-round PT reports distributed to participants.

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Introduction

The Directive 2008/50/EC [1] and subsequent amendments, including Directive (EU) 2024/2881 [2] on ambient air quality and cleaner air for Europe, set the framework for harmonised air-quality assessment across Europe. The European Reference Laboratory of Air Pollution (ERLAP) of the Joint Research Centre (JRC) organises Proficiency Tests (PT) to assess the comparability of measurements of National Reference Laboratories (NRL). ERLAP is accredited to the standard ISO 17043 for the pollutants and EN standard methods used during this proficiency test.

This technical report covers the 3 rounds of the campaign (PT1 (pt1), PT2 (pt2), PT3 (pt3)), providing the evidence required by ISO 17043 and ISO 17025 regarding the quality of the assigned values and the overall PT scheme operation.

Reference instrument selection and traceability

When more than one candidate reference analyser is available for a component, the reference instrument is selected by an objective, reproducible procedure that scores the candidates across all rounds of the campaign on four criteria: calibration fit quality (reduced chi-squared), drift stability, final assigned-value uncertainty, and inter-instrument concordance. For the NO/NO₂ dual-channel analyser a single physical instrument is selected for both channels.

The assigned values and their uncertainties are computed by the dedicated erlap R software. For SO₂, CO and NO the reference mixtures are generated by dynamic dilution of certified gas standards using molbloc flow measurements; NO₂ is obtained from the two-channel chemiluminescence model (NO and NO_x with converter efficiency); O₃ is referenced against a Standard Reference Photometer (SRP). The calibration curve is fitted with an Errors-in-Variables Generalized Least Squares (EIV-GLS) model that accounts for the uncertainty of both the reference values and the instrument readings.

The combined standard uncertainty of each assigned value is:

$$u(X) = \sqrt{u_{\text{cal}}^2 + u_{\text{drift}}^2 + u_{\text{hom}}^2}$$

Traceability is ensured through the certified cylinder concentrations, the molbloc flow calibration certificates, and the SRP reference.

Software validation

The erlap assigned-value software is validated through unit tests of the individual mathematical functions, integration tests against a previously validated reference implementation, and an independent cross-validation of the EIV-GLS regression implemented in Python, which agrees with the R implementation to within floating-point precision.

Assigned values across rounds

The following table presents the ERLAP assigned values for every round side by side, for each pollutant and run, together with the common σ_{PT} .

Table 1 **1**: ERLAP assigned values for each round, shown side by side, with the common sigmaPT.

Pollutant	Run	Unit	PT1	PT2	PT3	sigmaPT
SO ₂	0	µg/m ³	0.09	0.10	0.09	2.7
SO ₂	1	µg/m ³	341	342	342	10
SO ₂	2	µg/m ³	113	114	114	5.2
SO ₂	3	µg/m ³	29	29	29	3.3
SO ₂	4	µg/m ³	73	74	74	4.3
SO ₂	5	µg/m ³	154	154	154	6.1
CO	0	mg/m ³	0.00	0.00	0.00	0.12
CO	1	mg/m ³	0.69	0.69	0.69	0.13
CO	2	mg/m ³	10	10	10	0.36
CO	3	mg/m ³	1.0	1.0	1.0	0.14
CO	4	mg/m ³	2.2	2.2	2.2	0.17
CO	5	mg/m ³	5.6	5.6	5.6	0.25
O ₃	0	µg/m ³	1.5	0.04	0.20	2.0
O ₃	1	µg/m ³	242	244	240	6.8
O ₃	2	µg/m ³	144	143	142	4.9
O ₃	3	µg/m ³	164	164	163	5.3
O ₃	4	µg/m ³	379	383	378	9.6
O ₃	5	µg/m ³	242	241	240	6.8
NO	0	µg/m ³	-0.23	0.20	0.28	1.2
NO	1	µg/m ³	247	246	247	7.2
NO	2	µg/m ³	97	96	97	3.6
NO	3	µg/m ³	38	38	38	2.2
NO	4	µg/m ³	28	28	28	1.9
NO	5	µg/m ³	75	75	75	3.0
NO	6	µg/m ³	45	45	46	2.3
NO	7	µg/m ³	455	453	454	12
NO	8	µg/m ³	322	318	320	8.9
NO	9	µg/m ³	347	347	346	9.6
NO	10	µg/m ³	197	196	197	6.0
NO ₂	0	µg/m ³	0.27	0.22	-0.36	2.7
NO ₂	1	µg/m ³	6.4	6.4	6.1	2.9
NO ₂	2	µg/m ³	237	237	236	9.3
NO ₂	3	µg/m ³	0.62	0.67	0.10	2.7
NO ₂	4	µg/m ³	16	16	15	3.1
NO ₂	5	µg/m ³	0.37	0.47	0.05	2.7

Pollutant	Run	Unit	PT1	PT2	PT3	sigmaPT
NO ₂	6	µg/m ³	46	46	46	4.0
NO ₂	7	µg/m ³	168	169	169	7.4
NO ₂	8	µg/m ³	375	378	376	13
NO ₂	9	µg/m ³	7.5	7.8	8.3	2.9
NO ₂	10	µg/m ³	238	239	238	9.4

Stability of ERLAP reference values

Inter-round reproducibility

The table below reports, for each pollutant and concentration level, the inter-round standard deviation (s_R), coefficient of variation (CV%), and the ratio s_R / σ_{PT} . Values of s_R / σ_{PT} well below 0.3 indicate that the generation variability is negligible relative to the fitness-for-purpose criterion.

Table 22: Inter-round reproducibility of the ERLAP assigned values across 3 rounds. $s_R / \sigma_{PT} < 0.3$ confirms negligible generation variability.

Pollutant	Run	Unit	Rounds	Mean X	s_R (inter-round)	CV %	σ_{PT}	s_R / σ_{PT}
SO ₂	0	µg/m ³	3	0.09	0.01	6.19	2.7	0.002
SO ₂	1	µg/m ³	3	342	0.51	0.15	10	0.050
SO ₂	2	µg/m ³	3	114	0.38	0.34	5.2	0.074
SO ₂	3	µg/m ³	3	29	0.00	0.00	3.3	0.000
SO ₂	4	µg/m ³	3	74	0.33	0.45	4.3	0.078
SO ₂	5	µg/m ³	3	154	0.00	0.00	6.1	0.000
CO	0	mg/m ³	3	0.00	0.00	-	0.12	0.000
CO	1	mg/m ³	3	0.69	0.00	0.28	0.13	0.015
CO	2	mg/m ³	3	10	0.00	0.00	0.36	0.000
CO	3	mg/m ³	3	1.0	0.00	0.37	0.14	0.027
CO	4	mg/m ³	3	2.2	0.01	0.32	0.17	0.041
CO	5	mg/m ³	3	5.6	0.02	0.38	0.25	0.084
O ₃	0	µg/m ³	3	0.58	0.80	138.06	2.0	0.399
O ₃	1	µg/m ³	3	242	2.0	0.83	6.8	0.293
O ₃	2	µg/m ³	3	143	0.84	0.59	4.9	0.173
O ₃	3	µg/m ³	3	164	0.58	0.35	5.3	0.110
O ₃	4	µg/m ³	3	380	2.5	0.65	9.6	0.256
O ₃	5	µg/m ³	3	241	1.0	0.42	6.8	0.150
NO	0	µg/m ³	3	0.08	0.27	329.14	1.2	0.219
NO	1	µg/m ³	3	247	0.51	0.21	7.2	0.071
NO	2	µg/m ³	3	97	0.58	0.60	3.6	0.162
NO	3	µg/m ³	3	38	0.00	0.00	2.2	0.000
NO	4	µg/m ³	3	28	0.00	0.00	1.9	0.000
NO	5	µg/m ³	3	75	0.00	0.00	3.0	0.000
NO	6	µg/m ³	3	45	0.58	1.27	2.3	0.247
NO	7	µg/m ³	3	454	0.88	0.19	12	0.073
NO	8	µg/m ³	3	320	1.7	0.52	8.9	0.188
NO	9	µg/m ³	3	347	0.38	0.11	9.6	0.040
NO	10	µg/m ³	3	197	0.38	0.20	6.0	0.064
NO ₂	0	µg/m ³	3	0.04	0.35	808.13	2.7	0.131
NO ₂	1	µg/m ³	3	6.3	0.18	2.80	2.9	0.062

Pollutant	Run	Unit	Rounds	Mean X	sR (inter-round)	CV %	σ_{PT}	sR / σ_{PT}
NO ₂	2	µg/m ³	3	237	0.58	0.24	9.3	0.062
NO ₂	3	µg/m ³	3	0.46	0.32	68.65	2.7	0.118
NO ₂	4	µg/m ³	3	16	0.58	3.69	3.1	0.185
NO ₂	5	µg/m ³	3	0.30	0.22	72.80	2.7	0.081
NO ₂	6	µg/m ³	3	46	0.19	0.42	4.0	0.049
NO ₂	7	µg/m ³	3	169	0.51	0.30	7.4	0.069
NO ₂	8	µg/m ³	3	376	1.7	0.45	13	0.127
NO ₂	9	µg/m ³	3	7.9	0.41	5.22	2.9	0.142
NO ₂	10	µg/m ³	3	239	0.69	0.29	9.4	0.074

Note on negative assigned values at zero level

In occasional rounds, the ERLAP reference analyser may report a small negative reading at the zero concentration step (e.g. -0.2 nmol/mol for NO in one of the three rounds of this campaign). This reflects the normal baseline offset inherent to chemiluminescence (and other) measurement principles and does not represent a physical negative concentration. The value is retained as-is in the evaluation because:

1. Forcing the assigned value to zero would introduce a systematic correction inconsistent with the metrological model.
2. The expanded uncertainty at the zero level encompasses zero, confirming statistical compatibility.
3. The ISO 13528 evaluation framework accounts for this situation: the criterion $u(X) \geq 0.3 \times \sigma_{PT}$ triggers the z' score (or En score), which incorporates the reference uncertainty and appropriately relaxes the performance assessment at this level.
4. The D% indicator is suppressed when $X < 2 \times \sigma_{PT}$, avoiding misleading percentage deviations near zero.

No correction or filtering is applied; participants are evaluated against the measured reference value with its full uncertainty budget.

Compatibility with robust consensus (En)

The mean ERLAP assigned value is compared with the robust consensus of all participants pooled across rounds using the En statistic:

$$E_n = \frac{X_{ERLAP} - x^*}{\sqrt{U(X)^2 + U(x^*)^2}}$$

$|En| < 1$ confirms satisfactory compatibility.

Table 33: Compatibility of the ERLAP assigned value with the robust consensus (En score). $|En| < 1$ = satisfactory.

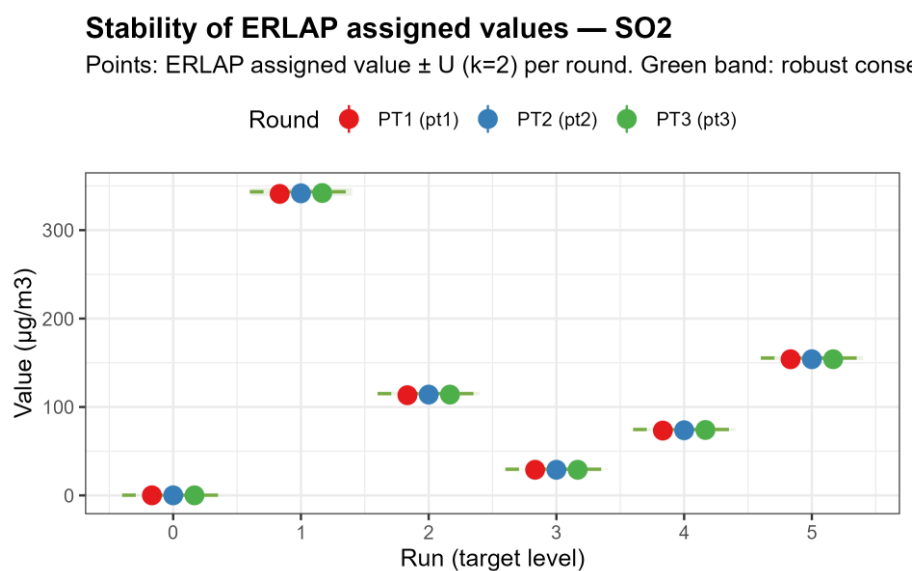
Pollutant	Run	ERLAP X	U(X)	x^*	U(x^*)	Diff	U(U(X)- U(x^*))	En	Evaluation
SO ₂	0	0.09	3.8	0.25	0.18	-0.16	3.8	-0.04	satisfactory
SO ₂	1	342	5.3	343	4.4	-1.8	6.9	-0.27	satisfactory
SO ₂	2	114	4.0	115	1.9	-1.3	4.4	-0.30	satisfactory
SO ₂	3	29	3.8	30	0.73	-0.58	3.9	-0.15	satisfactory
SO ₂	4	74	3.9	75	1.4	-0.88	4.1	-0.21	satisfactory
SO ₂	5	154	4.3	155	2.2	-1.4	4.8	-0.28	satisfactory

Pollutant	Run	ERLAP X	U(X)	x*	U(x*)	Diff	U(U(X)- U(x*))	En	Evaluation
CO	0	0.00	0.01	0.00	0.03	-0.00	0.03	-0.07	satisfactory
CO	1	0.69	0.02	0.68	0.04	0.01	0.04	0.26	satisfactory
CO	2	10	0.12	10	0.10	0.08	0.15	0.51	satisfactory
CO	3	1.0	0.02	1.0	0.04	0.02	0.04	0.40	satisfactory
CO	4	2.2	0.03	2.2	0.03	0.03	0.04	0.59	satisfactory
CO	5	5.6	0.07	5.6	0.05	-0.02	0.08	-0.26	satisfactory
O ₃	0	0.58	1.9	0.23	0.36	0.35	1.9	0.18	satisfactory
O ₃	1	242	2.0	240	1.2	1.2	2.3	0.54	satisfactory
O ₃	2	143	1.2	142	0.62	0.77	1.4	0.57	satisfactory
O ₃	3	164	1.3	163	0.80	0.51	1.6	0.33	satisfactory
O ₃	4	380	3.1	379	1.8	0.59	3.6	0.17	satisfactory
O ₃	5	241	1.9	240	0.89	0.64	2.1	0.30	satisfactory
NO	0	0.08	1.9	0.11	0.14	-0.03	1.9	-0.02	satisfactory
NO	1	247	3.0	246	2.6	0.95	4.0	0.24	satisfactory
NO	2	97	2.1	97	1.2	0.11	2.4	0.04	satisfactory
NO	3	38	1.9	38	0.63	0.12	2.0	0.06	satisfactory
NO	4	28	1.9	28	0.47	0.03	2.0	0.02	satisfactory
NO	5	75	2.0	75	0.94	0.06	2.2	0.03	satisfactory
NO	6	45	1.9	45	0.62	-0.09	2.0	-0.05	satisfactory
NO	7	454	4.5	453	3.8	1.4	5.9	0.23	satisfactory
NO	8	320	3.5	319	2.8	1.3	4.5	0.29	satisfactory
NO	9	347	3.6	345	3.3	1.9	4.9	0.39	satisfactory
NO	10	197	2.6	196	1.8	1.0	3.1	0.33	satisfactory
NO ₂	0	0.04	3.1	0.12	0.17	-0.07	3.1	-0.02	satisfactory
NO ₂	1	6.3	3.8	6.2	1.0	0.12	3.9	0.03	satisfactory
NO ₂	2	237	4.2	235	2.4	1.5	4.9	0.30	satisfactory
NO ₂	3	0.46	3.0	0.37	0.24	0.10	3.0	0.03	satisfactory
NO ₂	4	16	3.0	15	0.45	0.45	3.0	0.15	satisfactory
NO ₂	5	0.30	3.1	0.16	0.36	0.14	3.1	0.04	satisfactory
NO ₂	6	46	3.1	45	0.64	0.56	3.1	0.18	satisfactory
NO ₂	7	169	5.7	168	2.8	0.62	6.4	0.10	satisfactory
NO ₂	8	376	6.6	375	4.1	1.3	7.7	0.17	satisfactory
NO ₂	9	7.9	4.2	7.0	1.4	0.84	4.4	0.19	satisfactory
NO ₂	10	239	4.6	236	2.3	2.1	5.2	0.41	satisfactory

Stability plots

S02

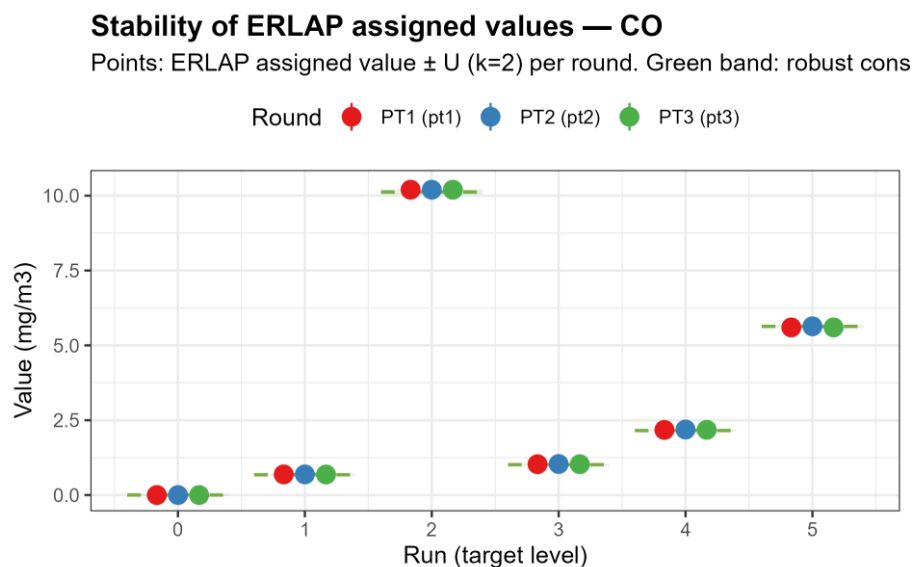
Figure 11: Stability of ERLAP assigned values for SO₂ across 3 rounds. Points: ERLAP value per round with U (k=2). Green band: robust consensus $\pm U(x^*)$.



Source: JRC 2026

CO

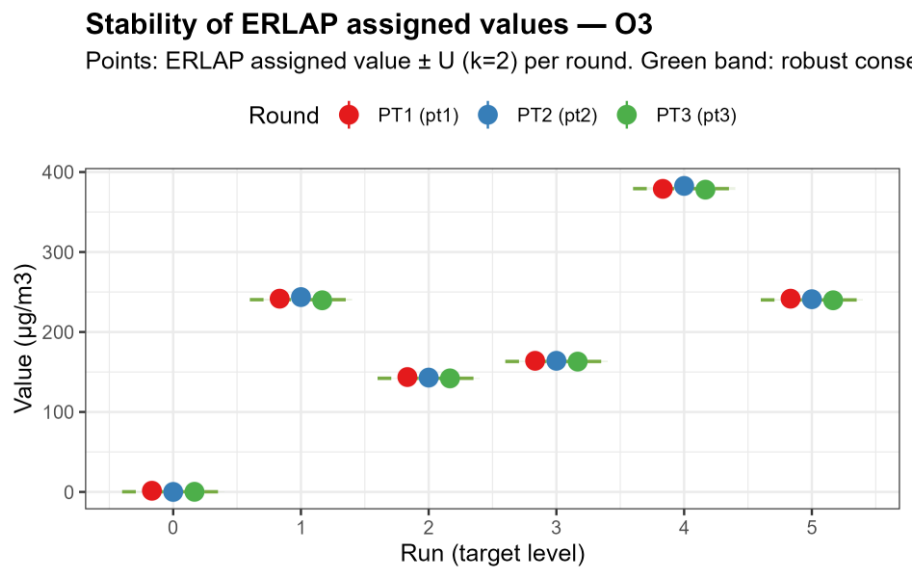
Figure 22: Stability of ERLAP assigned values for CO across 3 rounds. Points: ERLAP value per round with U (k=2). Green band: robust consensus $\pm U(x^*)$.



Source: JRC 2026

03

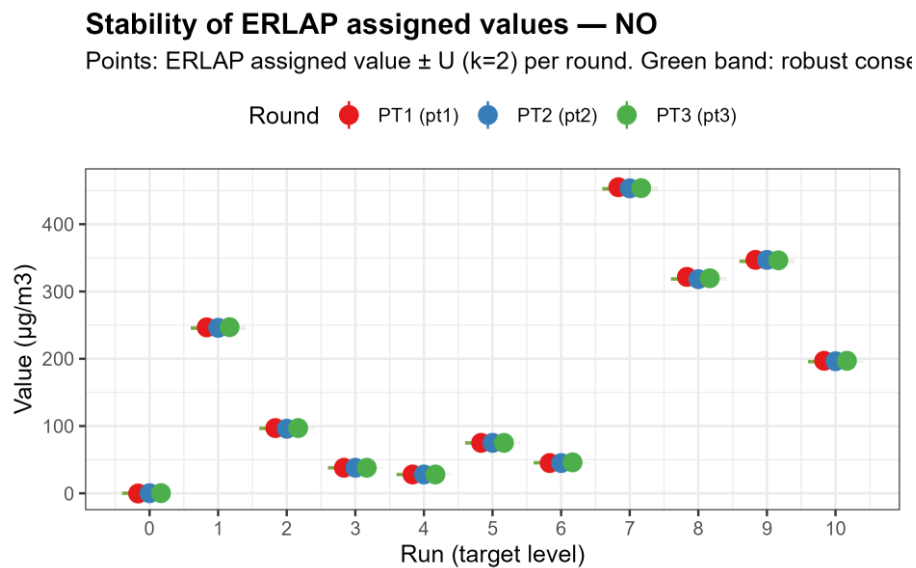
Figure 33: Stability of ERLAP assigned values for O3 across 3 rounds. Points: ERLAP value per round with U (k=2). Green band: robust consensus $\pm U(x^*)$.



Source: JRC 2026

NO

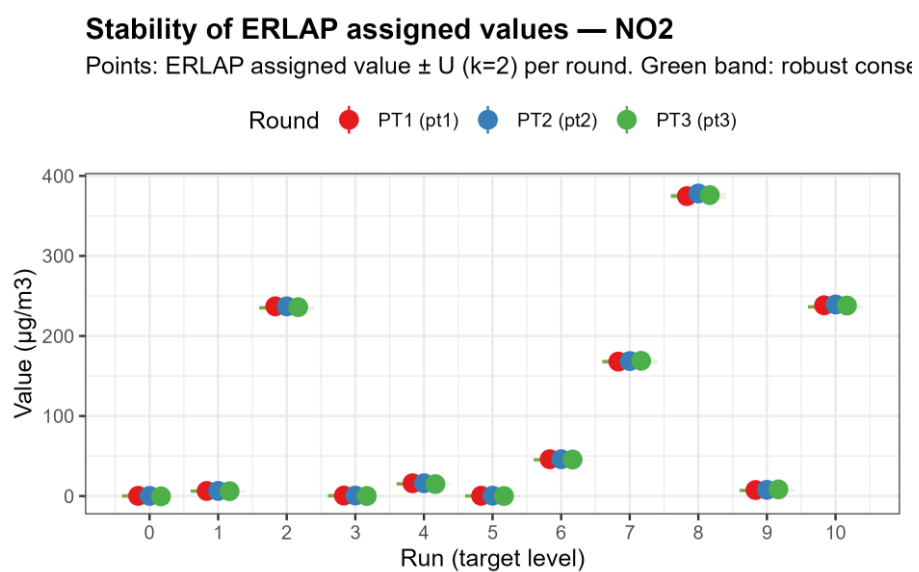
Figure 44: Stability of ERLAP assigned values for NO across 3 rounds. Points: ERLAP value per round with U (k=2). Green band: robust consensus $\pm U(x^*)$.



Source: JRC 2026

N02

Figure 5 **5**: Stability of ERLAP assigned values for NO2 across 3 rounds. Points: ERLAP value per round with U (k=2). Green band: robust consensus $\pm U(x^*)$.



Source: JRC 2026

Cross-round robust consensus (ISO 13528 clause 7.8)

For each pollutant and run, the participant results of all rounds are pooled and a robust consensus value x^* is computed with Algorithm A of ISO 13528:2015. The robust average x^* is compared with the assigned value X following ISO 13528:2022 clause 7.8.

Table 44: Robust consensus of pooled participant results (ISO 13528 Algorithm A) versus the ERLAP assigned value, with the clause 7.8 consistency check.

Pollutant	Run	Unit	Participants (n)	x^*	$u(x^*)$	Assigned value X	$u(X)$	$x^* - X$	$2 \times u_diff$	zeta	Check
SO ₂	0	µg/m ³	26	0.25	0.09	0.09	1.9	0.16	3.8	0.08	consistent
SO ₂	1	µg/m ³	27	343	2.2	342	2.6	1.8	6.9	0.53	consistent
SO ₂	2	µg/m ³	27	115	0.94	114	2.0	1.3	4.4	0.60	consistent
SO ₂	3	µg/m ³	27	30	0.36	29	1.9	0.58	3.9	0.30	consistent
SO ₂	4	µg/m ³	27	75	0.70	74	1.9	0.88	4.1	0.43	consistent
SO ₂	5	µg/m ³	27	155	1.1	154	2.1	1.4	4.8	0.57	consistent
CO	0	mg/m ³	24	0.00	0.01	0.00	0.01	0.00	0.03	0.14	consistent
CO	1	mg/m ³	24	0.68	0.02	0.69	0.01	-0.01	0.04	-0.51	consistent
CO	2	mg/m ³	25	10	0.05	10	0.06	-0.08	0.15	-1.0	consistent
CO	3	mg/m ³	25	1.0	0.02	1.0	0.01	-0.02	0.04	-0.80	consistent
CO	4	mg/m ³	25	2.2	0.02	2.2	0.01	-0.03	0.04	-1.2	consistent
CO	5	mg/m ³	25	5.6	0.03	5.6	0.03	0.02	0.08	0.52	consistent
O ₃	0	µg/m ³	24	0.23	0.18	0.58	0.94	-0.35	1.9	-0.37	consistent
O ₃	1	µg/m ³	25	240	0.59	242	0.98	-1.2	2.3	-1.1	consistent
O ₃	2	µg/m ³	25	142	0.31	143	0.60	-0.77	1.4	-1.1	consistent
O ₃	3	µg/m ³	25	163	0.40	164	0.67	-0.51	1.6	-0.66	consistent
O ₃	4	µg/m ³	25	379	0.91	380	1.5	-0.59	3.6	-0.33	consistent
O ₃	5	µg/m ³	24	240	0.45	241	0.97	-0.64	2.1	-0.60	consistent
NO	0	µg/m ³	27	0.11	0.07	0.08	0.95	0.03	1.9	0.03	consistent
NO	1	µg/m ³	28	246	1.3	247	1.5	-0.95	4.0	-0.48	consistent
NO	2	µg/m ³	28	97	0.60	97	1.1	-0.11	2.4	-0.09	consistent
NO	3	µg/m ³	28	38	0.31	38	0.95	-0.12	2.0	-0.12	consistent
NO	4	µg/m ³	28	28	0.23	28	0.95	-0.03	2.0	-0.04	consistent
NO	5	µg/m ³	28	75	0.47	75	1.00	-0.06	2.2	-0.06	consistent

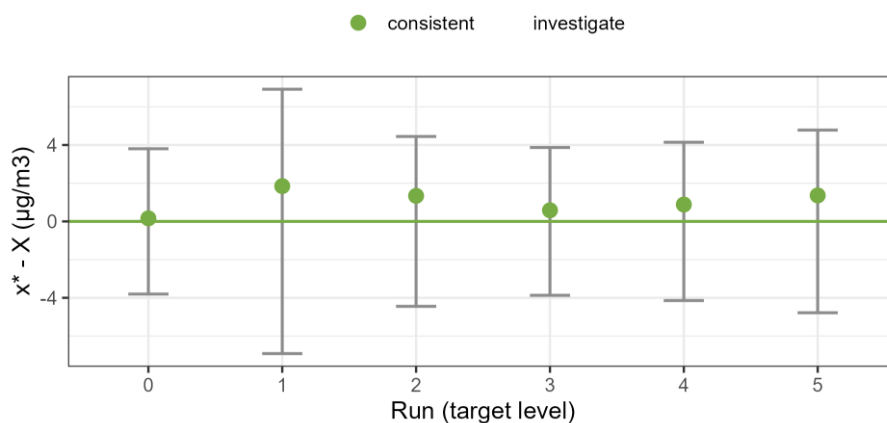
Pollutant	Run	Unit	Participants (n)	x^*	$u(x^*)$	Assigned value X	$u(X)$	$x^* - X$	$2 \times u_{diff}$	zeta	Check
NO	6	$\mu\text{g}/\text{m}^3$	28	45	0.31	45	0.95	0.09	2.0	0.09	consistent
NO	7	$\mu\text{g}/\text{m}^3$	28	453	1.9	454	2.2	-1.4	5.9	-0.47	consistent
NO	8	$\mu\text{g}/\text{m}^3$	28	319	1.4	320	1.8	-1.3	4.5	-0.57	consistent
NO	9	$\mu\text{g}/\text{m}^3$	28	345	1.6	347	1.8	-1.9	4.9	-0.78	consistent
NO	10	$\mu\text{g}/\text{m}^3$	28	196	0.89	197	1.3	-1.0	3.1	-0.66	consistent
NO ₂	0	$\mu\text{g}/\text{m}^3$	27	0.12	0.08	0.04	1.5	0.07	3.1	0.05	consistent
NO ₂	1	$\mu\text{g}/\text{m}^3$	27	6.2	0.51	6.3	1.9	-0.12	3.9	-0.06	consistent
NO ₂	2	$\mu\text{g}/\text{m}^3$	27	235	1.2	237	2.1	-1.5	4.9	-0.60	consistent
NO ₂	3	$\mu\text{g}/\text{m}^3$	27	0.37	0.12	0.46	1.5	-0.10	3.0	-0.06	consistent
NO ₂	4	$\mu\text{g}/\text{m}^3$	27	15	0.23	16	1.5	-0.45	3.0	-0.30	consistent
NO ₂	5	$\mu\text{g}/\text{m}^3$	27	0.16	0.18	0.30	1.5	-0.14	3.1	-0.09	consistent
NO ₂	6	$\mu\text{g}/\text{m}^3$	27	45	0.32	46	1.5	-0.56	3.1	-0.36	consistent
NO ₂	7	$\mu\text{g}/\text{m}^3$	27	168	1.4	169	2.9	-0.62	6.4	-0.19	consistent
NO ₂	8	$\mu\text{g}/\text{m}^3$	27	375	2.0	376	3.3	-1.3	7.7	-0.33	consistent
NO ₂	9	$\mu\text{g}/\text{m}^3$	27	7.0	0.70	7.9	2.1	-0.84	4.4	-0.38	consistent
NO ₂	10	$\mu\text{g}/\text{m}^3$	27	236	1.2	239	2.3	-2.1	5.2	-0.82	consistent

S02 — robust consensus

Figure 66: Consistency of the robust consensus with the assigned value for S02 (ISO 13528:2022 clause 7.8).

Robust consensus vs assigned value - S02

Informative: ISO 13528:2022 clause 7.8, participants pooled across all rounds



: assigned value ($x_{\text{diff}} = 0$). Grey band: acceptance limits $\pm 2 \times u_{\text{diff}}$, $u_{\text{diff}} = \sqrt{u_{\text{assigned}}^2 + u(x^*)^2}$. Points outside the band should be investigated ($|\text{zeta}| > 2$).

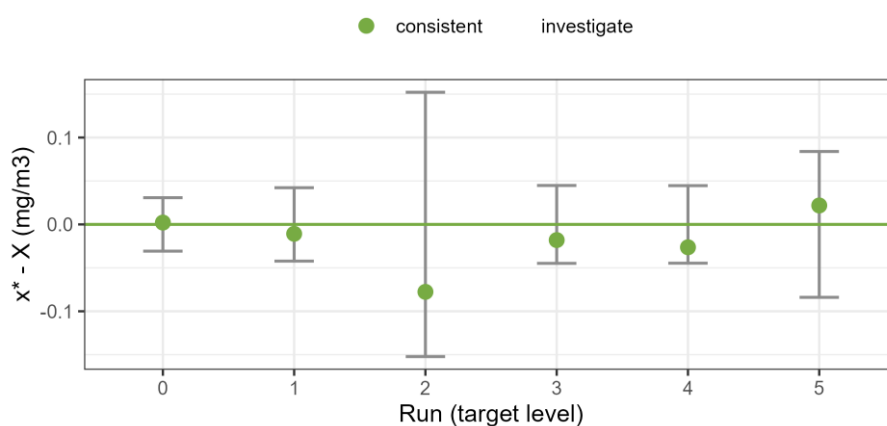
Source: JRC 2026

C0 — robust consensus

Figure 77: Consistency of the robust consensus with the assigned value for C0 (ISO 13528:2022 clause 7.8).

Robust consensus vs assigned value - C0

Informative: ISO 13528:2022 clause 7.8, participants pooled across all rounds



: assigned value ($x_{\text{diff}} = 0$). Grey band: acceptance limits $\pm 2 \times u_{\text{diff}}$, $u_{\text{diff}} = \sqrt{u_{\text{assigned}}^2 + u(x^*)^2}$. Points outside the band should be investigated ($|\text{zeta}| > 2$).

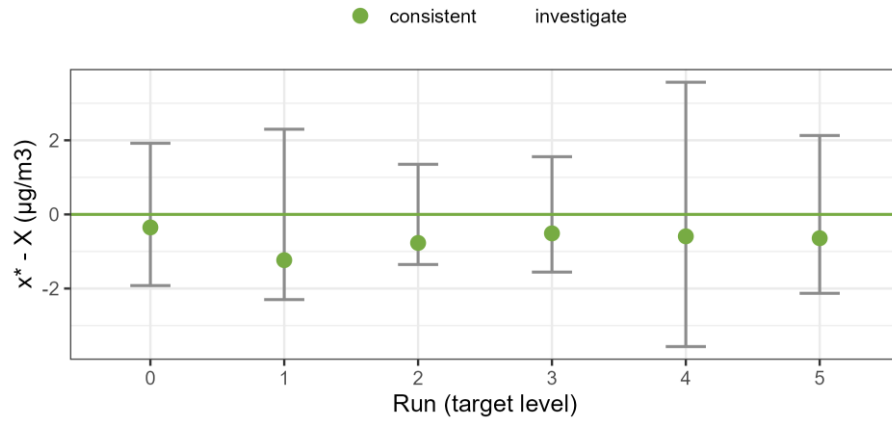
Source: JRC 2026

03 — robust consensus

Figure 88: Consistency of the robust consensus with the assigned value for O3 (ISO 13528:2022 clause 7.8).

Robust consensus vs assigned value - O3

Informative: ISO 13528:2022 clause 7.8, participants pooled across all rounds



: assigned value ($x_{\text{diff}} = 0$). Grey band: acceptance limits $\pm 2 \times u_{\text{diff}}$, $u_{\text{diff}} = \sqrt{u_{\text{assigned}}^2 + u(x^*)^2}$. Points outside the band should be investigated ($|\text{zeta}| > 2$).

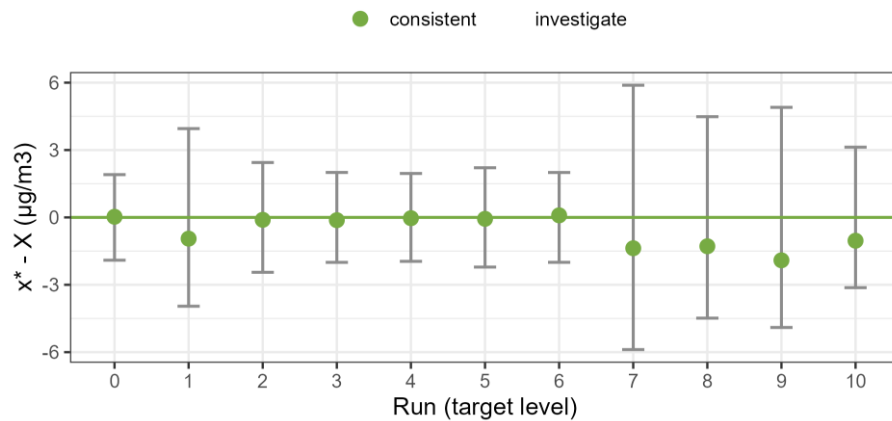
Source: JRC 2026

NO — robust consensus

Figure 99: Consistency of the robust consensus with the assigned value for NO (ISO 13528:2022 clause 7.8).

Robust consensus vs assigned value - NO

Informative: ISO 13528:2022 clause 7.8, participants pooled across all rounds



: assigned value ($x_{\text{diff}} = 0$). Grey band: acceptance limits $\pm 2 \times u_{\text{diff}}$, $u_{\text{diff}} = \sqrt{u_{\text{assigned}}^2 + u(x^*)^2}$. Points outside the band should be investigated ($|\text{zeta}| > 2$).

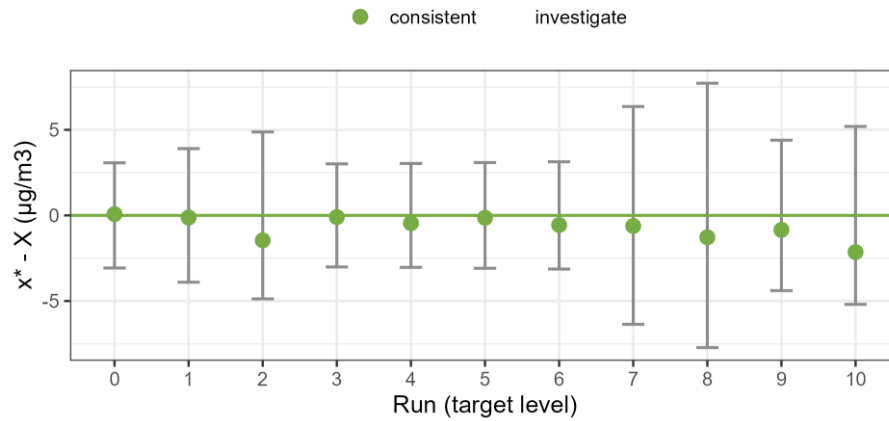
Source: JRC 2026

N02 — robust consensus

Figure 1010: Consistency of the robust consensus with the assigned value for NO2 (ISO 13528:2022 clause 7.8).

Robust consensus vs assigned value - NO2

Informative: ISO 13528:2022 clause 7.8, participants pooled across all rounds



: assigned value ($x_{\text{diff}} = 0$). Grey band: acceptance limits $\pm 2 \times u_{\text{diff}}$, $u_{\text{diff}} = \sqrt{u_{\text{assigned}}^2 + u(x^*)^2}$. Points outside the band should be investigated ($|\text{zeta}| > 2$).

Source: JRC 2026

Homogeneity of the test mixtures

ERLAP verifies the homogeneity of the delivered mixture using ozone as a worst case. Two identical analysers calibrated against an SRP primary standard are compared across the 20 positions of the sampling line. The test is acceptable when the absolute difference between the reference port and every other port is below 0.5%. The homogeneity test is performed once before the PT campaign; the same result applies to all rounds.

Table 55: Homogeneity verification of the ozone test mixture across the sampling-line ports. Acceptance criterion: absolute port-to-port difference < 0.5%.

Bench position	Sample Analyzer SN14	Ref Analyzer SN15	Diff. in nmol/mol	<0.5% passed?
20a/b	447.0	436.0	0.0	Yes
1a	446.0	436.0	-1.0	Yes
1b	446.0	435.0	0.0	Yes
2a	447.0	436.0	0.0	Yes
2b	447.5	436.0	0.5	Yes
3a	449.0	437.0	1.0	Yes
3b	449.0	437.0	1.0	Yes
4a	448.0	436.2	0.8	Yes
4b	449.0	437.7	0.3	Yes
5a	449.0	437.4	0.6	Yes
5b	449.0	437.6	0.4	Yes
6a	448.0	438.1	-1.1	Yes
6b	448.0	438.0	-1.0	Yes
7a	448.0	438.0	-1.0	Yes
7b	449.5	438.3	0.2	Yes
8a	449.0	438.4	-0.4	Yes
8b	449.0	438.4	-0.4	Yes
9a	450.0	438.6	0.4	Yes
9b	450.0	438.6	0.4	Yes
10a	449.0	438.4	-0.4	Yes
10b	449.0	438.5	-0.5	Yes
11a	449.0	438.5	-0.5	Yes
11b	450.0	438.5	0.5	Yes
12a	450.0	438.6	0.4	Yes
12b	450.0	438.6	0.4	Yes
13a	450.0	438.7	0.3	Yes
13b	450.0	438.7	0.3	Yes
14a	450.0	438.8	0.2	Yes
14b	450.0	438.8	0.2	Yes
15a	450.5	438.5	1.0	Yes
15b	450.0	438.6	0.4	Yes

Bench position	Sample Analyzer SN14	Ref Analyzer SN15	Diff. in nmol/mol	<0.5% passed?
16a	450.0	438.6	0.4	Yes
16b	449.0	438.3	-0.3	Yes
17a	451.0	438.3	1.7	Yes
17b	451.0	438.7	1.3	Yes
18a	450.0	438.7	0.3	Yes
18b	450.0	438.5	0.5	Yes
19a	451.0	438.7	1.3	Yes
19b	450.0	438.7	0.3	Yes
20a	450.5	438.8	0.7	Yes
20b	451.0	438.6	1.4	Yes
21a	451.5	439.5	1.0	Yes
21b	451.0	439.4	0.6	Yes
22a	450.0	439.4	-0.4	Yes
22b	450.0	438.8	0.2	Yes
22c	450.0	438.6	0.4	Yes
22d	449.0	438.6	-0.6	Yes
23a	448.0	439.0	-2.0	Yes
23b	450.0	438.0	1.0	Yes
23c	449.0	439.1	-1.1	Yes
23d	449.0	438.5	-0.5	Yes

External precision (ISO 5725)

The reproducibility and repeatability of the measurement methods are assessed following ISO 5725-2 using the participant data pooled across rounds.

External precision data were not available.

Data integrity check (assigned-value transfer)

The assigned values and their uncertainties are produced by the erlap package and manually transcribed into the PT report input workbooks. This section documents the automated verification that the manual transfer is exact. The check compares, for each PT round, component, run and step: the assigned value, standard uncertainty, and expanded uncertainty from the erlap output (db_upload_mass.csv) against the ERLAP rows in the report input files.

Conclusions

The evidence presented in this report demonstrates that:

1. The ERLAP reference values are **stable** across the 3 rounds of the campaign (s_R / σ_{PT} well below 0.3 for all pollutants and levels).
2. The assigned values are **compatible** with the robust consensus of participant results ($En < 1$ for all runs).
3. The **homogeneity** of the test mixtures is verified and within acceptance limits.
4. The **data transfer** from the calculation software to the report input files is verified and exact.
5. The PT scheme operates under controlled conditions as required by ISO 17043.

Confidentiality

The PT results evaluation is disseminated in alignment with the stipulations laid out in the AQUILA-N37 document [10], which has received unanimous consent from all NRL members within the AQUILA network. ERLAP is committed to preserving the confidentiality of laboratory data through the following measures:

- All administrative details furnished by the laboratory are deemed confidential and will not be disclosed to external parties.
- Entry to ERLAP premises is strictly limited to JRC-C5 Unit members and individuals granted permission (including cleaning, maintenance, safety, and security personnel).
- Unique passwords for the web-based data submission portal are issued upon successful PT enrollment. These passwords remain active until the conclusion of the PT. Participating laboratories have the option to modify their passwords through the online platform.

As part of their initial PT engagement with ERLAP, participants are required to sign a Confidentiality Involvement Form during their first participation to a PT organized by ERLAP.

Accreditation

ERLAP is accredited to the standard ISO 17043 for the organisation of proficiency tests for the pollutants and EN standard methods used during this PT.

[Insert accreditation certificate when available.]

Bibliography

- [1] Directive 2008/50/EC of the European Parliament and of the Council on ambient air quality and cleaner air for Europe.
- [2] Directive (EU) 2024/2881 of the European Parliament and of the Council on ambient air quality and cleaner air for Europe (recast).
- [3] EN 14626:2012 — Ambient air. Standard method for the measurement of the concentration of carbon monoxide by non-dispersive infrared spectroscopy.
- [4] EN 14212:2012 — Ambient air. Standard method for the measurement of the concentration of sulphur dioxide by ultraviolet fluorescence.
- [5] EN 14211:2012 — Ambient air. Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence.
- [6] EN 14625:2012 — Ambient air. Standard method for the measurement of the concentration of ozone by ultraviolet photometry.
- [7] ISO 6143:2001 — Gas analysis. Comparison methods for determining and checking the composition of calibration gas mixtures.
- [8] ISO 6145-7:2018 — Gas analysis. Preparation of calibration gas mixtures using dynamic methods. Part 7: Thermal mass-flow controllers.
- [9] ISO 6145-9:2009 — Gas analysis. Preparation of calibration gas mixtures using dynamic methods. Part 9: Saturation method.
- [10] AQUILA N37 — Position paper on methodology for the organisation of laboratory comparison exercises for gaseous air pollutants.
- [11] ISO 13528:2022 — Statistical methods for use in proficiency testing by interlaboratory comparison.
- [12] ISO 17043:2023 — Conformity assessment. General requirements for the competence of proficiency testing providers.
- [13] ISO 17025:2017 — General requirements for the competence of testing and calibration laboratories.
- [14] ISO 5725-1:1994 — Accuracy (trueness and precision) of measurement methods and results. Part 1: General principles and definitions.
- [15] ISO 5725-2:2019 — Accuracy (trueness and precision) of measurement methods and results. Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method.
- [16] ISO 5725-6:1994 — Accuracy (trueness and precision) of measurement methods and results. Part 6: Use in practice of accuracy values.

List of abbreviations

- AQUILA — Network of National Reference Laboratories for Air Quality
- CEN — European Committee for Standardization
- CO — Carbon monoxide
- CRM — Certified Reference Material
- DQO — Data Quality Objective
- EIV-GLS — Errors-in-Variables Generalized Least Squares
- ERLAP — European Reference Laboratory for Air Pollution
- EC — European Commission
- GPT — Gas Phase Titration
- ILC — Inter-Laboratory Comparison Exercise
- ISO — International Organization for Standardization
- JRC — Joint Research Centre
- NO — Nitrogen monoxide
- NO₂ — Nitrogen dioxide
- NO_x — Oxides of nitrogen (sum of NO and NO₂)
- NRL — National Reference Laboratory
- O₃ — Ozone
- PT — Proficiency Test
- PTP — Proficiency Test Provider
- SO₂ — Sulphur dioxide
- SRP — Standard Reference Photometer
- WHO CC — World Health Organization Collaborating Centre for Air Quality Management and Air Pollution Control

Mathematical symbols

- E_n — En score statistic (ISO 13528)
- $D\%$ — Percent difference between participant and assigned value
- r — Repeatability limit (ISO 5725)
- R — Reproducibility limit (ISO 5725)
- σ_{PT} — Standard deviation for proficiency assessment (ISO 13528)
- x^* — Robust average (ISO 13528 Algorithm A)
- s^* — Robust standard deviation (ISO 13528 Algorithm A)
- s_r — Repeatability standard deviation (ISO 5725)
- s_R — Reproducibility standard deviation (ISO 5725)
- U_X — Expanded uncertainty of the assigned/reference value (ISO 13528)
- U_{xi} — Expanded uncertainty of the participant's value
- u_X — Standard uncertainty of the assigned/reference value (ISO 13528)
- X — Assigned/reference value (ISO 13528)
- x_i — Average of reported values by participant i (for a given parameter and concentration level)
- z' — z' score statistic (ISO 13528)
- α — Converter efficiency (EN 14211)