

CCQM-K23.b and COOMET.QM-K23.b

Key comparison CCQM-K23.b

MEASURAND : Amount-of-substance fraction of Carbon dioxide in Natural gas type II

NOMINAL VALUE : 0.03 mol/mol

GAS MIXTURE : Expressed in mol/mol: Nitrogen (0.07 mol/mol), Carbon dioxide (0.03 mol/mol), Ethane (0.094 mol/mol), Propane (0.034 mol/mol), *n*-Butane (0.01 mol/mol), *iso*-Butane (0.008 mol/mol), Methane (0.754 mol/mol)

$x_{\text{Lab}i}$ result of measurement carried out by laboratory i

$U_{\text{Lab}i}$ stated uncertainty of laboratory i at a 95 % level of confidence

$k_{\text{Lab}i}$ stated coverage factor

$x_{i\text{ref}}$ amount of substance fraction in the cylinder sent to laboratory i , from preparation

$u_{i\text{ref}}$ combined standard uncertainty of $x_{i\text{ref}}$

$u_{i\text{ref}} = (u_{i\text{prep}}^2 + u_{i\text{ver}}^2)^{1/2}$ where $u_{i\text{prep}}$ and $u_{i\text{ver}}$ are the standard uncertainties of preparation and verification respectively for which the numerical values can be found in Table 6 of the Final Report.

Lab i	Cylinder number	$x_{\text{Lab}i}$ / (10^{-2} mol/mol)	$U_{\text{Lab}i}$ / (10^{-2} mol/mol)	$k_{\text{Lab}i}$	$x_{i\text{ref}}$ / (10^{-2} mol/mol)	$u_{i\text{ref}}$ / (10^{-2} mol/mol)	Date of measurement
NPL	VSL205170	2.9927	0.0040	2	2.99416	0.00161	07 Sep 2005
SMU	VSL200238	3.0069	0.0060	2	3.01141	0.00162	13 Dec 2005
CMI	VSL200229	2.9770	0.0100	2	3.00282	0.00161	21 Sep 2005
VNIIM	VSL302766	3.0080	0.0090	2	3.01583	0.00162	05 Dec 2005
MKEH	VSL202794	3.0375	0.0060	4.53	3.02991	0.00162	03 Oct 2005
NMi-VSL	VSL133436	2.9940	0.0070	2	2.99375	0.00161	09 Sep 2005
CENAM	VSL302704	3.0130	0.0220	2	3.01822	0.00162	21 Dec 2005
CEM	VSL200231	3.0088	0.0150	2	3.00721	0.00161	20 Oct 2005
BAM	VSL200239	3.0060	0.0009	2	3.00688	0.00161	21 Sep 2005
NMIA	VSL200246	3.0133	0.0043	2.18	3.01568	0.00162	10 Sep 2005
IPQ	VSL200241	2.9880	0.0360	2	3.00379	0.00161	29 Sep 2005
INMETRO	VSL200236	2.9860	0.0230	2	3.00469	0.00161	17 Oct 2005
GUM	VSL200237	3.0040	0.0200	2	3.00749	0.00162	05 Jan 2006
NIM	VSL305182	3.0020	0.0300	2	3.01088	0.00162	06 Dec 2005
KRISS	VSL200230	3.0090	0.0045	2	3.00711	0.00161	27 Sep 2005
NMIJ	VSL200248	3.0147	0.0081	2	3.01222	0.00162	22 Dec 2005

Key comparison COOMET.QM-K23.b

MEASURAND : Amount-of-substance fraction of Carbon dioxide in Natural gas

NOMINAL VALUE : 0.03 mol/mol

GAS MIXTURE : Expressed in mol/mol: Nitrogen (0.07 mol/mol), Carbon dioxide (0.03 mol/mol), Ethane (0.095 mol/mol), Propane (0.035 mol/mol), *n*-Butane (0.01 mol/mol), *iso*-Butane (0.008 mol/mol), Methane (balance)

$x_{\text{Lab } i}$ result of measurement carried out by laboratory i participant in COOMET.QM-K23.b

$U_{\text{Lab } i}$ expanded uncertainty of laboratory i participant in COOMET.QM-K23.b at a 95 % level of confidence

$k_{\text{Lab } i}$ stated coverage factor

$x_{i\text{ref}}$ amount of substance fraction in the cylinder sent to laboratory i participant in COOMET.QM-K23.b, from preparation

$u_{i\text{ref}}$ combined standard uncertainty of $x_{i\text{ref}}$

$u_{i\text{ref}} = (u_{i\text{prep}}^2 + u_{i\text{ver}}^2)^{1/2}$ where $u_{i\text{prep}}$ and $u_{i\text{ver}}$ are the standard uncertainties of preparation and verification respectively

Lab i	Cylinder number	$x_{\text{Lab } i}$ / (10^{-2} mol/mol)	$U_{\text{Lab } i}$ / (10^{-2} mol/mol)	$k_{\text{Lab } i}$	$x_{i\text{ref}}$ / (10^{-2} mol/mol)	$u_{i\text{prep}}$ / (10^{-2} mol/mol)	$u_{i\text{ver}}$ / (10^{-2} mol/mol)	Date of measurement
VNIIM	D200273	2.925	0.009	2	2.92117	0.00078	0.00234	2008
UkrCSM	D200292	2.663	0.014	2	2.67252	0.00078	0.00214	2008
BelGIM	D200278	2.992	0.008	2	2.99103	0.00078	0.00239	2008
BAM	D200385	3.0029	0.009	2	3.00047	0.00075	0.00240	2008
SMU	D200368	2.947	0.012	2	2.93729	0.00076	0.00235	2008
CMI	D200383	2.912	0.05	2	2.95492	0.00077	0.00236	2008

Key comparison CCQM-K23.b

MEASURAND :	Amount-of-substance fraction of Carbon dioxide in Natural gas type II
NOMINAL VALUE :	0.03 mol/mol
GAS MIXTURE :	Expressed in mol/mol: Nitrogen (0.07 mol/mol), Carbon dioxide (0.03 mol/mol), Ethane (0.094 mol/mol), Propane (0.034 mol/mol), <i>n</i> -Butane (0.01 mol/mol), <i>iso</i> -Butane (0.008 mol/mol), Methane (0.754 mol/mol)

Key comparison reference value: there is no single reference value for this comparison, the value obtained from preparation, $x_{i\text{ref}}$, is taken as the reference value for laboratory i .

The degree of equivalence of each laboratory i with respect to the reference value is given by a pair of terms:

$D_i = (x_{\text{Lab}i} - x_{i\text{ref}})$ and U_i , its expanded uncertainty at a 95% level of confidence, both expressed in 10^{-2} mol/mol;
 $U_i = 2[(U_{\text{Lab}i} / k_{\text{Lab}i})^2 + u_{i\text{ref}}^2]^{1/2}$, using a coverage factor $k = 2$. D_i and U_i are also given in relative terms.

The degree of equivalence between two laboratories is given by a pair of terms: $D_{ij} = D_i - D_j = (x_i - x_{i\text{ref}}) - (x_j - x_{j\text{ref}})$ and

U_{ij} , its expanded uncertainty at a 95% level of confidence, both expressed in 10^{-2} mol/mol;

$U_{ij} = 2[(U_{\text{Lab}i} / k_{\text{Lab}i})^2 + (U_{\text{Lab}j} / k_{\text{Lab}j})^2 + u_{i\text{ref}}^2 + u_{j\text{ref}}^2]^{1/2}$, using a coverage factor $k = 2$.

The pair-wise degrees of equivalence are not explicitly computed.

Linking COOMET.QM.23.b to CCQM-K23.b

The pilot laboratory VNIIM is used as the linking laboratory. In order to link the results of COOMET.QM-K23.b to those of CCQM-K23.b, an uncertainty term is added to the standard uncertainty of the reference value, $u_{i\text{ref}}$, for the laboratory i participating in COOMET.QM-K23.b. This additional uncertainty term is equal to the absolute value of D_i obtained by VNIIM in CCQM-K23.b.

The degree of equivalence of a laboratory participant in COOMET.QM-K23.b with respect to the reference value is given by a pair of terms, both expressed in 10^{-2} mol/mol:

$D_i = (x_{\text{Lab}i} - x_{i\text{ref}})$ and its expanded uncertainty ($k = 2$), U_i ,

with $U_i = [U_{\text{Lab}i}^2 + 2u_{\text{ref}}^2 + D_{\text{VNIIM (CCQM-K23.b)}}^2]^{1/2}$.

D_i and U_i are also given in relative terms.

No pair-wise degrees of equivalence have been computed for participants in COOMET.QM-K23.b.

CCQM-K23.b and COOMET.QM-K23.b

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Degrees of equivalence, offset D_i and expanded uncertainty ($k = 2$) U_i , expressed in 10^{-2} mol/mol, and given in relative terms (%)

Lab <i>i</i>	D_i / (10^{-2} mol/mol)	U_i / (10^{-2} mol/mol)	$D_i / x_{i\text{ref}}$ / %	$U_i / x_{i\text{ref}}$ / %
NPL	-0.0015	0.0051	-0.05	0.17
SMU	-0.0045	0.0068	-0.15	0.23
CMI	-0.0258	0.0105	-0.87	0.35
VNIIM	-0.0078	0.0096	-0.26	0.32
MKEH	0.0076	0.0042	0.25	0.14
NMi-VSL	0.0002	0.0077	0.01	0.26
CENAM	-0.0052	0.0222	-0.17	0.74
CEM	0.0016	0.0153	0.05	0.51
BAM	-0.0009	0.0034	-0.03	0.11
NMIA	-0.0024	0.0051	-0.08	0.17
IPQ	-0.0158	0.0361	-0.53	1.21
INMETRO	-0.0187	0.0232	-0.63	0.78
GUM	-0.0035	0.0203	-0.12	0.68
NIM	-0.0089	0.0302	-0.30	1.01
KRISS	0.0019	0.0056	0.06	0.19
NMIJ	0.0025	0.0088	0.08	0.29
VNIIM*	0.0038	0.0126	0.13	0.43
UkrCSM*	-0.0095	0.0167	-0.36	0.62
BelGIM*	0.0010	0.0123	0.03	0.41
BAM*	0.0024	0.0129	0.08	0.43
SMU*	0.0097	0.0151	0.33	0.52
CMI*	-0.0429	0.0508	-1.45	1.72

* indicates participants in COOMET.QM-K23.b

CCQM-K23.b and COOMET.QM-K23.b Carbon dioxide in Natural gas type II

Nominal value 0.03 mol/mol

Degrees of equivalence: D_i and expanded uncertainty U_i ($k = 2$) given in relative terms

