

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

Key comparison CCQM-K23.b

MEASURAND : Amount of substance fraction of Ethane in Natural gas type II

NOMINAL VALUE : 0.094 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)

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

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

$k_{Lab\ i}$ stated coverage factor

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

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

$u_{i\ ref} = (u_{i\ prep}^2 + u_{i\ ver}^2)^{1/2}$ where $u_{i\ prep}$ and $u_{i\ ver}$ are the standard uncertainties of preparation and verification respectively for which the numerical values can be found in Table 7 of the Final Report.

Lab <i>i</i>	Cylinder number	$x_{Lab\ i}$ / (10 ⁻² mol/mol)	$U_{Lab\ i}$ / (10 ⁻² mol/mol)	$k_{Lab\ i}$	$x_{i\ ref}$ / (10 ⁻² mol/mol)	$u_{i\ ref}$ / (10 ⁻² mol/mol)	Date of measurement
NPL	VSL205170	9.4194	0.0072	2	9.41761	0.00482	07 Sep 2005
SMU	VSL200238	9.4140	0.0170	2	9.41386	0.00482	13 Dec 2005
CMI	VSL200229	9.2900	0.0360	2	9.42315	0.00482	21 Sep 2005
VNIIM	VSL302766	9.3860	0.0300	2	9.40419	0.00481	05 Dec 2005
MKEH	VSL202794	9.3887	0.0038	2.11	9.37970	0.00480	03 Oct 2005
NMi-VSL	VSL133436	9.4150	0.0230	2	9.41842	0.00482	09 Sep 2005
CENAM	VSL302704	9.6200	0.1200	2	9.60958	0.00491	21 Dec 2005
CEM	VSL200231	9.3954	0.0360	2	9.39533	0.00480	20 Oct 2005
BAM	VSL200239	9.4162	0.0028	2	9.40663	0.00481	21 Sep 2005
NMIA	VSL200246	9.4160	0.0060	2.18	9.40837	0.00481	10 Sep 2005
IPQ	VSL200241	9.3920	0.0370	2	9.41178	0.00481	29 Sep 2005
INMETRO	VSL200236	9.3720	0.0700	2	9.37697	0.00480	17 Oct 2005
GUM	VSL200237	9.2910	0.0700	2	9.29267	0.00476	05 Jan 2006
NIM	VSL305182	9.4070	0.0753	2	9.40450	0.00481	06 Dec 2005
KRISS	VSL200230	9.4100	0.0113	2	9.41509	0.00482	27 Sep 2005
NMIJ	VSL200248	9.4240	0.0210	2	9.43195	0.00482	22 Dec 2005

Key comparison COOMET.QM-K23.b

MEASURAND : Amount-of-substance fraction of Ethane in Natural gas

NOMINAL VALUE : 0.095 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)

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

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

$k_{Lab\ i}$ stated coverage factor

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

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

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

Lab <i>i</i>	Cylinder number	$x_{Lab\ i}$ / (10 ⁻² mol/mol)	$U_{Lab\ i}$ / (10 ⁻² mol/mol)	$k_{Lab\ i}$	$x_{i\ ref}$ / (10 ⁻² mol/mol)	$u_{i\ prep}$ / (10 ⁻² mol/mol)	$u_{i\ ver}$ / (10 ⁻² mol/mol)	Date of measurement
VNIIM	D200273	9.388	0.026	2	9.38197	0.0012	0.00751	2008
UkrCSM	D200292	8.906	0.019	2	8.91803	0.0012	0.00713	2008
BelGIM	D200278	9.431	0.012	2	9.40949	0.0012	0.00753	2008
BAM	D200385	9.438	0.028	2	9.44354	0.0012	0.00755	2008
SMU	D200368	9.115	0.027	2	9.12638	0.0012	0.00730	2008
CMI	D200383	9.328	0.107	2	9.38749	0.0011	0.00751	2008

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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)

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 (%)

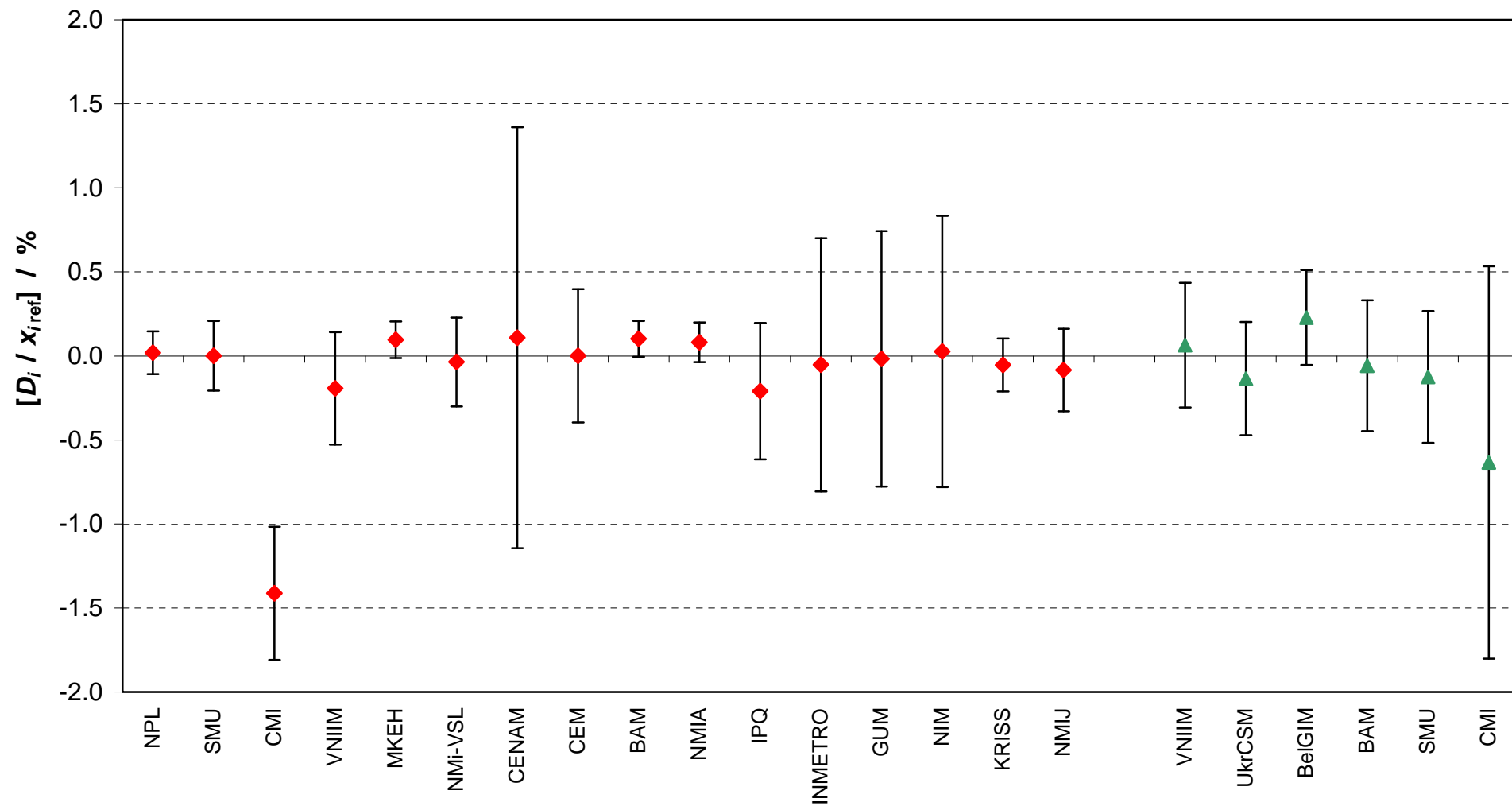
Lab <i>i</i> ↓	D_i $/ (10^{-2} \text{ mol/mol})$	U_i $/ (10^{-2} \text{ mol/mol})$	$D_i / x_{i\text{ref}}$	$U_i / x_{i\text{ref}}$ $/ \%$
NPL	0.0018	0.0120	0.02	0.13
SMU	0.0001	0.0195	0.00	0.21
CMI	-0.1332	0.0373	-1.41	0.40
VNIIM	-0.0182	0.0315	-0.19	0.34
MKEH	0.0090	0.0102	0.10	0.11
NMi-VSL	-0.0034	0.0249	-0.04	0.26
CENAM	0.0104	0.1204	0.11	1.25
CEM	0.0001	0.0373	0.00	0.40
BAM	0.0096	0.0100	0.10	0.11
NMIA	0.0076	0.0111	0.08	0.12
IPQ	-0.0198	0.0382	-0.21	0.41
INMETRO	-0.0050	0.0707	-0.05	0.75
GUM	-0.0017	0.0706	-0.02	0.76
NIM	0.0025	0.0759	0.03	0.81
KRISS	-0.0051	0.0148	-0.05	0.16
NMIJ	-0.0080	0.0231	-0.08	0.25
VNIIM*	0.0060	0.0349	0.06	0.37
UkrCSM*	-0.0120	0.0300	-0.13	0.34
BelGIM*	0.0215	0.0266	0.23	0.28
BAM*	-0.0055	0.0367	-0.06	0.39
SMU*	-0.0114	0.0358	-0.12	0.39
CMI*	-0.0595	0.1096	-0.63	1.17

* indicates participants in COOMET.QM-K23.b

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

Nominal value 0.094 mol/mol

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



Red diamonds: participants in CCQM-K23.b

Green triangles: participants in COOMET.QM-K23.b