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

Key comparison CCQM-K23.b

MEASURAND : **Amount-of-substance fraction of Nitrogen in Natural gas type II**

NOMINAL VALUE : **0.07 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)

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

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

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

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

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

$u_{i\,\mathrm{ref}} = (u_{i\,\mathrm{prep}}^2 + u_{i\,\mathrm{ver}}^2)^{1/2}$ where $u_{i\,\mathrm{prep}}$ and $u_{i\,\mathrm{ver}}$ are the standard uncertainties of preparation and verification respectively for which the numerical values can be found in Table 5 of the Final Report.

Lab *i*	Cylinder number	$x_{\mathrm{Lab}i}$ / (10^{-2} mol/mol)	$U_{\mathrm{Lab}i}$ / (10^{-2} mol/mol)	$k_{\mathrm{Lab}i}$	$x_{i\,\mathrm{ref}}$ / (10^{-2} mol/mol)	$u_{i\,\mathrm{ref}}$ / (10^{-2} mol/mol)	Date of measurement
NPL	VSL205170	7.0012	0.0112	2	7.00807	0.00363	07 Sep 2005
SMU	VSL200238	7.0294	0.018	2	7.02641	0.00363	13 Dec 2005
CMI	VSL200229	7.007	0.045	2	7.04538	0.00363	21 Sep 2005
VNIIM	VSL302766	7.121	0.017	2	7.11231	0.00363	05 Dec 2005
MKEH	VSL202794	7.0685	0.0078	4.53	7.06610	0.00363	03 Oct 2005
NMi-VSL	VSL133436	7.034	0.014	2	7.03273	0.00363	09 Sep 2005
CENAM	VSL302704	6.889	0.057	2	6.89662	0.00363	21 Dec 2005
CEM	VSL200231	6.9947	0.034	2	6.99485	0.00363	20 Oct 2005
BAM	VSL200239	7.01894	0.00211	2	7.02572	0.00363	21 Sep 2005
NMIA	VSL200246	7.013	0.007	2.18	7.01675	0.00363	10 Sep 2005
IPQ	VSL200241	6.997	0.026	2	7.01193	0.00363	29 Sep 2005
INMETRO	VSL200236	7.037	0.042	2	7.00103	0.00363	17 Oct 2005
GUM	VSL200237	7.039	0.048	2	7.03594	0.00363	05 Jan 2006
NIM	VSL305182	6.963	0.0345	2	6.99373	0.00363	06 Dec 2005
KRISS	VSL200230	7.027	0.009	2	7.02403	0.00363	27 Sep 2005
NMIJ	VSL200248	7.0208	0.0094	2	7.02637	0.00363	22 Dec 2005

Key comparison COOMET.QM-K23.b

MEASURAND : **Amount-of-substance fraction of Nitrogen in Natural gas**

NOMINAL VALUE : **0.07 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)

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

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

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

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

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

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

Lab *i*	Cylinder number	$x_{\mathrm{Lab}i}$ / (10^{-2} mol/mol)	$U_{\mathrm{Lab}i}$ / (10^{-2} mol/mol)	$k_{\mathrm{Lab}i}$	$x_{i\,\mathrm{ref}}$ / (10^{-2} mol/mol)	$u_{i\,\mathrm{prep}}$ / (10^{-2} mol/mol)	$u_{i\,\mathrm{ver}}$ / (10^{-2} mol/mol)	Date of measurement
VNIIM	D200273	7.109	0.019	2	7.11364	0.0012	0.00569	2008
UkrCSM	D200292	6.387	0.034	2	6.40277	0.0012	0.00512	2008
BelGIM	D200278	7.104	0.012	2	7.10073	0.0012	0.00568	2008
BAM	D200385	7.039	0.021	2	7.02603	0.0012	0.00562	2008
SMU	D200368	7.331	0.029	2	7.32617	0.0012	0.00586	2008
CMI	D200383	7.084	0.110	2	7.09918	0.0011	0.00568	2008

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

Key comparison CCQM-K23.b

MEASURAND :	**Amount-of-substance fraction of Nitrogen in Natural gas type II**
NOMINAL VALUE :	**0.07 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)

Key comparison reference value: there is no single reference value for this comparison, the value obtained from preparation, $x_{i\,ref}$, 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:
$D_i = (x_{Lab\,i} - x_{i\,ref})$ and U_i, its expanded uncertainty at a 95% level of confidence, both expressed in 10^{-2} mol/mol;
$U_i = 2[(U_{Lab\,i} / k_{Lab\,i})^2 + u_{i\,ref}^2]^{1/2}$, 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: $D_{ij} = D_i - D_j = (x_i - x_{i\,ref}) - (x_j - x_{j\,ref})$ and
U_{ij}, its expanded uncertainty at a 95% level of confidence, both expressed in 10^{-2} mol/mol;
$U_{ij} = 2[(U_{Lab\,i} / k_{Lab\,i})^2 + (U_{Lab\,j} / k_{Lab\,j})^2 + u_{i\,ref}^2 + u_{j\,ref}^2]^{1/2}$, using a coverage factor $k = 2$.
The pair-wise degrees of equivalence are not explicitely 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, $u_{i\,ref}$, 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:
$D_i = (x_{Lab\,i} - x_{i\,ref})$ and its expanded uncertainty ($k = 2$), U_i,
with $U_i = [U_{Lab\,i}^2 + 2u_{ref}^2 + D_{VNIIM\,(CCQM\text{-}K23.b)}^2]^{1/2}$.
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

MEASURAND : **Amount-of-substance fraction of Nitrogen in Natural gas type II**

NOMINAL VALUE : **0.07 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)

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

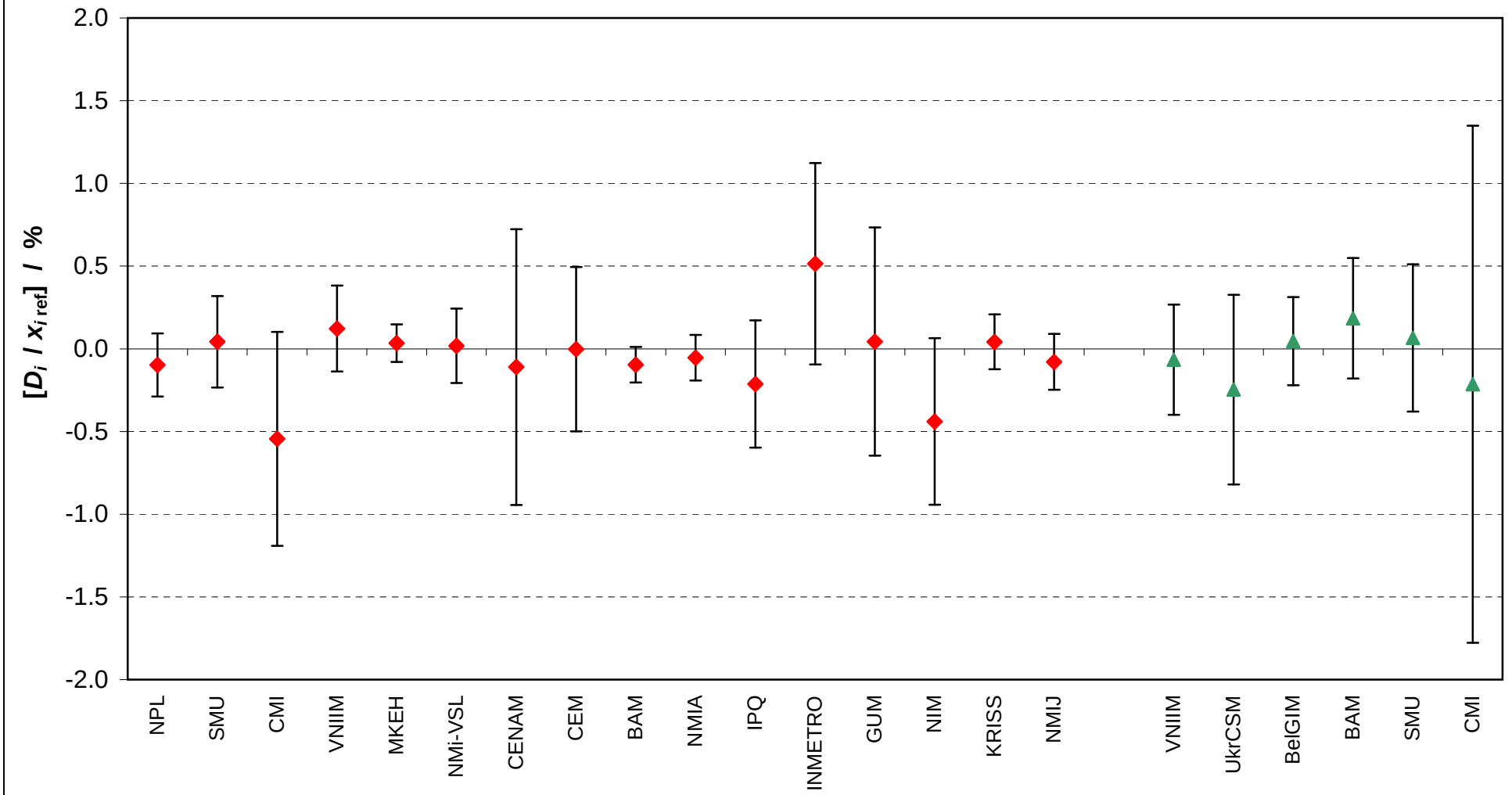
Lab *i* ⇩	D_i / (10^{-2} mol/mol)	U_i / (10^{-2} mol/mol)	$D_i / x_{i\,ref}$ / %	$U_i / x_{i\,ref}$ / %
NPL	**-0.007**	0.013	**-0.10**	0.19
SMU	**0.003**	0.019	**0.04**	0.28
CMI	**-0.038**	0.046	**-0.54**	0.65
VNIIM	**0.009**	0.018	**0.12**	0.26
MKEH	**0.002**	0.008	**0.03**	0.11
NMi-VSL	**0.001**	0.016	**0.02**	0.22
CENAM	**-0.008**	0.057	**-0.11**	0.83
CEM	**0.000**	0.035	**0.00**	0.50
BAM	**-0.007**	0.008	**-0.10**	0.11
NMIA	**-0.004**	0.010	**-0.05**	0.14
IPQ	**-0.015**	0.027	**-0.21**	0.38
INMETRO	**0.036**	0.043	**0.51**	0.61
GUM	**0.003**	0.049	**0.04**	0.69
NIM	**-0.031**	0.035	**-0.44**	0.50
KRISS	**0.003**	0.012	**0.04**	0.17
NMIJ	**-0.006**	0.012	**-0.08**	0.17
VNIIM*	**-0.0046**	0.0237	**-0.07**	0.33
UkrCSM*	**-0.0158**	0.0367	**-0.25**	0.57
BelGIM*	**0.0033**	0.0190	**0.05**	0.27
BAM*	**0.0130**	0.0256	**0.18**	0.36
SMU*	**0.0048**	0.0326	**0.07**	0.45
CMI*	**-0.0152**	0.1110	**-0.21**	1.56

* indicates participants in COOMET.QM-K23.b

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

Nominal value 0.07 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