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

**Key comparison CCQM-K23.b**

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

**NOMINAL VALUE :** **0.754 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 11 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 | 75.3890 | 0.0166 | 2 | 75.3811 | 0.0152 | 07 Sep 2005 |
| **SMU** | VSL200238 | 75.2800 | 0.1300 | 2 | 75.3514 | 0.0152 | 13 Dec 2005 |
| **CMI** | VSL200229 | 75.6170 | 0.3780 | 2 | 75.3435 | 0.0152 | 21 Sep 2005 |
| **VNIIM** | VSL302766 | 75.3200 | 0.0400 | 2 | 75.2844 | 0.0152 | 05 Dec 2005 |
| **MKEH** | VSL202794 | 75.3027 | 0.0040 | 3.31 | 75.3291 | 0.0152 | 03 Oct 2005 |
| **NMi-VSL** | VSL133436 | 75.3700 | 0.0800 | 2 | 75.3638 | 0.0152 | 09 Sep 2005 |
| **CENAM** | VSL302704 | 75.2800 | 0.5900 | 2 | 75.2653 | 0.0152 | 21 Dec 2005 |
| **CEM** | VSL200231 | 75.3740 | 0.2140 | 2 | 75.3764 | 0.0152 | 20 Oct 2005 |
| **BAM** | VSL200239 | 75.3595 | 0.0113 | 2 | 75.3618 | 0.0152 | 21 Sep 2005 |
| **NMIA** | VSL200246 | 75.4000 | 0.1000 | 2.18 | 75.3597 | 0.0152 | 10 Sep 2005 |
| **IPQ** | VSL200241 | 75.4900 | 0.4100 | 2 | 75.3471 | 0.0152 | 29 Sep 2005 |
| **INMETRO** | VSL200236 | 75.6500 | 0.2800 | 2 | 75.4083 | 0.0152 | 17 Oct 2005 |
| **GUM** | VSL200237 | 75.3300 | 0.5000 | 2 | 75.4481 | 0.0152 | 05 Jan 2006 |
| **NIM** | VSL305182 | 75.4330 | 0.3772 | 2 | 75.3953 | 0.0152 | 06 Dec 2005 |
| **KRISS** | VSL200230 | 75.3500 | 0.0497 | 2 | 75.3546 | 0.0152 | 27 Sep 2005 |
| **NMIJ** | VSL200248 | 75.2814 | 0.1630 | 2 | 75.3308 | 0.0152 | 22 Dec 2005 |

**Key comparison COOMET.QM-K23.b**

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

**NOMINAL VALUE :** **0.754 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 | 75.397 | 0.034 | 2 | 75.3844 | 0.0025 | 0.010 | 2008 |
| **UkrCSM** | D200292 | 77.092 | 0.045 | 2 | 77.0322 | 0.0025 | 0.009 | 2008 |
| **BelGIM** | D200278 | 75.230 | 0.02 | 2 | 75.2470 | 0.0025 | 0.010 | 2008 |
| **BAM** | D200385 | 75.2549 | 0.045 | 2 | 75.2590 | 0.0025 | 0.010 | 2008 |
| **SMU** | D200368 | 75.478 | 0.046 | 2 | 75.4627 | 0.0025 | 0.010 | 2008 |
| **CMI** | D200383 | 75.470 | 0.454 | 2 | 75.3056 | 0.0025 | 0.010 | 2008 |

**Key comparison CCQM-K23.b**

| | |
|---|---|
| **MEASURAND :** | **Amount-of-substance fraction of Methane in Natural gas type II** |
| **NOMINAL VALUE :** | **0.754 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, $x_{i\,\mathrm{ref}}$, 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:**
**$D_i = (x_{\mathrm{Lab}i} - x_{i\,\mathrm{ref}})$ and $U_i$, its expanded uncertainty at a 95% level of confidence, both expressed in $10^{-2}$ mol/mol;**
**$U_i = 2[(U_{\mathrm{Lab}i} / k_{\mathrm{Lab}i})^2 + u_{i\,\mathrm{ref}}^2]^{1/2}$, 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: $D_{ij} = D_i - D_j = (x_i - x_{i\,\mathrm{ref}}) - (x_j - x_{j\,\mathrm{ref}})$ and**
**$U_{ij}$, its expanded uncertainty at a 95% level of confidence, both expressed in $10^{-2}$ mol/mol;**
**$U_{ij} = 2[(U_{\mathrm{Lab}i} / k_{\mathrm{Lab}i})^2 + (U_{\mathrm{Lab}j} / k_{\mathrm{Lab}j})^2 + u_{i\,\mathrm{ref}}^2 + u_{j\,\mathrm{ref}}^2]^{1/2}$, 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, $u_{i\,\mathrm{ref}}$, 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:**
**$D_i = (x_{\mathrm{Lab}i} - x_{i\,\mathrm{ref}})$ and its expanded uncertainty ($k = 2$), $U_i$,**
**with $U_i = [U_{\mathrm{Lab}i}^2 + 2u_{\mathrm{ref}}^2 + D_{\mathrm{VNIIM\ (CCQM\text{-}K23.b)}}^2]^{1/2}$.**
**$D_i$ 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 Methane in Natural gas type II**

**NOMINAL VALUE :** **0.754 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 (%)**

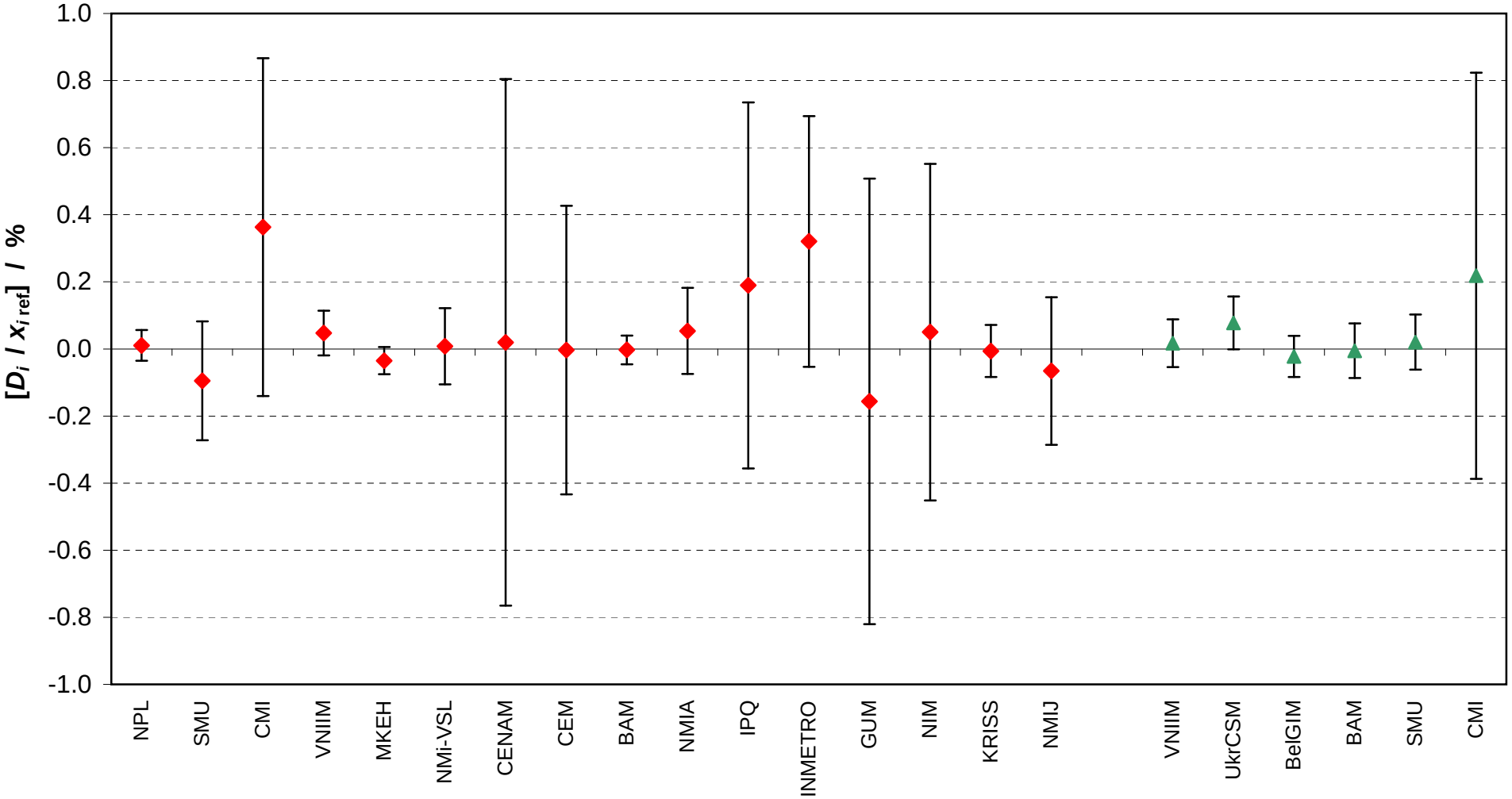
| Lab *i* ⇩ | $D_i$ / ($10^{-2}$ mol/mol) | $U_i$ / ($10^{-2}$ mol/mol) | $D_i / x_{i\,ref}$ / % | $U_i / x_{i\,ref}$ / % |
|---|---|---|---|---|
| **NPL** | **0.008** | 0.035 | **0.01** | 0.05 |
| **SMU** | **-0.071** | 0.134 | **-0.09** | 0.18 |
| **CMI** | **0.274** | 0.379 | **0.36** | 0.50 |
| **VNIIM** | **0.036** | 0.050 | **0.05** | 0.07 |
| **MKEH** | **-0.026** | 0.030 | **-0.04** | 0.04 |
| **NMi-VSL** | **0.006** | 0.086 | **0.01** | 0.11 |
| **CENAM** | **0.015** | 0.591 | **0.02** | 0.78 |
| **CEM** | **-0.002** | 0.324 | **0.00** | 0.43 |
| **BAM** | **-0.002** | 0.032 | **0.00** | 0.04 |
| **NMIA** | **0.040** | 0.097 | **0.05** | 0.13 |
| **IPQ** | **0.143** | 0.411 | **0.19** | 0.55 |
| **INMETRO** | **0.242** | 0.282 | **0.32** | 0.37 |
| **GUM** | **-0.118** | 0.501 | **-0.16** | 0.66 |
| **NIM** | **0.038** | 0.378 | **0.05** | 0.50 |
| **KRISS** | **-0.005** | 0.058 | **-0.01** | 0.08 |
| **NMIJ** | **-0.049** | 0.166 | **-0.07** | 0.22 |
| **VNIIM*** | **0.0128** | 0.0538 | **0.02** | 0.07 |
| **UkrCSM*** | **0.0598** | 0.0608 | **0.08** | 0.08 |
| **BelGIM*** | **-0.0170** | 0.0462 | **-0.02** | 0.06 |
| **BAM*** | **-0.0041** | 0.0613 | **-0.01** | 0.08 |
| **SMU*** | **0.0153** | 0.0620 | **0.02** | 0.08 |
| **CMI*** | **0.1644** | 0.4559 | **0.22** | 0.61 |

* indicates participants in COOMET.QM-K23.b

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

**Nominal value 0.754 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