

**Key comparison CCM.P-K1.a**

**MEASURAND :** Effective area of two piston-cylinder units, DH 6594 and DHI 107, determined from dimensional measurements

**NOMINAL VALUE :** 10 cm<sup>2</sup>

$x_i$ : result of measurement carried out by laboratory  $i$

$u_i$ : combined standard uncertainty of  $x_i$

**Piston-cylinder DH 6594**

Lab $i$	$x_i$ / cm <sup>2</sup>	$u_i / x_i$ / 10 <sup>-6</sup>	Date of measurement
PTB	*	3.4	95-06
IMGC-CNR	*	10.5	96-03
NIST	*	4.4	96-09
BNM-LNE	*	2.4	97-03
PTB	*	3.7	97-09

*Note: 2 measurements at PTB*

\* The exact effective area of piston-cylinder DH 6594 is not reported here because the assembly is currently being used as transfer standard in a EUROMET comparison.

**Piston-cylinder DHI 107**

Lab $i$	$x_i$ / cm <sup>2</sup>	$u_i / x_i$ / 10 <sup>-6</sup>	Date of measurement
BNM-LNE	9.805118	2.3	95-06
NIST	9.805230	4.5	95-12
IMGC-CNR	9.805176	11.1	96-06
PTB	9.805216	4.2	96-09
BNM-LNE	9.805139	2.2	97-06

*Note: 2 measurements at BNM-LNE*

Key comparison CCM.P-K1.a

MEASURAND : Effective area of two piston-cylinder units, DH 6594 and DHI 107, determined from dimensional measurements

NOMINAL VALUE : 10 cm<sup>2</sup>

The key comparison reference value,  $x_R$ , for each transfer standard is obtained as the non-weighted average of the results from the four participants. The results of the institutes which performed two measurements on the same transfer standard were averaged before the reference value calculation. The standard uncertainty of each reference value,  $u_R$ , is taken as the experimental standard deviation of the mean.

DH 6594:  $x_R = * \text{ cm}^2$ ;  $u_R / x_R = 1.7 \cdot 10^{-6}$       DHI 107:  $x_R = 9.805188 \text{ cm}^2$ ;  $u_R / x_R = 2.4 \cdot 10^{-6}$

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

$D_i = (x_i - x_R) / x_R$ , the relative deviation from the reference value, and  $U_i = 2 (u_i^2 + u_R^2)^{0.5} / x_R$ , its expanded uncertainty ( $k = 2$ ).

The degree of equivalence between two laboratories is given for each transfer standard by a pair of terms:

$D_{ij} = D_i - D_j = (x_i - x_j) / x_R$ , the relative difference between their results, and  $U_{ij} = 2 (u_i^2 + u_j^2)^{0.5} / x_R$ , its expanded uncertainty ( $k = 2$ ).

DH 6594:

Lab  $j$   $\implies$

Lab  $i$   $\Downarrow$

	$D_i$ / 10 <sup>-6</sup>		$U_i$ / 10 <sup>-6</sup>		BNM-LNE		IMGC-CNR		NIST		PTB	
	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>
BNM-LNE	-4.3	5.8					-7.9	21.6	-4.5	10.0	-4.9	8.8
IMGC-CNR	3.5	21.2	7.9	21.6					3.4	22.4	2.9	22.2
NIST	0.2	9.4	4.5	10.0	-3.4	22.4					-0.5	11.4
PTB	0.6	7.8	4.9	8.8	-2.9	22.2	0.5	11.4				

DHI 107:

Lab  $j$   $\implies$

Lab  $i$   $\Downarrow$

	$D_i$ / 10 <sup>-6</sup>		$U_i$ / 10 <sup>-6</sup>		BNM-LNE		IMGC-CNR		NIST		PTB	
	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>	$D_{ij}$ / 10 <sup>-6</sup>	$U_{ij}$ / 10 <sup>-6</sup>
BNM-LNE	-6.0	6.5					-4.8	22.6	-10.4	10.2	-8.9	9.6
IMGC-CNR	-1.2	22.7	4.8	22.6					-5.5	24.0	-4.1	23.8
NIST	4.3	10.1	10.4	10.2	5.5	24.0					1.4	12.4
PTB	2.9	9.6	8.9	9.6	4.1	23.8	-1.4	12.4				

**CCM.P-K1.a**  
**Degrees of equivalence for effective areas of piston-cylinder units**  
**DH 6594 and DHI 107**

