

# **COOMET.EM-S1**

**Supplementary bilateral comparison of the national AC/DC voltage transfer references between VNIIM (Russia) and Ukrmetrteststandard (Ukraine)**

**Final Report**

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## I. INTRODUCTION

This intercomparison was fulfilled in conformity with the agreed project of COOMET under ref. No 273-a/RU/03 at ELECTRICITY area. It is bilateral comparison between Ukrmetrteststandard (Ukraine) and VNIIM (Russia) (pilot laboratory). This project was arranged with an aim to establish degree of equivalence between Ukraine and Russia measurement standards and to confirm uncertainties declared by the participants. The results of the comparison will be used for confirmation calibration and measurement capabilities provided by Ukrmetrteststandard (Ukraine). VNIIM (Russia) (pilot laboratory) participated in CCEM-K6.a and has already presented their CMC in this area. The measurements had started in November 2004 and completed in February 2005.

## II. DEFINITION OF THE MEASUREMENT

The relative AC/DC voltage transfer difference  $\delta$  of the PMJTC is defined as:

$$\delta = (V_{ac} - V_{dc}) / V_{dc} , \quad (1)$$

where  $V_{ac}$  – is the RMS value of the AC voltage;

$V_{dc}$  – is the DC voltage which when reversed produces the same mean output voltage of the thermal converter as  $V_{ac}$ .

The following designations are used below:

$\delta_{ua}$  and  $\delta_{ru}$  – are the results (1) which obtained for the traveling standard PMJTC by national standards Ukrainian and Russian respectively;

$u_{ua}$  and  $u_{ru}$  – are the standard measurement uncertainties consequently;

$U_{ua}$  and  $U_{ru}$  – are the expanded measurement uncertainties (with  $k=2$ ) of results  $\delta_{ua}$ ,  $\delta_{ru}$  respectively;

$D_{U-R}$  – is the difference between the results  $\delta_{ua}$  and  $\delta_{ru}$ ;  $D_{U-R} = \delta_{ua} - \delta_{ru}$ ;

$U_{U-R}$  – is the expanded uncertainty of the difference  $D_{U-R}$ .

### III. PARTICIPANTS AND PERSONNEL

The supplementary bilateral comparison of the national AC/DC voltage transfer references fulfilled between participants:

VNIIM                                      D.I. Mendeleev Institute for Metrology. Russia.  
(pilot laboratory)                      G. Telitchenko

Ukrmetrteststandard      State research and production center for standardization, metrology,  
certification and protection of consumer's right. Ukraine.  
V. Kopshyn, Yu. Darmenko

### IV. MEASUREMENT TRAVELING STANDARD and MEASURING CONDITIONS

The AC/DC Thin-film Planar Multi-junction Thermal Converter (PMJTC) was used as the traveling standard. This PMJTC marked as 256, 2001 and its specifications are the following:

input voltage	1,5 V
output voltage	90 mV
input resistance	180 $\Omega$
output resistance	10 k $\Omega$
TC of sensitivity	$-2200 \times 10^{-6} \text{ K}^{-1}$
time-constant	1,8 s

According to the Technical Protocol agreed by both participants the measurements were made for voltage point 1 volt and in the frequency range 20 Hz – 1 MHz. under following conditions:

- 1) frequency range was realized at the frequency points: 20 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz.
- 2) for each of the frequency points the 20 independent observations were carried out. Measurement results  $\delta_{ua}$  and  $\delta_{ru}$  for each frequency point were obtained as a mean of 20 independent observations.

3) the expanded measurement uncertainty for the results  $\delta_{ua}$  or  $\delta_{ru}$  accepted with a coverage factor of  $k=2$ .

## VI. EVALUATION OF MEASUREMENT DATA

The results and associated measurement uncertainties, obtained by participants are given in Table 1.

Table 1. Measurement results  $\delta_{ua}$ ,  $\delta_{ru}$  and respectively expanded uncertainties  $U_{ua}$ ,  $U_{ru}$  (with  $k=2$ ) for Ukrainian and Russian AC/DC voltage transfer references.

Traveling standard, voltage point	Participant	Time	Value	Rel. AC-DC transfer difference $\delta_{lab}$ and expanded uncertainty $U_{lab}$ ( $k=2$ ) in $10^{-6}$ at the frequencies				
				20 Hz	1 kHz	10 kHz	100 kHz	1 MHz
PMJTC 256, 1 V	Ukraine (ua)	Nov 2004	$\delta$	<b>0</b>	<b>- 2,0</b>	<b>-1,5</b>	<b>- 5,0</b>	<b>16</b>
			$U$	8,1	4,1	4,2	5,8	41
	Russia (ru)	Dec 2004	$\delta$	<b>1,7</b>	<b>- 0,5</b>	<b>-1,2</b>	<b>- 3,8</b>	<b>1,9</b>
			$U$	1,5	1,5	1,5	3	24

Pairwise degree of equivalence between measurement reference standards is calculated as a difference  $D_{U-R} = \delta_{ua} - \delta_{ru}$  and associated expanded uncertainty  $U_{U-R}$  :

$$U_{U-R} = 2\sqrt{u_{ua}^2 + u_{ru}^2 - 2 \cdot \text{cov}(\delta_{ua}, \delta_{ru})} \quad (2)$$

The uncertainties declared by the participants are confirmed if the following condition is hold:

$$|D_{U-R}| \leq U_{U-R} \quad (3)$$

Where

$D_{U-R}$  – is the difference between the results  $\delta_{ua}$  and  $\delta_{ru}$ ;  $D_{U-R} = \delta_{ua} - \delta_{ru}$ ;

$U_{U-R}$  – is the expanded uncertainty of the difference  $D_{U-R}$ .

The evaluation of degree of equivalence between Russian and Ukrainian AC/DC voltage transfer references carried out by means of (2) and (3) is presented in Table 2. The measurement results obtained by Ukrmetrteststandard and VNIIM are independent.

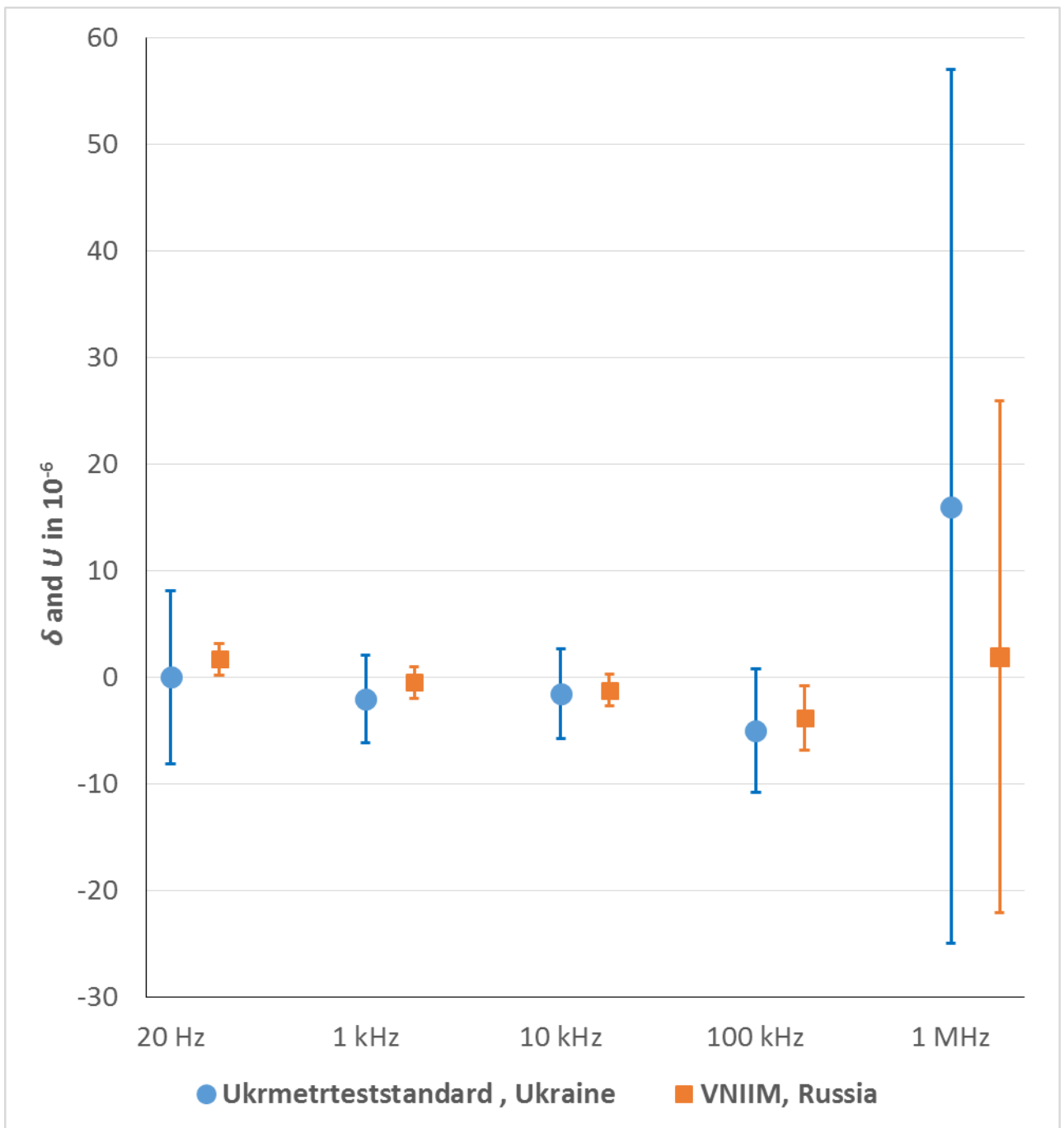


Figure 1. The measured values of the AC/DC voltage transfer differences  $\delta_{ua}$ ,  $\delta_{ru}$  at the frequency points 20 Hz, 1 kHz, 10 kHz, 100 kHz and 1 MHz that are given together with bar indicating the expanded ( $k=2$ ) measurement uncertainties  $U_{ua}$ ,  $U_{ru}$  respectively.

Table 2. Evaluation of degree of equivalence for Ukrainian and Russian AC/DC voltage transfer references.

	Evaluation of equivalence at the frequencies				
	20 Hz	1 kHz	10 kHz	100 kHz	1 MHz
Difference $ D_{U-R}  =  \delta_{ua} - \delta_{ru} $ , in $10^{-6}$	1,7	1,54	0,32	1,18	14,1
Combined uncertainty $U_{U-R}$ in $10^{-6}$	8,2	4,4	4,5	6,5	47,5
Conformity to demand: $ D_{U-R}  \leq U_{U-R}$	Yes	Yes	Yes	Yes	Yes

## VI. CONCLUSION

The results obtained by Ukrmetrteststandard (Ukraine) and VNIIM (Russia) in COOMET.EM-S1 shows agreement within their given expanded uncertainties.