

SUPPLEMENTARY COMPARISON OF THE STANDARDS OF THE UNIT FOR ROUNDNESS MEASUREMENTS

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Abstract: A trilateral comparison has been performed in the subject field of roundness measurement - the national metrological institutes: VNIIMS (Russia), Belgim (Belarus), NCSIM (Ukraine) took part The comparison was led by VNIIMS, Russia. The circulated standards were a roundness transfer standard in the in comparison form of a glass hemisphere and a magnification standard often referred to as a «Flick» standard. The results of the comparisons show the correspondence of measurement uncertainties to the declared values, and the compared measurement standards are equivalent.

Introduction

A trilateral comparison has been performed in the subject field of roundness measurement. The national metrological institutes: VNIIMS (Russia), Belgim (Belarus), NCSIM (Ukraine) took part in the comparison. The comparison was led by VNIIMS, Russia and happened between July 2017 and August. The circulated standards were a roundness transfer standard in the form of a glass hemisphere and a magnification standard often referred to as a «Flick» standard. Data from the roundness standard were processed using a Gaussian filter and a bandpass up to 50 undulations per revolution to provide a measured value of roundness Deviation (RONt). For the magnification standard, data were also filtered and the fitted element was the circumscribed circle together with the deviation of the valleys (RONv). The results of comparisons show that correspondence of measurement uncertainties to the declared values and the compared measurement standards are equivalent.

Purpose of the comparison is the definition of the degree of standard equivalence.

Transfer standards



Picture 1 – Hemisphere standard



Picture 2 – Flick standard

Hemisphere standard is a glass hemisphere fixed in a mount, serial number 7328 (pic. 1).

Flick standard is a cylindrical specimen fixed in a mount with flick serial number X341 (pic. 2).

The key characteristics of the transfer standards are described in Table .

Table

Transfer standard	Serial number	Nominal value, mkm
Hemisphere standard	7328	0,016
Flick standard	X341	296,5

Measuring procedure

Hemisphere standard has been measured in plane 3.0 mm above the top of its mount. All measurements were made using a 53,5 mm hatchet shaped stylus with 6,4 mm radius (VNIIMS and NCSIM) and 100 mm stylus with 1 mm radius (BELGIM). A spindle speed of 6r.p.m., at sampling rate of 2000 ordinates per revolution, a gauge resolution of 1.2 nm (VNIIMS and NCSIM) and 0.3nm (BELGIM). 1-50 UPR GAUSS digital

roundness filter have been applied throughout the measurement using Ultra Roundness Software.

Flick standard has been measured in the middle plane of the working zone. All measurements were made using a 53,5 mm hatchet shaped stylus with 6,4 mm radius (NCSIM) and 100 mm stylus with 1 mm radius (VNIIMS and BELGIM). A spindle speed of 6 r.p.m., at sampling rate of 2000 ordinates per revolution, a gauge resolution 12 nm (NCSIM) and 8 nm (VNIIMS and BELGIM) have been used. No filter has been applied throughout the measurement.

Measurement standards

BelGIM, Belarus



Picture 3

The measurement standard includes:

- Talyron 565 roundness measuring instrument (Taylor Hobson) including Ultra Roundness software with Talymin 5 inductive gauge (see picture 3);
- set of roundness and cylindricity standards;
- set of slip gauges for gauge calibration

VNIIMS (Russia)



Picture 4

The measurement standard includes:

- interferometric system for gauge calibration;
- set of roundness and cylindricity standards;
- instrument for roundness measurements in

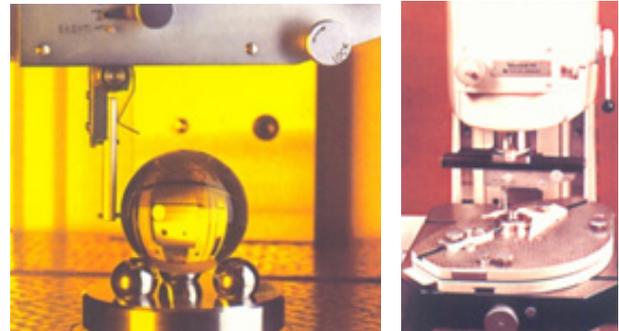
polar system of coordinates(see picture 4)

- instrument for roundness measurements in a cylindrical system of coordinates (see picture 4)

NSC „Institute of metrology“, Ukraine

The measurement standard includes:

- Talyron 73 roundness measuring instrument (Taylor Hobson) including Ultra Roundness software (see picture 5);



Picture 5

- set of roundness standard

Mathematical model for measurement

The value of out of the roundness of transfer standard should be calculated with the formula

$$Y = X_u + \delta_s + \delta_{FR} + \delta_R + \delta_L + \delta_C ,$$

where Y – is out of roundness of standard, mcm;

X_u – is the mean arithmetic value of measurements results, mcm;

δ_s - RMS of mean arithmetic value of standard, mcm

δ_{FR} – is the correction for radial accuracy, mcm;

δ_R – is the correction for resolution, mcm;

δ_L - is the correction for gauge linearity, mcm;

δ_C , is the correction for instrument calibration standard uncertainty, mcm

Results of measurements

The results of measurements of Hemisphere and flick standards are shown in Tables 6 and 7.

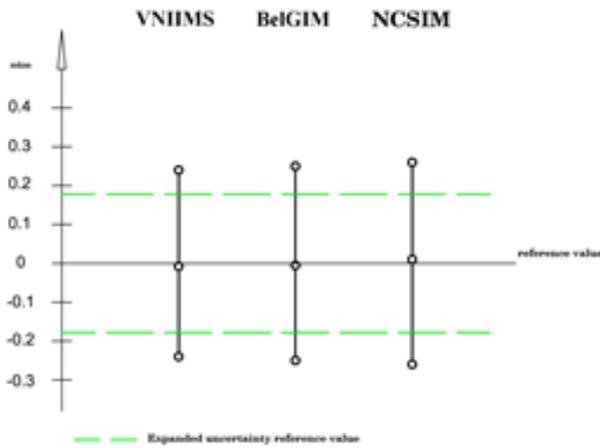
Results of measurements of Hemisphere standard.

Results of measurements of Flick standard:

The differences between measurement results and reference value for the hemisphere as well as for the associated expanded uncertainties are plotted on pic. 7.

Table 6

Characteristic	Laboratory		
	VNIIMS	BelGIM	NCSIM
Ront, μm	0,0273	0,0283	0,031559
Declared uncertainty U, μm (k=2, P=95 %)	0,028	0,028	0,036



Picture 6

Conclusions

The results of comparison show that the measurement uncertainties are within the declared values.

The measurement standards which were compared are equivalent.

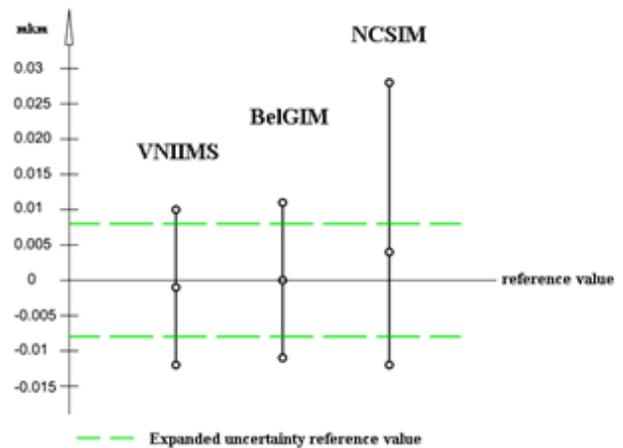
The results of the comparisons of measurement standards of the unit of length in measuring deviations from roundness VNIIMS BelGIM and NSC "IM" may be considered positive.

Bibliography

- [1] ISO/IEC Guide 98-3:2008 Uncertainty of measurement -- Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)
- [2] COOMET R/GM/11:2010 Recommendation Regulations for Comparison of Measurement Standards from the National Metrology Institutes of COOMET.
- [3] COOMET R/GM/14:2006 Guide on Estimation of the COOMET Key Comparison Data

Table 7

Characteristic	Laboratory		
	VNIIMS	BelGIM	NCSIM
Ront, μm	296,534	296,537	296,559
Declared uncertainty U, μm (k=2, P=95 %)	0,60	0,61	0,63



Picture 7

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