



# **EURAMET Key Comparison between INRIM and UME in Vickers Hardness Scales (HV1 - HV30)**

**Technical Protocol**

**EURAMET.M.H-K1.a.b**

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## 1. Introduction

A bilateral key comparison between INRIM (National Metrology Institute of Italy) and TUBITAK UME (National Metrology Institute of Turkey) had been decided to be organized in the field of Hardness Metrology to figure out the consistency of the national hardness standards in both countries realizing Vickers Hardness measurements in accordance with ISO 6507-1:2018 and ISO 6507-3:2018 standards. Widely used Vickers Hardness scales such as HV1 and HV30 will be the scope of the comparison which will be piloted by INRIM. This comparison is supposed to be linked to the CCM key comparisons CCM.H-K1.b.c and the hardness scales and levels are selected accordingly.

The blocks to be used in the comparison will be provided by UME. It is required that each NMI will realize measurement of hardness reference blocks for three hardness levels for each scale. Measurements will be realized first by UME as the provider of the hardness reference blocks, then the pilot laboratory, then again by UME for checking the stability of transfer standards.

The NMIs are requested to realize traceability of each component constituting the hardness scales on their national standards to the base SI units and constitute their uncertainty budgets before the comparison measurements.

## 2. Participating Institutes

**Organizer** : The European Association of National Metrology Institutes, EURAMET

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## 3. Transfer Standards to be Used in the Comparison

In the bilateral comparison one set of hardness reference blocks, composed of three blocks, will be used for both hardness scales, HV1 and HV30. Three blocks for three hardness levels will be used and a total of three hardness reference blocks will be provided by UME. Some information related to the hardness reference blocks to be used in the comparison is given below.

### All Scales (HV1 - HV30)

No	Hardness Value	Serial Number	Producer
1	200	294-472	YAMAMOTO
2	500	294-481	YAMAMOTO
3	800	224-804	YAMAMOTO

The first measurements will be performed by UME as the provider of the blocks and the hardness blocks will be sent to the pilot institute INRIM. Then INRIM will realize its measurements and send the blocks back to UME. UME will perform a second set of measurements to check the stability of the blocks.

UME is responsible for providing the blocks to be used in the comparison. The costs for transportation, customs and related administrative fees will be covered by UME. Below are pictures of the transfer standards to be used in the comparison.

### Transfer Standards for HV1 - HV30 Scales



S/N: 294-472, 200 HV



S/N: 294-481, 500 HV



S/N: 224-804, 800 HV

## 4. Procedure

Each participant shall first assure that the national standards to be used in the comparison at least be in accordance with ISO 6507-1:2018 [1] and ISO 6507-3:2018 [2] standards. Under these circumstances the components to be calibrated/verified are as follows;

- Force
- Testing cycle
- Indenter geometrical parameters
- Indentation measurement system

After management of calibration of the components given above, the blocks shall be placed in the laboratory one day before the measurements for temperature equilibrium. The measurement steps shall be as follows;

- Before starting the measurements, make sure the standardizing machines are working properly in accordance with their design parameters and relevant ISO standards requirements
- Make sure that the anvil where the blocks are seated on and both surfaces of the reference blocks are clean. For this purpose Isopropyl alcohol and a suitable soft material can be used
- Make sure that the relevant scale and related indenter and other requirements are mounted/selected etc.
- Record the ambient temperature

- Mark (circle) 5 free places where the indentation is supposed to be realized, uniformly distributed over the surface of the block, number them and indicate the diagonal measurement direction with suitable letters such as X,Y etc.
- Make 5 hardness measurements in the marked areas on the surface of the block and record diagonal measurement results on the data form
- Record the ambient temperature

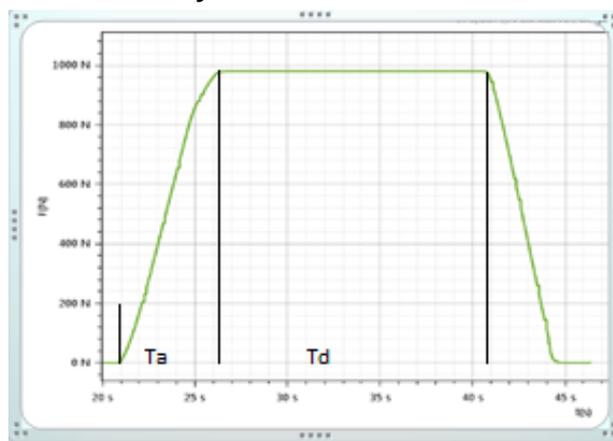
## 5. Reference Values of Influence Parameters

To perform measurements under same or very similar conditions by the participants it will be significant to agree on reference values of the influence parameters and testing cycles and realize them as much as possible. In this comparison the following reference values shall be used in the measurements. Deviations from these values shall be taken into the uncertainty calculations. Below are the reference values and measurement cycle to be used in HV1 and HV30 measurements.

### Reference Values and Measurement Cycle for Vickers Hardness Scales

<i>Reference values for HV1 and HV30 Scales</i>				
<b>Symbol</b>	<b>Test parameters</b>	<b>Reference value</b>	<b>Start measurement</b>	<b>Stop measurement</b>
$F$	Total test force for HV1	9,807 N	-	-
	Total test force for HV30	294,2 N	-	-
$\alpha$	Angle of the indenter	136°	Tip of the indenter	400 $\mu\text{m}$
$V_{app}$	Indenter approach speed	$\leq 200 \mu\text{m}\cdot\text{s}^{-1}$	$\sim 0\% F$	$\sim 1\% F$
$T_a$	Application time of test force	(7 $\pm$ 1) s	$\sim 1\% F$	$\sim 99\% F$
$T_d$	Duration of the total force	(14 $\pm$ 1) s	$\sim 99\% F$	$\sim 99\% F$
$T$	Temperature of test	23°C	Beginning of the test	End of the test

### Measurement Cycle for Vickers Hardness Scales



## 6. Uncertainty Evaluation

Before the measurements, each participant laboratory shall carry out the calibration of the hardness standardizing machines and calculate their uncertainties. The following parameters which will constitute the uncertainty budgets are requested to be mentioned in the uncertainty calculations.

- test force
- indentation measurement system
- tip angle of the indenter
- tip radius of the indenter
- length of line of junction of the indenter
- reproducibility of the primary hardness machine

EURAMET/cg-16/v.02 [3] and JCGM 100 [4] documents may be used for the uncertainty budget calculations. Each laboratory has the responsibility for determining their own uncertainty budget and uncertainty value for each measurement or a common budget can be used. The uncertainty budget is requested to be presented to the pilot laboratory together with the measurement results.

## 7. Time Table of the Measurements

The measurements will be made first by UME as the provider of the reference hardness blocks and then the pilot laboratory INRIM and then UME again for checking the stability of the transfer standards. The measurements are planned to be realized in accordance with the following time table.

<b>Institute/Country</b>	<b>Lab</b>	<b>Date of measurements</b>
UME, Turkey	Participant	October, 2017
INRIM, Italy	Pilot	November, 2017
UME, Turkey	Participant	December, 2017

## 8. Transportation

The travelling standards (hardness reference blocks) are transported in a protective case or wooden box which will be prepared by UME. When the blocks are sent/transported, the receiving institute must inspect them and notify the sending laboratory by e\_mail. Before packing the blocks for transportation to the next participant (after measurements are finished) they shall not be cleaned with Isopropyl alcohol not to delete the marked area for the indentations realized by the institutes. The blocks shall be wrapped in their anti-rusting paper, put in their original case and placed in the transportation box so that no damage can happen during transportation.

Travelling standards should be accompanied by custom documents, ei. with ATA carnet if an ATA carnet is used.

## **9. Data Compilation**

Each laboratory will enter the measurement results and uncertainty values in the data sheet provided in the annex for each hardness reference block.

The participants are requested to give a short description of their national standards used for the comparison measurements.

The pilot laboratory is responsible for collecting and compiling the measurement data from the participants and prepare the reports.

The first draft, draft A, will be prepared as soon as all the results have been received from the participants.

After comments, remarks and discussion, a second draft, draft B, will be subsequently prepared for the EURAMET and will include an Appendix containing proposals for a reference value and degrees of equivalence. If it is approved by the EURAMET, a Final Report will be prepared and sent to the EURAMET.

The results will be used to support the CMCs of the participating laboratories declared in Appendix C of the MRA.

## **10. References**

- [1] EN ISO 6507-1: 2018, Metallic Materials – Vickers Hardness Test - Part1: Test Method
- [2] EN ISO 6507-3: 2018, Metallic Materials - Vickers Hardness Test - Part3: Calibration of Reference Blocks
- [3] EURAMET/cg-16/v.02: 2011, Guidelines on the Estimation of Uncertainty in Hardness Measurements
- [4] JCGM 100: 2008, Evaluation of measurement data - Guide to the expression of uncertainty in measurement.
- [5] EN ISO/IEC 17043: 2010, Conformity Assessment-General requirements for proficiency testing.

## Annex: Measurement Data Form

### HV1 Scale

		Block Serial No			Temperature		
		Lens/NA			Indenter Serial No		
No	dh / $\mu\text{m}$	dv / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	HV1	HV1 <sub>mean</sub>	Uncertainty / HV1
1							
2							
3							
4							
5							

		Block Serial No			Temperature		
		Lens/NA			Indenter Serial No		
No	dh / $\mu\text{m}$	dv / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	HV1	HV1 <sub>mean</sub>	Uncertainty / HV1
1							
2							
3							
4							
5							

		Block Serial No			Temperature		
		Lens/NA			Indenter Serial No		
No	dh / $\mu\text{m}$	dv / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	HV1	HV1 <sub>mean</sub>	Uncertainty / HV1
1							
2							
3							
4							
5							

### HV30 Scale

		Block Serial No			Temperature		
		Lens/NA			Indenter Serial No		
No	dh / $\mu\text{m}$	dv / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	HV30	HV30 <sub>mean</sub>	Uncertainty / HV30
1							
2							
3							
4							
5							

		Block Serial No			Temperature		
		Lens/NA			Indenter Serial No		
No	dh / $\mu\text{m}$	dv / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	HV30	HV30 <sub>mean</sub>	Uncertainty / HV30
1							
2							
3							
4							
5							

		Block Serial No			Temperature		
		Lens/NA			Indenter Serial No		
No	dh / $\mu\text{m}$	dv / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	d <sub>mean</sub> / $\mu\text{m}$	HV30	HV30 <sub>mean</sub>	Uncertainty / HV30
1							
2							
3							
4							
5							