



**EURAMET Supplementary Comparison between  
INRiM and UME in Brinell Hardness Scales  
(HBW1/30 - HBW2,5/187,5)**

**Technical Protocol**

**EURAMET.M.H-S2.a.b**

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## 1. Introduction

A supplementary comparison between INRIM (National Metrology Institute of Italy), TUBITAK UME (National Metrology Institute of Turkey) and PTB (National Metrology Institute of Germany) had been decided to be organized in the field of Hardness Metrology to figure out the consistency of the national hardness standards in all countries realizing Brinell Hardness measurements in accordance with ISO 6506-1:2014 and ISO 6506-3:2014 standards. Widely used Brinell Hardness scales such as HBW1/30 and HBW2,5/187,5 will be the scope of the comparison which will be piloted by INRIM.

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 and the second participating 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

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<b>Pilot Lab.</b>	<b>Alessandro GERMAK</b> Istituto Nazionale di Ricerca Metrologica Strada delle Cacce, 91 10135 Torino, ITALY tel: +39 011 3919 924 C.F./P.IVA: 09261710017 <a href="mailto:A.Germak@inrim.it">A.Germak@inrim.it</a>
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### 3. Transfer Standards to be Used in the Comparison

In the comparison two sets of hardness reference blocks, each composed of three blocks, will be used for the mentioned hardness scales HBW1/30 and HBW2,5/187,5. Three blocks for three hardness levels will be used for each scale and a total of six hardness reference blocks will be provided by UME. Some information related to the hardness reference blocks to be used is given below.

#### HBW1/30 Scale

No	Hardness Value	Serial Number	Producer
1	165	293-250	YAMAMOTO
2	305	294-366	YAMAMOTO
3	565	290-730	YAMAMOTO

#### HBW2,5/187,5 Scale

No	Hardness Value	Serial Number	Producer
1	165	293-258	YAMAMOTO
2	300	294-367	YAMAMOTO
3	570	290-736	YAMAMOTO

All measurements will be performed first by UME as the provider of the blocks and then the hardness blocks will be sent to the pilot laboratory INRIM. Then INRIM will realize its measurements and send the blocks to the second participation laboratory PTB. Then PTB will realize its measurements and send the blocks back to UME. UME will perform a second set of measurements for checking the stability of the transfer standards.

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 HBW1/30 Scale



S/N: 293-250, 165 HBW1/30

S/N: 294-366, 305 HBW1/30

S/N: 290-730, 565 HBW1/30

## Transfer Standards for HBW2,5/187,5 Scale



S/N: 293-258, 165 HBW2,5/187,5



S/N: 294-367, 300 HBW2,5/187,5



S/N: 290-736, 570 HBW2,5/187,5

### 4. Procedure

Each participant shall first assure that the national standards to be used in the comparison at least be in accordance with ISO 6501-1:2014 [1] and ISO 6506-3:2014 [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 diameter measurement direction with suitable letters such as X,Y etc.
- Make 5 measurements in the marked circles on the surface of the block and record them on the data form
- Record the ambient temperature

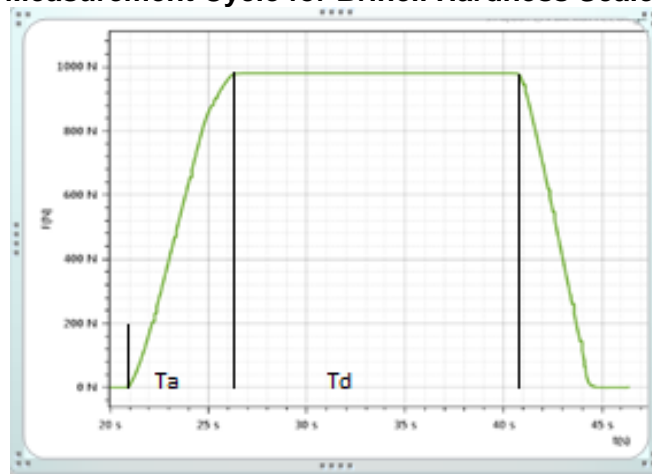
### 5. Reference Values of Influence Parameters

To perform measurements under same or very similar conditions 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 the HBW1/30 and HBW2,5/187,5 measurements.

## Reference Values and Measurement Cycle for Brinell Hardness Scales

<i>Reference values for HBW1/30 and HBW2,5/187,5 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 HBW1/30	294,2 N	-	-
	Total test force for HBW2,5/187,5	1839,0 N	-	-
$D$	Diameter of the indenter	(1±0,003) mm (2,5±0,003) mm	-	-
$V_{app}$	Indenter approach speed	≤ 200 μm·s <sup>-1</sup>	~0% F	~1% F
$T_a$	Application time of test force	(7±1) s	~1% F	~99% F
$T_d$	Duration of the total force	(14±1) s	~99% F	~99% F
$T$	Temperature of test	23°C	Beginning of the test	End of the test

### Measurement Cycle for Brinell Hardness Scales



## 6. Uncertainty Evaluation

Before the measurements, each participant laboratory shall carry out the calibration of the hardness standardizing machine 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
- diameter of the indenter
- application time of test force
- duration of the total force
- 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.

Institute/Country	Lab	Date of measurements
UME, Turkey	Participant	September, 2019
INRIM, Italy	Pilot	October, 2019
PTB, German	Participant	November, 2019
UME, Turkey	Participant	December, 2019

## 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 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. 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 6506-1: 2014, Metallic Materials – Brinell Hardness Test - Part1: Test Method
- [2]EN ISO 6506-3: 2014, Metallic Materials - Brinell 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.**

**HBW1/30 Scale**

		Block Serial No			Temperature		
		Lens/NA			Indenter Serial No		
No	dh / mm	dv / mm	d <sub>mean</sub> / mm	d <sub>mean</sub> / mm	HBW 1/30	HBW 1/30 <sub>mean</sub>	Uncertainty / HBW1/30
1							
2							
3							
4							
5							

		Block Serial No			Temperature		
		Lens/NA			Indenter Serial No		
No	dh / mm	dv / mm	d <sub>mean</sub> / mm	d <sub>mean</sub> / mm	HBW 1/30	HBW 1/30 <sub>mean</sub>	Uncertainty / HBW1/30
1							
2							
3							
4							
5							

		Block Serial No			Temperature		
		Lens/NA			Indenter Serial No		
No	dh / mm	dv / mm	d <sub>mean</sub> / mm	d <sub>mean</sub> / mm	HBW 1/30	HBW 1/30 <sub>mean</sub>	Uncertainty / HBW1/30
1							
2							
3							
4							
5							

### HBW2,5/187,5 Scale

Block Serial No					Temperature		
Lens/NA					Indenter Serial No		
No	dh / mm	dv / mm	d <sub>mean</sub> / mm	d <sub>mean</sub> / mm	HBW 2,5/187,5	HBW 2,5/187,5 <sub>mean</sub>	Uncertainty / HBW2,5/187,5
1							
2							
3							
4							
5							

Block Serial No					Temperature		
Lens/NA					Indenter Serial No		
No	dh / mm	dv / mm	d <sub>mean</sub> / mm	d <sub>mean</sub> / mm	HBW 2,5/187,5	HBW 2,5/187,5 <sub>mean</sub>	Uncertainty / HBW2,5/187,5
1							
2							
3							
4							
5							

Block Serial No					Temperature		
Lens/NA					Indenter Serial No		
No	dh / mm	dv / mm	d <sub>mean</sub> / mm	d <sub>mean</sub> / mm	HBW 2,5/187,5	HBW 2,5/187,5 <sub>mean</sub>	Uncertainty / HBW2,5/187,5
1							
2							
3							
4							
5							