Swedish Metrology and Quality AB

Accred. no. 10436
Proficiency testing
ISO/IEC 17043

To participants

Final Report on an interlaboratory comparison (ILC) of the calibration in the force area part 2 position of the beam

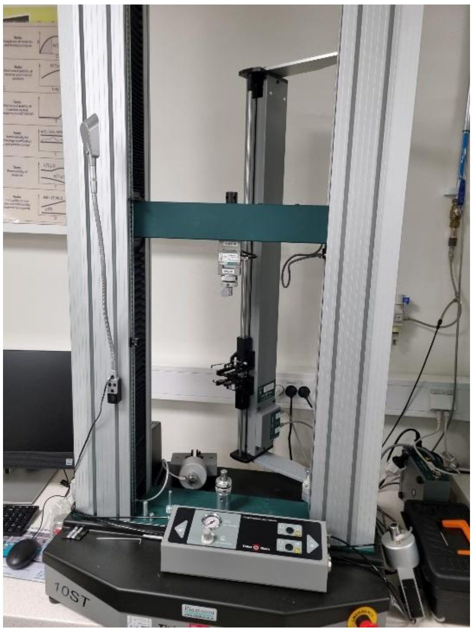
There a more separate part:

Part 1 force tension and compression

Part 3 speed of beam

Part 4 Extensometer

Material testing machine



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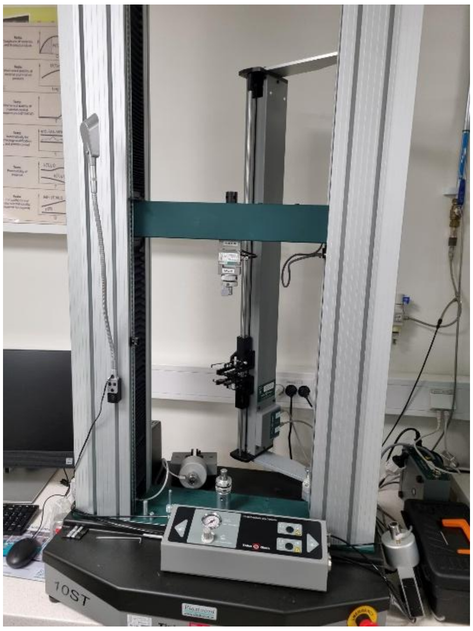
Content



Abstract

This interlaboratory comparison was conducted to verify and evaluate the calibration results produced by participating calibration laboratories, in accordance with the requirements of ISO/IEC 17025:2017 and the principles of ISO/IEC 17043:2023. The comparison focused on the calibration of the cross-section displacement measurement of a universal tensile testing machine with a measuring range of 10 kN. The participants used their own software and calibration procedures, while a defined subset of calibration points was selected for evaluation.

Reference measurements were performed using a laser interferometer with a resolution of 0.0001 mm under control of environmental conditions. Measurement results from the participants were assessed against assigned reference values using the En-value approach, which normalizes the deviation between participant results and reference values with respect to the combined expanded uncertainties.

The comparison comprised 51 evaluated calibration points. Several participants demonstrated satisfactory technical competence, with En-values within the acceptance criterion |En| < 1. However, 25 En-values exceeded this limit, indicating deviations larger than expected from the stated uncertainties. Limitations related to the magnitude of the reference uncertainty were identified and are discussed in the report.

Overall, the intercomparison provides objective evidence of calibration performance and supports the assessment of laboratory competence for accreditation purposes.

Purpose and implementation of the comparison

This interlaboratory comparison serves as a tool to verify results from the measurement carried out by calibration laboratories. It is an effective method to demonstrate technical capacity of the participant and serves as a technical base for accreditation as required by ISO/IEC 17025:2017 (SS-EN ISO/IEC 17025:2018) as specified in point 7.7.2.

Information about the testing machine that was calibrated

Tinius Olsen, model DBBSTOL-10kN-08-1035, serial no. AP46115.
Universal testing machine, model 5ST Series, serial no. ST-AFR-02589GB.
PC with Horizon Software, version 10.3.0.7. –
Cable belonging to the object and system.
Measuring range 10 kN compression and tension

Participants in the intercomparison

Details are given in part 1 of the report

Calibration instructions

Details are given in part 1 of the report

Cross section measurement beam--*Agreed calibration points*

Distance in mm
1
2
3
4
10
20
30
50
100
200
500
1000

The participants calibrated according to their software as they were using the same software but only the described points were evaluated as a part of this project.

Planning and instruction details

The participants were asked to send calibration certificates to the organiser after finishing the calibration.

The evaluator uses the principles of the ISO/IEC 17043:2023 in the reporting.

Administrative information

Address to send the required documents:
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Reference calibrations

The positioning of the tensile testing machine was calibrated with a laser interferometer. The reflector was mounted on the machine's moving beam, and the beam splitter was mounted on the machine's lower base. The resolution was set to 0.0001 mm.

The equipment was set to zero when the machine's fixed scale was in position 230 mm.

From this position, five measurements series were performed in steps according to the results table. The temperature of the measuring machine was measured with two temperature sensors placed on the machine's lower base and on the back of the left column.

The environmental parameters room temperature, relative humidity and air pressure were used to calculate the refractive index of the air.

The results have not been corrected for the temperature of the object.

Reference calibration certificate

105101–1337162-K01 Rev 1

Analysis of the calibration results

The evaluator used the principles in the ISO/IEC 17043:2023.

As an easy-to-understand measure to judge each participant result. Its distance to the assigned reference value is used, normalized with respect to the uncertainty in this difference. This measure En-value is calculated for every force according to equation (1).

$$En_{,} = \left| \frac{x_{i,} - x_{ref,}}{\sqrt{U_{i,}^2 + U_{ref,}^2}} \right|$$

x_i: Single measurement result (deviation from nominal value); index *i* and *j* count the various participants

x_{ref}: Assigned inter-comparison reference value.

U_i: The estimated expanded uncertainty (k=2) stated by each laboratory.

U_{ref}: The estimated expanded uncertainty (k=2) of the assigned reference value.

En_i: The calculated En-value for each participant i.

The principle of the intercomparison

An absolute value of E_n of less than |1| is often used as a criterion for an acceptable measurement quality, according to ISO/IEC 17043:2010, B.4.1.1. It means a reported deviation x_i from the nominal mass value by a participant does not deviate more from the assigned reference comparison value x_{ref} than what can be expected from the calculated uncertainty in this difference.

$$E_n < 1: \quad |x_i - x_{ref}| < \sqrt{U_i^2 + U_{ref}^2}$$

However, to make this measure a reliable one for an inter-comparison the reference U_{ref} must be small enough not to contribute significantly to the right side of equation 4. Due to the quadratic combination ideally U_{ref} should be in the range of 1/3 of U_i. That was not possible in this case

Measuring results on calibration

The following tables and diagrams present the deviation of indication along with the stated measurement uncertainty for each calibration point and the related reference values.

Cross Section measurement

Beam distance	Table 1	1 mm	
Identification	Error µm	Uncertainty µm	En value
1	5,5	8,8	0,24
5	-2,3	3,0	1,10
7	-0,7	2,5	0,83
9	1,2	4,9	0,32
10	0,4	3,4	0,53
	Ref error	Ref Uncertainty	
	3,2	4,0	

Beam distance	Table 2	2 mm	
Identification	Error µm	Uncertainty µm	En value
1	5,6	5,2	0,34
6	-3,6	2,6	1,47
7	-0,1	5,0	0,55
9	-2,4	4,9	0,92
10	-5,8	3,9	1,65
	Ref error	Ref Uncertainty	
	3,4	4,0	

Beam distance	Table 3	3 mm	
Identification	Error µm	Uncertainty µm	En value
1	8,9	8,3	0,23
6	-2,8	3,9	1,72
7	0,1	7,5	0,79
9	-1,7	4,8	1,36
10	-3,7	6,1	1,44
	Ref error	Ref Uncertainty	
	6,8	4,0	

Beam distance	Table 4	4 mm	
Identification	Error µm	Uncertainty µm	En value
1	15,6	18	0,49
5	2,3	3	0,86
6	1,8	5,2	0,73
7	0,2	10	0,59
9	-1,6	4,8	1,31
10	-1,0	16	0,46
	Ref error	Ref Uncertainty	
	6,6	4,0	

Beam distance	Table 5	10 mm	
Identification	Error µm	Uncertainty µm	En value
1	31,6	23	1,07
5	2,0	3	0,91
6	1,8	13	0,35
7	0,4	25	0,24
9	-2,0	3,8	1,54
10	-0,1	23	0,29
	Ref error	Ref Uncertainty	
	6,6	4,1	

Beam distance	Table 6	20 mm	
Identification	Error µm	Uncertainty µm	En value
1	53,3	26	1,72
5	2,2	3	1,10
6	0,0	26	0,30
7	3,6	50	0,09
9	-6,5	3,4	2,66
10	-9,7	16	1,06
	Ref error	Ref Uncertainty	
	7,9	4,2	

Beam distance	Table 7	30 mm	
Identification	Error µm	Uncertainty µm	En value
1	71,7	18	3,35
6	0,2	39	0,24
7	5,3	75	0,06
9	-10,0	7	2,40
10	-17,8	6,5	3,53
	Ref error	Ref Uncertainty	
	9,7	4,3	

Beam distance	Table 8	50 mm	
Identification	Error µm	Uncertainty µm	En value
1	85,1	16	4,20
5	6,8	3	1,57
6	-3,0	65	0,28
7	9,1	125	0,05
9	-4,5	3,8	3,36
10	-22,6	5	5,63
	Ref error	Ref Uncertainty	
	15,3	4,5	

Beam distance	Table 9	100 mm	
Identification	Error µm	Uncertainty µm	En value
1	108,5	15	5,27
5	21,7	4	0,53
6	-9,6	130	0,27
7	38,2	250	0,05
9	1,0	3,7	3,87
10	-20,3	4,2	6,95
	Ref error	Ref Uncertainty	
	25,1	5,0	

Beam distance	Table 10	200 mm	
Identification	Error µm	Uncertainty µm	En value
1	261,1	20	10,32
5	48,7	6	0,37
7	33,4	500	0,02
	Ref error	Ref Uncertainty	
	45,6	6,0	

Beam distance	Table 11	500 mm	
Identification	Error µm	Uncertainty µm	En value
1	589,7	13	30,59
5	108,5	15	0,14
7	94,8	1250	0,01
	Ref error	Ref Uncertainty	
	106,1	9,0	

Equipment used during the calibrations by participants

Some laboratories explain that they use gauge blocks.

Some laboratories explained that they used gauge blocks in combination wit other specialised equipment

Final conclusions

In this inter comparison several of the participants could demonstrate a convincing capacity to calibrate and give relevant values in relationship to their uncertainties.

In the intercomparison documents 51 calibration points and 25 En values are higher than 1.

Acknowledgement

Elastocon AB that allowed us to use the machine on their site during the process

Primary laboratory RISE, National Reference laboratory of Sweden

References:

- ISO/IEC 17043:2023 Conformity assessment – General requirements for proficiency testing
- ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories
- ISO 13528 Statistical methods for use in proficiency testing by interlaboratory comparison
- Evaluation of measurement data – Guide to the expression of uncertainty in measurement, GUM (JCGM 100:2008)
- EA-4/02 M:2013 Evaluation of Uncertainty of Measurement in Calibration
- International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM)
- ISO 7500-1:2018 calibration of force machines
- ISO 9513:2012 calibration of extensometers